Ohio Department of Transportation

FREIGHT STUDY

Strategic Plan - Final

January 22, 2018





DEL-23/36/42 Freight Corridor Study
PID No. 100104

MOTT MACDONALD

US 23/36/42 Freight Study

Final Strategic Plan

January 22, 2018

DEL-23/36/42 Freight Corridor Study
PID No. 100104

Prepared for:

Ohio Department of Transportation
District 6
400 E. William Street
Delaware, Ohio 43015

Prepared by:

MOTT MACDONALD

Table of Contents

Introduction 1
Stakeholder Outreach 2
Existing and Future Conditions Assessment 4
Needs and Conditions Assessment 6
Goods Movement Analysis 8
Economic Impact Assessment 9
Benefit Cost Analysis 11
Evaluation of Proposed Improvements 14
Evaluation Metrics 17
Evaluation Matrix and Final Rank 18
Funding 20

List of Figures

Figure 1- Study Limits 1
Figure 2- Stakeholder Map 2
Figure 3- Transportation and Distribution Facility Trends in Ohio 8
Figure 4- Goods Movement Index for Ohio and Study Area 10
Figure 5- SR 37 Segment near US 42 15

List of Tables

Table 1- Stakeholder List 3
Table 2- Locations Evaluated in the Existing and Future Conditions Analysis 5
Table 3- Locations Evaluated in the Needs and Conditions Analysis 7
Table 4- Top 5 Proposed Improvements by Benefit-Cost Ratio 13
Table 5- Recommended Improvement by Location 16
Table 6- Top 5 Recommended Improvements by Final Rank 18
Table 7- Evaluation Matrix Dashboard View 19

Appendices

Appendix A- Proposed Improvement Cost Estimates
Appendix B- Benefit Cost Analysis
Appendix C- Safety Priority Rank Summary

Introduction

Overview

The purpose of the Delaware County US 23/36/42 Freight Study is to evaluate the study-specific corridors and their ability to safely and efficiently move goods. The US 23, US 36, SR 37, and US 42 corridors have been identified by the Ohio Department of Transportation (ODOT) as routes critical to freight movement locally, in the State of Ohio, and beyond. Recognizing the role these highways serve as critical freight routes, this freight study is designed to identify improvements that address the operational needs of the corridors.

The three major reports completed as part of this Freight Study previous to this report were the (1) *Stakeholder Outreach Summary*, (2) *Existing and Future Conditions Report*, and (3) *Needs and Conditions Report*. This Strategic Plan is the final report in this series of deliverables. The plan documents and summarizes work performed to date, but is also intended to serve as a succinct planning document that identifies and prioritizes incremental enhancements that support the safe and efficient flow of freight along the US 23, US 36, SR 37, and US 42 corridors.

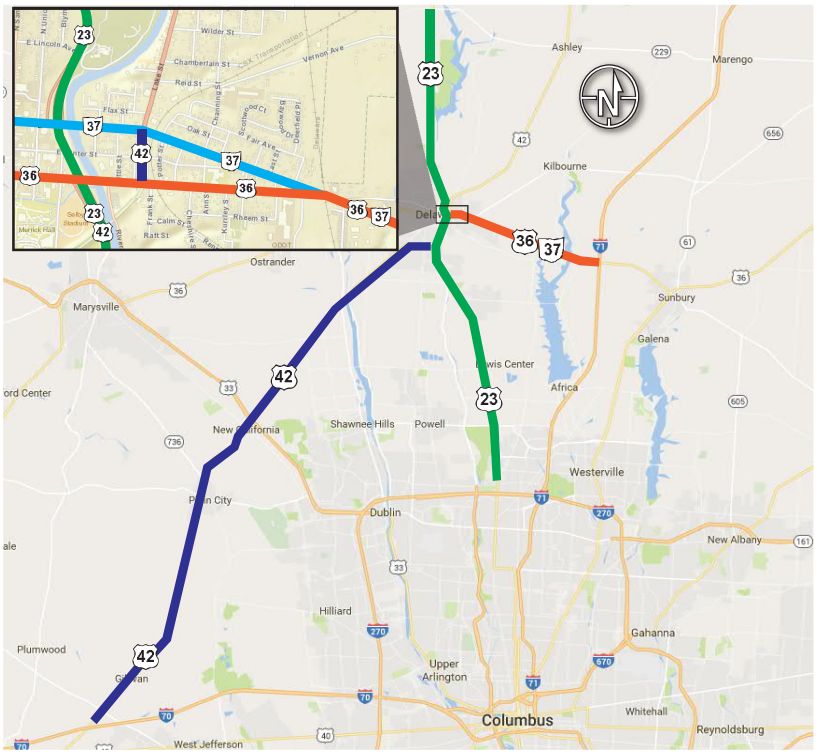
This Strategic Plan provides an overview of the methodology, as applied to the study routes, and summarizes the collaboration, stakeholder outreach, technical and other analyses used to arrive at a discrete list of recommended improvements.

Background

This freight study was born out of *Access Ohio 2040*, the State of Ohio's long range transportation plan. *Access Ohio 2040* recognized that Ohio's non-interstate routes are a critical part of Ohio's freight network, particularly for intrastate freight and truck movements. *Access Ohio 2040* also identified a high priority freight network of strategic corridors known as the Strategic Transportation System (STS). The STS is a large network of 22 critical transportation corridors that serves as the backbone of Ohio's freight infrastructure. The study routes of US 23, US 36, SR 37, and US 42 were identified on this list of critical transportation corridors. The study area for this Strategic Plan is shown in Figure 1. The total mileage of all routes is approximately 60 miles. The study limits are as follows:

- US 23: Franklin County to Marion County (21.4 miles)
- US 36: US 23 to I-71 (7.6 miles)
- SR 37: US 23 to US 36 (1.0 mile)
- US 42: I-70 to SR 37 (29.5 miles)

Figure 1 - Study Limits



Methodology

The basis for this study was the *STS 2-Lane Operational Improvement Study Methodology* produced through the ODOT Office of Statewide Planning and Research (dated February 3, 2017).

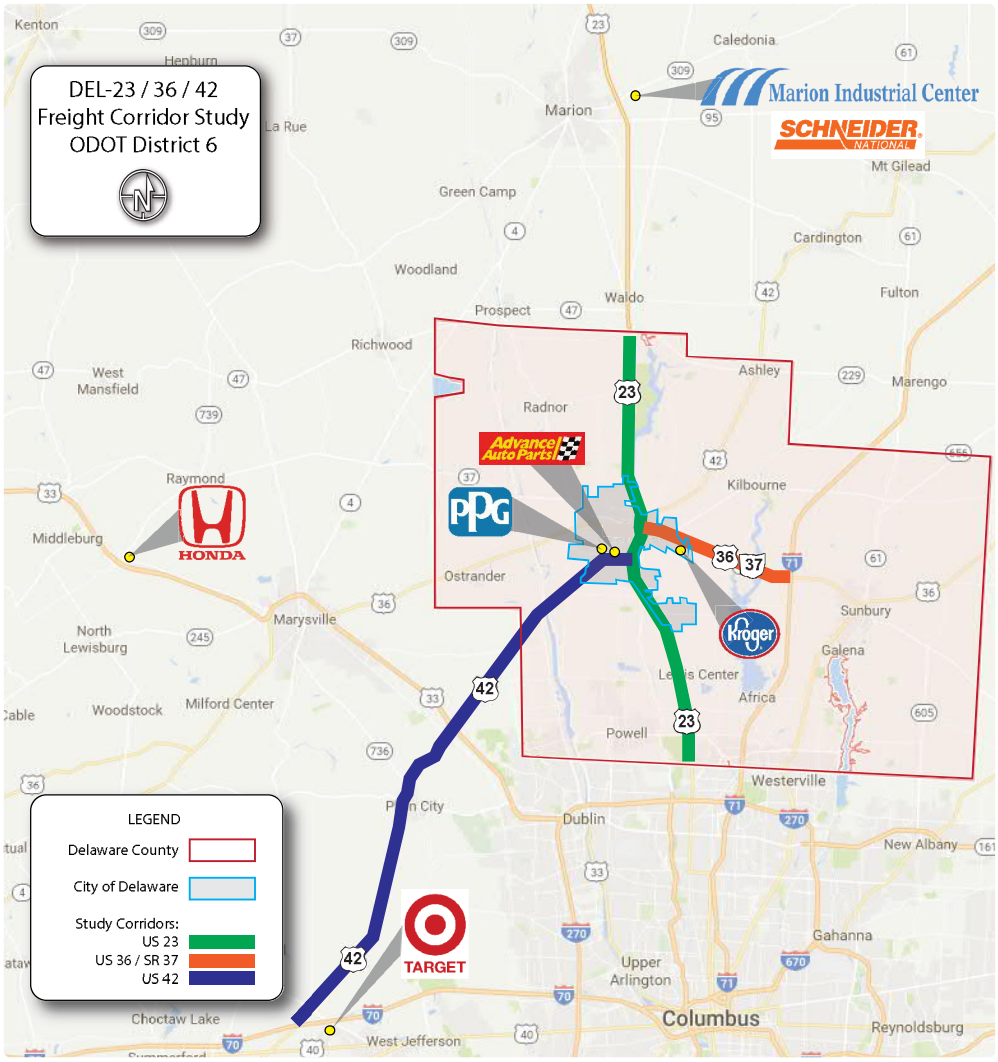
Recognizing the variability between study corridors, the methodology has a built-in mechanism which allows for adjustments and refinements to suit the specific needs of a given corridor and therefore the methodology for this study was an adaptation of the STS 2-Lane methodology.

Stakeholder Outreach

Stakeholder outreach was conducted with the goal of gaining local perspectives into freight operations along the US 23/36/42 freight study corridors. Representatives from ODOT and Mott MacDonald met early on with several targeted stakeholders and conducted in-person interviews to obtain their firsthand knowledge of the study area, and to identify locations of interest along the study corridors for incorporation into each phase of the study.

The team met with a range of freight mobility stakeholders including intermodal and warehouse facility managers, freight logistics companies, manufacturers, distributors, and public agencies. The team also made sure to engage stakeholders from throughout the study region, shown in Figure 2, to ensure that stakeholder input was received for each study corridor.

Figure 2 - Stakeholder Map



The study team completed eight in-person interviews with 15 stakeholders between April and August of 2016. Seven stakeholders represented the trucking industry, and eight represented local and state public agencies, shown in Table 1. All interviews were documented and a standard survey instrument was developed to help facilitate discussion between the team and stakeholders.

Table 1 - Stakeholder List

Representing Trucking Industry	Representing Public Agencies
Marion Industrial Center	City of Delaware
Schneider	Delaware County
Advance Auto Parts	Delaware County Economic Development
Target	Delaware County Engineer
Honda	ODOT D6 Planning & Engineering
Kroger	ODOT Union County Manager
PPG	ODOT Delaware County Manager
	Delaware Now

In the interviews, trucking industry stakeholders described their operations, inbound and outbound truck activity, typical freight routes, and highlighted any known issues that existed along their freight routes. Recurring themes identified by these stakeholders included narrow lanes, congestion along corridors, sharp turns, and overall network connectivity. Specifically identified locations included the US 36/SR 37 split ("The Point"), the I-71/US 36 and US 42/US 33 interchanges, and the US 23 northbound interchange with US 36.

Additional input was received from ODOT and other public agency stakeholders. Public agency input was valuable to the study, providing the study team with their local knowledge of the study area, including roadway information, traffic patterns, and known travel paths. They also shared known safety and congestion hot spots for incorporation into the study. This input led to additional study locations such as the spur of SR 37 from US 23 to US 36.

Stakeholder input was essential in determining a list of critical locations along the study corridors. In total, the stakeholder outreach process produced 18 locations for future study, as documented in the *Stakeholder Outreach Summary (dated January 6, 2017)*. These locations were carried forward to the *Existing and Future Conditions Report* where specific metrics were used to confirm the existence of issues preventing the safe and efficient movement of goods throughout the study area.

Existing and Future Conditions Assessment

The purpose of the existing and future condition assessment was to confirm the presence of issues at the locations carried forward from the stakeholder outreach efforts, and to identify any new locations where issues may impact freight movements through the study corridors. An *Existing and Future Conditions Report (dated June 19, 2017)* was completed to summarize the analysis of several factors, including Safety, Traffic Operations, Geometry, and Physical Conditions. A summary of each is below:

Safety



ODOT's GIS Crash Analysis Tool (GCAT) was used to initiate spatial queries of each corridor for a high-level safety assessment. Detailed analyses were completed for locations that were identified as high crash locations, identified by stakeholders as a perceived high crash location, and/or locations that appeared on an ODOT or Mid-Ohio Regional Planning Commission (MORPC) safety priority list.

Traffic Operations



Focus intersections were analyzed using the Highway Capacity Manual (delays) and Synchro (queues). Delays were measured against acceptable Level of Service (LOS) thresholds of LOS D or better. At locations where existing traffic counts were unavailable, the study team conducted turning movement counts.

Geometry



Geometric analyses included examining existing lane and shoulder widths, horizontal and vertical curvature, horizontal and vertical clearances, intersection angle, turning radii, and sight distances. Analysis was completed at locations where geometric constraints were most likely to impact the movement of freight, utilizing a WB-62 design vehicle.

Physical Conditions



Physical condition assessments included evaluating pavement conditions along each study corridor and any structures carrying or passing over individual study corridors. The study team used ODOT data to identify locations with a Pavement Condition Rating (PCR) of 65 or below, and any structures with a General Appraisal of less than five or a Load Rating of less than 150% of the Ohio Legal Limit.

ODOT requested those locations that only exhibited an identified physical conditions issue be removed from further analysis. The reason was that all locations that fit this criteria where already accounted for through other ODOT improvement programs.

Following the analysis of each study corridor, 12 additional locations were added to the original list of 18 stakeholder identified locations, bringing the total number of locations for study to 30. These 30 locations are shown in Table 2. Each of these study locations was presented in detail in the *Existing and Future Conditions Report*. Stakeholder identified issues are shown, along with those confirmed by Mott MacDonald. Study locations that either a) had a confirmed safety, traffic operations, or geometric issue or b) where existing projects or studies were not already in progress were carried forward for detailed analysis and improvement identification in the *Needs and Conditions Report*.

Table 2 - Locations Evaluated in the Existing and Future Conditions Analysis

						Stakeholder Identified					Confirmed				
ID	County	Route	Log Point	Location	Type	Traffic Operations	Safety	Geometry	Physical Condition	Other	Traffic Operations	Safety	Geometry	Physical Condition	Other
1	DEL	US 23	0.00-10.63	DEL line to US 42	Segment	✓					✓	✓			
2	DEL	US 23	11.89	US 36	Interchange	✓		✓			✓		✓		
3	DEL	US 23	12.12	SR 37	Interchange	✓					✓	✓			
4	DEL	US 23	13.86	Panhandle Rd	Intersection							✓			
5	DEL	US 23	14.20	Big Lots/McDonald's	Intersection		✓					✓			
6	DEL	US 23	14.37	Hills-Miller Rd	Intersection	✓	✓								
7	DEL	US 23	16.25 -21.42	along Delaware Lake	Segment					✓				✓	
8	DEL	US 23	21.42	SR 229 (Norton)	Intersection	✓	✓					✓			
9	DEL	US 36	10.39 - 17.95	US 23 to I-71	Segment	✓	✓				✓	✓			
10	DEL	US 36	10.62	US 42 (Lake St)	Intersection	✓		✓			✓	✓	✓		
11	DEL	US 36	10.63	Bike Path	Structure									✓	
11	DEL	US 36	10.66	CSX Railroad	Structure									✓	
12	DEL	US 36	11.26	"The Point" (36/37)	Intersection	✓	✓	✓			✓	✓	✓	✓	
12	DEL	US 36	11.26	NS Railroad	Structure									✓	
13	DEL	US 36	11.70	SR 521	Intersection	✓					✓	✓			
14	DEL	US 36	14.85	Lackey / CR 10	Intersection							✓			
15	DEL	US 36	15.99	CR 10A / N Old State Rd	Intersection		✓					✓			
16	DEL	US 36	17.07	Africa Rd	Intersection							✓			
17	DEL	US 36	17.95	I-71	Interchange	✓	✓	✓			✓	✓			
18	DEL	SR 37	10.48 - 11.44	US 23 to US 36	Segment	✓	✓	✓			✓	✓	✓		
19	DEL	SR 37	10.81	US 42 (Lake St)	Intersection	✓	✓	✓			✓	✓	✓		
20	DEL	SR 37	11.03	Channing St	Intersection			✓				✓	✓		
21	MAD UNI DEL	US 42	12.81 - 25.15 0.00 - 9.89 0.00 - 7.29	I-70 to London Rd	Segment			✓					✓		
22	MAD	US 42	12.98	I-70	Interchange							✓			
23	UNI	US 42	0.11	SR 161	Intersection	✓									
24	UNI	US 42	4.20	Industrial Parkway	Intersection			✓				✓	✓		
25	UNI	US 42	4.58	US 33	Interchange	✓	✓				✓	✓			
26	DEL	US 42	1.56	SR 257 / SR 745	Intersection	✓		✓				✓	✓		
27	DEL	US 42	2.13	SR 257 / Riverside	Intersection	✓		✓				✓	✓		
28	DEL	US 42	3.25	S. Section Line Rd	Intersection	✓									
29	DEL	US 42	4.87	Sawmill Pkwy	Intersection										
30	DEL	US 42	7.28	US 23	Intersection			✓					✓		

Needs and Conditions Assessment

The purpose of the needs and conditions assessment was to correlate potential improvements to the confirmed issues identified in the *Existing and Future Conditions Report*, with an emphasis on incremental operational and safety improvements for freight traffic.

Locations where proposed improvements were previously determined, or locations where studies were already in progress were not analyzed in this report, but were still carried through to the Strategic Plan. The final product was a *Needs and Conditions Report (dated November 6, 2017)* aimed at identifying low cost improvements at locations where potential improvements had not yet been identified.

Mott MacDonald evaluated potential improvements using the same quantitative metrics used in the *Existing and Future Conditions Report*, in the categories of Safety, Traffic Operations, and Geometrics.







Qualitative metrics were applied when specific metrics did not apply, or where safety and/or operational benefits were expected but not quantifiable. Additionally, all potential improvements had to specifically enhance the flow of freight traffic without negatively impacting adjacent routes or relocating an identified issue.

Of the 30 locations identified in the *Existing and Future Conditions Report*, 11 locations were not analyzed in the Needs and Conditions Report. Generally, these locations were not analyzed because improvements had already been identified by ODOT and/or funded through other means.

For the remaining 19 locations, each was assigned at least one potential improvement, with most locations having more than one potential improvement. Each potential improvement addressed one or more of the confirmed issues at the location, was expected to enhance freight flow, and was not expected to negatively affect adjacent routes or shift issues elsewhere. Table 3 shows a list of all locations carried forward into the Needs and Conditions Report, along with a chart of potential improvements at each of these locations.

A preliminary recommendation was made based off all the information gathered at the time of the report, specifically including stakeholder feedback, existing conditions data, and a thorough evaluation of the performance metrics in the categories noted above.

The improvements and preliminary recommendations of the *Needs and Conditions Report* are carried forward into this Strategic Plan. These recommendations, in combination with cost/benefit metrics developed from the Economic Analysis, Goods Movement Analysis, and additional stakeholder feedback were used to develop final recommendations for incremental safety and operational improvements at locations along the study corridors.

Table 3 - Locations Evaluated in the Needs and Conditions Analysis

						Confirmed Issues					Potential Countermeasures									
ID	County	Route	Log Point	Location	Type	Traffic Operations	Safety	Geometry	Physical Condition	Other	Upgrade Signage/Striping	Improve Signal Operation	Improve Turn Radius	Turn Lane Improvements	Signal Improvements	Reconfigure Intersection	Pavement Improvements	Widen Roadway	Bridge Improvement	Interchange Improvement
2	DEL	US 23	11.89	US 36	Interchange	✓		✓				✓	✓			✓			✓	✓
3	DEL	US 23	12.12	SR 37	Interchange	✓	✓					✓					✓			
4	DEL	US 23	13.86	Panhandle Rd	Intersection		✓				✓	✓								
5	DEL	US 23	14.20	Big Lots/McDonald's	Intersection		✓				✓	✓			✓					
6	DEL	US 23	14.37	Hills-Miller Rd	Intersection						✓	✓			✓					
8	DEL	US 23	21.42	SR 229 (Norton)	Intersection		✓				✓	✓		✓	✓	✓				
9	DEL	US 36	10.39 - 17.95	US 23 to I-71	Segment	✓	✓													
14	DEL	US 36	14.85	Lackey / CR 10	Intersection		✓				✓									
15	DEL	US 36	15.99	CR 10A / N Old State Rd	Intersection		✓				✓			✓						
16	DEL	US 36	17.07	Africa Rd	Intersection		✓				✓			✓						
18	DEL	SR 37	10.48 - 11.44	US 23 to US 36	Segment	✓	✓	✓			✓							✓		
19	DEL	SR 37	10.81	US 42 (Lake St)	Intersection	✓	✓	✓				✓	✓	✓		✓		✓		
20	DEL	SR 37	11.03	Channing St	Intersection		✓	✓			✓				✓	✓				
22	MAD	US 42	12.98	I-70	Interchange		✓					✓			✓	✓				✓
24	UNI	US 42	4.20	Industrial Parkway	Intersection		✓	✓					✓	✓		✓				
25	UNI	US 42	4.58	US 33	Interchange	✓	✓							✓	✓	✓				✓
26	DEL	US 42	1.56	SR 257 / SR 745	Intersection		✓	✓			✓		✓	✓		✓				
27	DEL	US 42	2.13	SR 257 / Riverside	Intersection		✓	✓					✓	✓		✓				
30	DEL	US 42	7.28	US 23	Intersection			✓			✓									

Goods Movement Analysis

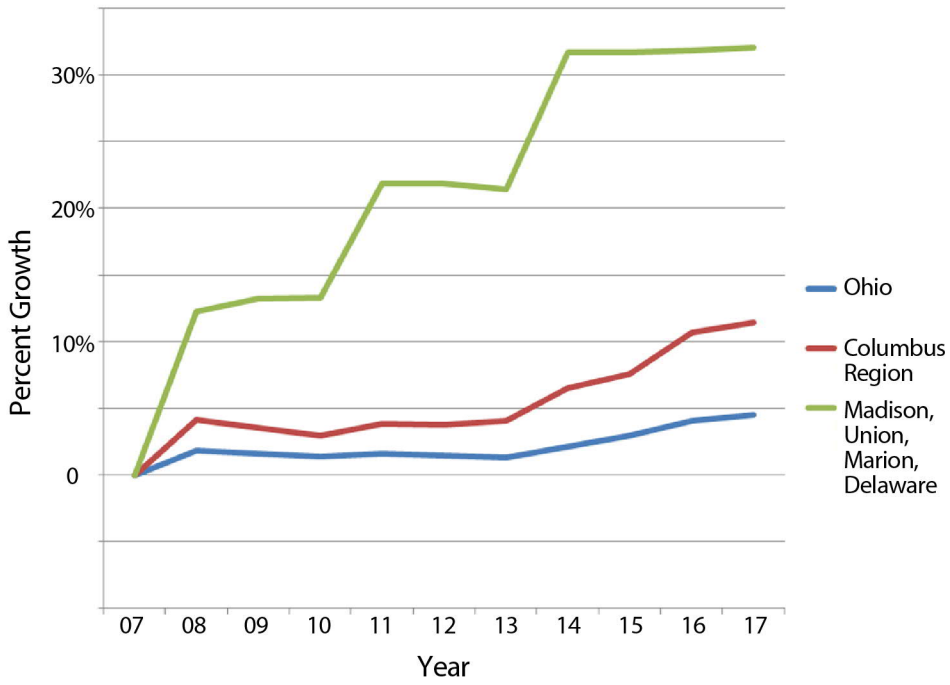
Analysis of goods movement was deemed critical to identify how national and regional goods movement and land use trends relate to the study area. Identifying how freight moves through the study area is helpful when prioritizing specific corridors or locations for improvements.

The Goods Movement Analysis report identified that Central Ohio relies heavily on highways, and that highway usage is dominant in this region because of Columbus' central location within a 10-hour drive of nearly 50% of the US population and manufacturing capacity.

Nationally, according to data from the USDOT Bureau of Transportation Statistics, 70% of individual freight movements cover less than 250 miles, and of those movements, approximately 80% occur by truck. Feedback obtained during the stakeholder outreach period of the report corroborate these statistics locally within the study area. Many of the goods movement stakeholders reported that their goods travel by truck roughly within a 250-mile radius from the study area that reaches into the States of Michigan, Indiana, Kentucky, Western Pennsylvania and New York.

In terms of land usage, real estate data shows growth in transportation and distribution facilities is increasing throughout the State of Ohio, with 4% total growth from 2007 to 2017. Central Ohio as a region saw 11% growth over the same period. When examined at the county level, study area growth is up 32% over the 2007 to 2017 period, shown in Figure 3, further emphasizing the significance of goods movement in the study area.

Figure 3 - Transportation and Distribution Facility Trends in Ohio



Data from the goods movement analysis was summarized in the *Goods Movement Analysis Memo (dated October 20, 2017)* and is incorporated into this Strategic Plan. Specifically, the trends related to goods movement, transportation and distribution facilities, and land use were incorporated into qualitative assessments, and the evaluation and prioritization of potential improvements.

Economic Impact Assessment

The Economic Impact Assessment illustrates the economic relationship between each zip code in the study area and the goods movement industry. By identifying which zip codes rely more heavily on the goods movement industry than others, the potential economic benefits of a given improvement over another can be quantified and prioritized by stakeholders.

The zip-code level analysis identified specific regions within the study area that were more dependent on the efficient movement of goods compared to others, and relied on three data sources:

1. IMPLAN, an input-output software package that can assess and compare the relationship between goods movement related industry sectors and total industry consumption at the zip code level.

2. Metrics including Census population data, Census employer-household dynamics data, and real estate data to understand the size and orientation of goods movement related sectors at the zip code level in the study area.

3. Truck trip destination data provided by ODOT summarizing the volume of daily truck origins and destinations aggregated by zip code.

These data were combined to develop a goods movement index for each zip code in the study area that reflect a zip code's relative dependence on the Goods Movement industry (on a scale from 6 to 36). Higher scores reflect a higher overall dependence on the Goods Movement industry compared to the other zip codes within the study area, and are represented by darker colors on the map in Figure 4.

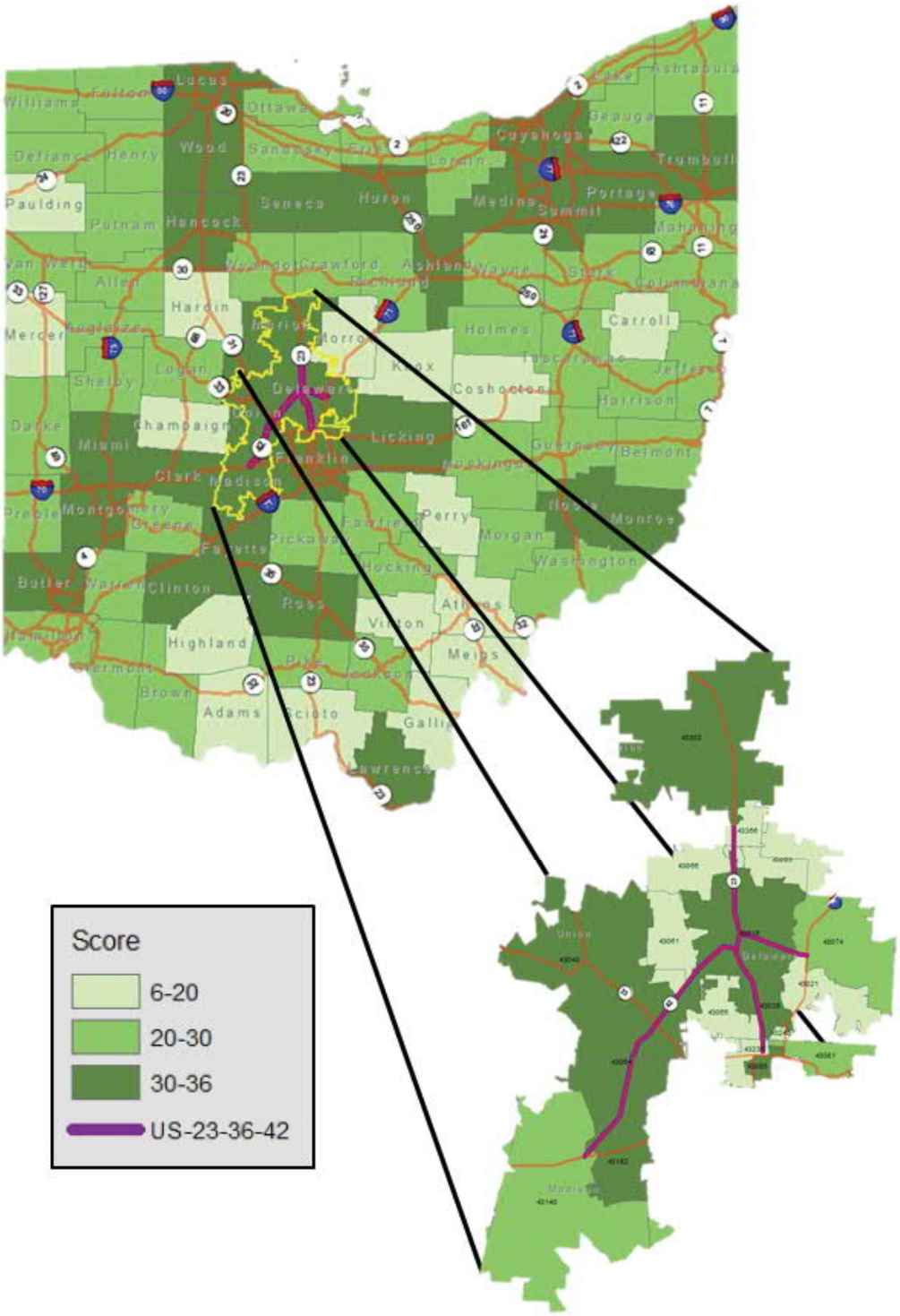
Also in Figure 4, county level data for the entire state, collected as part of the *VAR-STW-STS 2-Lane Operational Improvement Study (PID 97881)* is shown along side the zip code level results for the study area. Areas of darker shades of green are those that are more dependent on the goods movement industry, while areas that are lighter shades of green are less dependent. The zip code influence area for the US 23/36/42 study is outlined in yellow, and the study corridors are shown in purple.

The results of the economic impact assessment show that the areas along the study corridors are highly dependent on the safe and efficient movement of goods, on both the county and zip code level. The zip code of the City of Delaware (43015) scored highly in terms of economic dependence on the goods movement industry.

The analysis was supplemented by a spreadsheet tool that can be calibrated to weigh metrics differently based on region specific conditions. The results can be calibrated, for example, to weigh commercial real estate metrics higher than truck trip metrics. The results shown in this study reflect equal weight to all metrics.

The results of the economic impact assessment were summarized in the *Economic Analysis Memo (date July 24, 2017)* and are incorporated into the Strategic Plan. The results are used in the evaluation and prioritization of proposed improvements for the study area. The calibration tool has also been incorporated into a comprehensive evaluation matrix, where the user can adjust the weights of various economic metrics to modify the entire data set based on region specific conditions. The evaluation matrix is discussed in more detail later in this report.

Figure 4 - Goods Movement Index for Ohio and Study Area



Benefit Cost Analysis

Purpose

An important metric in the analysis of potential improvements is the Benefit/Cost Ratio (B/C). Mott MacDonald completed a Benefit Cost Analysis (BCA) to quantify and monetize the benefits of a given improvement identified in the *Needs and Conditions Report* in relation to their present day costs. Mott MacDonald compared all proposed improvements against the existing conditions at the location of the proposed improvement.

Costs

Mott MacDonald prepared planning level cost estimates for the proposed improvements carried forward from the Needs and Conditions report for incorporation into the BCA. Costs were estimated for major cost drivers based on ODOT's 2016 Summary of Contracts Awarded. Contingencies, including allowances for design and minor quantities were applied to all proposed improvements except those that could be easily implemented by ODOT forces or incorporated into maintenance projects, such as signage improvements at individual intersections. Mott MacDonald did not include right of way costs as they were not deemed a major cost driver for any of the improvements. Cost estimates are included as Appendix A.

Net Present Value and Discount Rate

To accurately compare proposed improvements, Mott MacDonald annualized costs at a 7% discount rate over the service life of the improvement to determine Net Present Value (NPV). NPV represents the time value of money (i.e. one dollar today is more valuable than one dollar in the future) and is taken to be the current year. For the purposes of this study, the current year was 2017. The 7% discount rate was based on guidance from FHWA for use on federally funded projects (Circular No. A94 from the Federal Office of Management and Budget). The service life of an improvement was determined with guidance provided by FHWA and ODOT and is defined as the estimated number of years before the proposed improvement would need major reinvestment to continue optimum operation. Service life categories on this study included:

- 5 Years – signing and pavement marking changes, upgrades or placing new signs, markings where they were previously not present, etc.
- 10 Years – intelligent traffic systems (radar detection, queue warning, etc.)
- 20 Years – intersection traffic control change (stop to signal or roundabout), pavement resurfacing, pavement widening, etc.

To provide consistency in analyzing proposed improvements, a 20 year analysis period was used to determine NPV. This means that if an improvement had an expected service life of 10 years, the cost of the improvement would occur in year 0 and year 10 and the cost would have to be factored twice throughout the 20 year analysis period.

Benefits

Mott MacDonald identified several categories from which benefits could be quantified and/or monetary value derived. Monetized benefits were derived from improvements in safety and traffic operations. A summary of each is provided below.

Safety Benefits

Safety benefits are derived from a proposed improvement's ability to improve safety, by reducing the number of crashes at a given location and/or reducing crash severity. Mott MacDonald used ODOT's GCAT System to assemble existing crash data along each corridor and at each study location. Existing crash data was input into ODOT's Economic Crash Analysis Tool (ECAT), which uses Highway Safety Manual methodology to determine expected crash frequencies and the potential for safety improvement at existing locations.

Mott MacDonald used ECAT to determine the predicted crash frequencies and overall service life crash reductions of all proposed improvements. ECAT produces a NPV of safety benefits that represents the value of the service life crash reduction based on FHWA guidance. The total dollar value is based on the severity of the crashes reduced. Monetized benefits of reducing one crash of each severity type is as follows:

Fatal and Incapacitating (Serious) Injury: $336,145
Non-Incapacitating Injury: $56,146
Possible Injury: $38,056
Property Damage Only: $8,576

The highest NPV amounts are associated with improvements that reduce the highest severity crashes. Mott MacDonald incorporated the NPV of safety benefits for each improvement as the safety component of the B/C ratio. Other ECAT data, such as the potential for safety benefit at a given study location, and the total number of crashes reduced by a proposed improvement are incorporated into later stages of the Strategic Plan.

Operational Benefits

Operational benefits are derived from the reduction of total travel time produced by a given proposed improvement compared to the existing conditions. Highway Capacity Manual methodology was used to calculate both existing and proposed delays where possible. Mott MacDonald converted the difference in delay between the existing and proposed conditions into an average annual delay for a given study location using the following equation:

Convert average peak hour delay per vehicle (seconds) to annual delay (vehicle hours)...

$$A_p \times V_p \times 5\,\frac{\text{days}}{\text{week}} \times 52\,\frac{\text{weeks}}{\text{year}} \times 1\,\frac{\text{hour}}{3600\ \text{sec}} \times 3.0 = A_y$$

Where,

A_P = average peak hour delay per vehicle (seconds)
V_P = total intersection entering vehicular volume in the peak hour
A_Y = average annual delay (in vehicle hours)

The equation uses five days a week to represent a typical condition of similar weekday peaks per week, Monday through Friday. An expansion factor of 3.0 is used to factor peak hour delay across an entire day.

Mott MacDonald monetized delay reduction using guidance from the U.S. Department of Transportation 2016 Valuation of Travel Time Memorandum to determine the value of the travel time reductions (in dollars per hour) for both passenger cars and trucks as broken down below:

Passenger Vehicle: $14.68
Truck: $27.20

A weighted average of these values was produced for each study location based on the location's truck percentage, as determined through turning movement counts at intersections, or 24-hour counts on segments. Multiplying this by the average annual delay reduction produced a monetized value of annual travel time savings. Service life of the proposed improvement along with a 7% discount rate was incorporated into the calculations to produce the net present value of each proposed improvement's travel time reduction.

Mott MacDonald incorporated the NPV of travel time reduction as the operations component of the B/C ratio. Additional data points produced by the operational analysis, including overall delay reduction and level of service (LOS) are incorporated into later stages of the Strategic Plan.

Benefit Cost Ratio

The safety and operational components of monetary benefits were added to produce the total benefit of a given proposed improvement. Dividing the total benefit by the proposed improvement's cost from the planning level estimate produces a final B/C ratio.

A B/C ratio greater than 1.0 means that the operational and safety benefits of a given improvement are greater than the cost to construct the given improvement, and are ideal improvements to pursue. B/C ratios less than 1.0 are improvements where the total operational and safety benefits do not outweigh the total cost.

Table 4 - Top 5 Proposed Improvements by Benefit-Cost Ratio

Study Location Information					Monetized Benefit	Estimated 20 Year Cost	B/C Ratio
ID	County	Route	Location	Proposed Improvement			
15	DEL	US 36	CR 10A / N Old State Rd	Construct Left Turn Lanes on US 36	$4,041,749	$439,000	9.21
8	DEL	US 23	SR 229 (Norton)	Convert 4 Leg Intersection to RCUT	$1,699,328	$218,000	7.80
10	DEL	US 36	US 42 (Lake St)	William Street Widening	$2,911,016	$695,800	4.17
20	DEL	SR 37	Channing St	Convert 4 Leg Intersection to RI-RO, Install PHB	$872,546	$229,000	3.81
25	UNI	US 42	US 33	Construct Left Turn Lanes on Each Exit Ramp	$3,391,166	$1,242,000	2.73

In total, 11 of the 19 locations analyzed in the Needs and Conditions Report had proposed improvements with quantifiable benefits where a B/C ratio could be calculated. 9 of the 11 proposed recommendations had a B/C ratio greater than 1.0. The top 5 improvements by B/C ratio are shown in Table 4.

The BCA was utilized to identify the improvements that were most likely to positively impact the movement of freight, increase safety, and improve overall operations at each study location. These data are incorporated into the Strategic Plan to assist stakeholders with decision making, and the evaluation and prioritization of improvements throughout the study area. Supporting data for the BCA is included as Appendix B.

Evaluation of Proposed Improvements

The evaluation of proposed improvements began with the identification of confirmed issues in the *Existing and Future Conditions Report*, and continued with an initial list of improvements aimed at improving freight flow for each study location in the *Needs and Conditions Report*. The Benefit Cost Analysis (BCA) took these improvements and monetized the quantifiable safety and operational benefits of each proposed improvement to produce a B/C ratio along with a wide variety of additional evaluation metrics. Locations where future projects were already identified and/or funded did not receive analysis in the BCA, but have been carried through to the evaluation and project prioritization stage of the study.

Several locations had more than one proposed improvement evaluated as part of the BCA. At locations where more than one proposed improvement was evaluated, Mott MacDonald used Economic, Safety, and Operational metrics along with B/C ratios and qualitative assessments to determine which improvement to recommend at a specific location. At several locations, more than one countermeasure was found to have an expected positive benefit on the flow of freight traffic. In these cases, recommended improvements were based on a combination of countermeasures.

Below are discussions of improvements at locations where recommendations relied more heavily on qualitative assessments.

Location 6 – US 23 at Hills-Miller Road

At the US 23 and Hills-Miller Road intersection, Mott MacDonald evaluated both the installation of an eastbound right turn lane, and the replacement of the Prepare to Stop When Flashing (PTSWF) installation with radar detection and signal ahead signage.

An eastbound right turn lane would reduce overall intersection delay and has a quantifiable travel time savings. Replacing the PTSWF installation with radar detection is expected to reduce the risk of high speed rear end crashes and provide dilemma zone protection, however this is difficult to quantify in terms of monetized benefits. Possibly the biggest benefit to replacing the PTSWF installation with radar detection is that it will provide consistency among clearance intervals at other signalized intersections along the US 23 corridor. Mott MacDonald believes that both improvements provide valuable benefits and they have been combined into one recommendation.

Location 8 – US 23 at SR 229 (Norton Road)

At the US 23 and SR 229 (Norton Road) intersection, Mott MacDonald evaluated the addition of left turn phasing to the existing permissive only signal, the conversion of the 4-leg intersection to a partial Restricted Crossing U-Turn (RCUT) intersection, and the conversion to a full RCUT. The existing crash pattern at the intersection indicates potential safety issues, including two fatal crashes (one of which involved a tractor/semi-trailer).

Conversion to permissive/protected operation would provide a safety benefit but would increase overall intersection delay, specifically to freight traffic on US 23. Safety and operational benefits are expected with a partial RCUT due to the removal of US 23 left turns (reducing the risk of left turn and angle crashes) and improving operations for US 23, however it is difficult to quantify its benefits. Mott MacDonald was able to derive safety and operational benefits for the full RCUT. Based on the expected benefits, Mott MacDonald recommends the full RCUT to address freight flow and safety.

Locations 14 and 15 - US 36/SR 37 at Lackey Old State Road/CR 10 and at CR 10A/North Old State Road

At these two unsignalized intersections along US 36/SR 37, ODOT recently completed a safety study and received funding to begin preliminary engineering on intersection alternatives including RCUTs at both locations. Due to the recent completion of this safety study, the results, including the RCUT recommendation, were not fully vetted in our evaluation process. While the RCUT alternative is not fully evaluated in this report, it is expected to provide benefits to freight flow along US 36/SR 37 and therefore should be considered a potential improvement.

Location 18 – SR 37 Segment from US 23 to SR 36

Location 18 is the segment of SR 37 between US 36 and US 23, and is the only direct link between US 36 and US 23 north. The segment serves as a major freight connection in the study area (Figure 5). Mott MacDonald evaluated widening SR 37 to include a center two-way left turn lane (TWLTL). The purpose of this improvement would be to remove left turning vehicles from the through lanes, improving overall operations along the segment. The recommendations along SR 37 could be combined as part of a corridor wide improvement.

Figure 5 - SR 37 Segment near US 42



Location 19 – SR 37 at US 42 (Lake Street)

SR 37 at US 42 is an intersection within the SR 37 study segment. Mott MacDonald evaluated two potential improvements; a roundabout and a realignment of the approach legs through the intersection.

A primary constraint at this location is an active railroad crossing immediately east of the intersection. Given the intersection volumes, specifically high truck percentages, a capacity analysis revealed that a single lane roundabout would not provide operational improvements, and a multi-lane roundabout would be necessary. Due to the likely impacts and physical constraints of the multi-lane roundabout, Mott MacDonald explored the realignment in more detail.

A realignment would improve turning radii, increase the capacity of existing turn lanes, create a new northbound turn lane, and provide for improved pedestrian accommodations. The safety and operational benefits of reconstructing the intersection are difficult to quantify and impacts to utilities and properties are expected. However, this location is a freight bottleneck and Mott MacDonald believes that realigning will provide both safety and operational improvements and therefore recommends this option.

Location 20 – SR 37 at Channing Street

The SR 37 and Channing Street intersection is also located within the SR 37 study segment. At this intersection, Mott MacDonald recommends the conversion of the Channing approaches to right-in, right-out only, and the installation of a pedestrian hybrid beacon (PHB) to facilitate signalized pedestrian access to Conger Elementary school. Volumes on the Channing Street approaches are minimal and there are several adjacent streets that would accommodate through and left turn traffic with negligible impacts to traffic operations. This recommendation can also be combined with other SR 37 segment locations as a corridor wide improvement.

Location 26 – US 42 at SR 745/257

At the US 42 and SR 745/257 intersection, Mott MacDonald evaluated both installing left turn lanes on US 42 only, and installing left turn lanes on all approaches. Capacity analysis shows a small reduction in signal efficiency for both improvements, but this does not fully account for existing delays produced by left turning vehicles restricting through movements, especially on US 42. Left turn lanes on all approaches produce the highest safety benefits. Truck volumes on all approaches are 5% or higher of total approach volumes. Turn lanes on all approaches are recommended as they would have a positive safety impact and a positive impact on freight flow through the intersection.

Table 5 shows the proposed improvement for each location analyzed in the *Needs and Conditions Report*. After evaluating and assigning recommendations at each study location, Mott MacDonald completed an evaluation for the entire study area. The goal of the study area evaluation was to develop an evaluation matrix containing all pertinent data for each location, and to prioritize all recommended improvements based on a set of detailed evaluation metrics.

Table 5 - Recommended Improvement by Location

Study Location Information						Confirmed			Recommendation
ID	County	Route	Log Point	Location	Type	Traffic Operations	Safety	Geometry	Proposed Improvement
2	DEL	US 23	11.89	US 36	Interchange	✓		✓	Signal Coordination w/ Henry St
3	DEL	US 23	12.12	SR 37	Interchange	✓	✓		Signal Coordination w/ N Union St
4	DEL	US 23	13.86	Panhandle Rd	Intersection		✓		Upgrade Existing Signage
5	DEL	US 23	14.20	Big Lots/McDonald's	Intersection		✓		Install Radar Detection and Upgrade Signage
6	DEL	US 23	14.37	Hills-Miller Rd	Intersection				Add a RTL on EB Approach
8	DEL	US 23	21.42	SR 229 (Norton)	Intersection		✓		Convert 4 Leg Intersection to RCUT
9	DEL	US 36	10.39 - 17.95	US 23 to I-71	Segment	✓	✓		Access Management Strategies
14	DEL	US 36	14.85	Lackey / CR 10	Intersection		✓		Upgrade Existing Signage
15	DEL	US 36	15.99	CR 10A / N Old State Rd	Intersection		✓		Construct Left Turn Lanes on US 36
16	DEL	US 36	17.07	Africa Rd	Intersection		✓		Upgrade Existing Signage
18	DEL	SR 37	10.48 - 11.44	US 23 to US 36	Segment	✓	✓	✓	Install Center TWLTL, Realignment at 37/42
19	DEL	SR 37	10.81	US 42 (Lake St)	Intersection	✓	✓	✓	Realign Existing Intersection
20	DEL	SR 37	11.03	Channing St	Intersection		✓	✓	Convert 4 Leg Intersection to RI-RO, Install PHB
22	MAD	US 42	12.98	I-70	Interchange		✓		Add Left Turn Signal Phasing at Both Ramps
24	UNI	US 42	4.20	Industrial Parkway	Intersection		✓	✓	Convert 4 Leg Intersection to a Roundabout
25	UNI	US 42	4.58	US 33	Interchange	✓	✓		Construct Left Turn Lanes on Each Exit Ramp
26	DEL	US 42	1.56	SR 257 / SR 745	Intersection		✓	✓	Construct Left Turn Lanes on All Approaches
27	DEL	US 42	2.13	SR 257 / Riverside	Intersection		✓	✓	Construct Left Turn Lanes on US 42
30	DEL	US 42	7.28	US 23	Intersection			✓	Install Advance Queue Warning System

Evaluation Metrics

The BCA was a critical component of the detailed evaluation of potential improvements. The results of the BCA were integrated into an evaluation matrix designed to assist stakeholders and decision makers in the prioritization of projects within the study area. To further the BCA, this evaluation matrix was developed to incorporate economic, safety, operational, and heavy vehicle usage metrics along with a variety of additional data points to rank each proposed improvement with an emphasis on freight mobility, positive economic impact, and safety.

Economic Metrics

In addition to the Goods Movement Index, economic evaluation metrics included: regional trends related to goods movement; location, size, and type of transportation and distribution facilities; and current zoning and land use.

Safety Metrics

In addition to monetized safety benefits, Mott MacDonald incorporated a safety rank into the evaluation matrix based on the potential for safety improvement and predicted annual crash reduction. Emphasis was also given to locations that appear on one of ODOT's safety priority lists. Data from the 2015 and 2016 Highway Safety Improvement Program (HSIP) rankings lists, and Safety Integrated Project (SIP) maps is integrated into the evaluation matrix as part of the safety evaluation of proposed improvements. A summary of safety priority rankings from ODOT and MORPC are provided as Appendix C.

Combining these metrics places an emphasis on improvements that reduce crashes and crash severity at locations with a history of high crash frequencies.

Operational Metrics

In addition to annual travel time savings, Mott MacDonald evaluated operations based on peak hour traffic capacity, intersection and approach LOS, and potential for air quality improvement (reduced emissions). An operations analysis rank was created based on these metrics and incorporated into the evaluation matrix

Incorporating overall operations and the impacts of a proposed improvement is critical as it is directly related to the efficient movement of freight throughout the study area.

Heavy Vehicle Utilization

As the movement of goods is highly dependant on heavy vehicles (trucks), Mott MacDonald incorporated a heavy vehicle utilization rank into the evaluation matrix. This rank measures a) total heavy vehicle volume and b) heavy vehicle usage as a percentage of total volume to place an emphasis on improvements at locations with the highest amount of daily heavy vehicle usage. Heavy vehicles are defined as Type B & C vehicles, otherwise defined as single unit trucks and larger.

Mott MacDonald used ADT data from ODOT counting stations along the study corridors to determine the truck volume through study locations. US 23 has a higher total volume of heavy vehicles, while US 42 has a higher percentage of heavy vehicles compared to passenger vehicles. To account for both values, Mott MacDonald combined the rankings of total volume, and volume as a percentage of total traffic to develop a comprehensive heavy vehicle utilization rank.

Evaluation Matrix and Final Rank

Proposed improvement rankings from the economic, safety, operations, and heavy vehicle metrics are combined with a ranking of each proposed improvement's B/C ratio to produce a Final Rank within the evaluation matrix. The metrics incorporated into the Final Rank combine all available data to give decision makers a snapshot of the proposed improvements that maximize both quantitative and qualitative benefits versus their overall estimated costs. The Final Rank is not intended to be a standalone decision making tool, but rather as an integral part of a decision making process which includes quantitative analysis, qualitative evaluation, and sound engineering judgement. Recommendations from this Final Rank have not been vetted through ODOT's NEPA/PDP process and should only be used for prioritization and funding purposes.

To that end, every column in the evaluation matrix is sortable, from individual data points within an evaluation metric to macro-level data points such as estimated project cost. Several additional data points, such as air quality improvement, possible funding sources, and whether an individual study location is present on a state or local safety priority list are also included for prioritization purposes. This allows the user to sort improvements based on whatever metric or detail is most important or most useful for their prioritization efforts. Table 6 is a snapshot of the top 5 recommendations in the evaluation matrix sorted by Final Rank. Table 7 on the following page is a snapshot of the evaluation matrix.

Table 6 - Top 5 Recommended Improvements by Final Rank

Study Location Information					Evaluation Ranks						
ID	County	Route	Location	Proposed Improvement	Economic Analysis Rank	Safety Analysis Rank	Operational Analysis Rank	B/C Ratio Rank	Heavy Vehicle Utilization	Safety Priority Location	Final Rank
25	UNI	US 42	US 33	Construct Left Turn Lanes on Each Exit Ramp	4	10	2	5	7	✓	1
15	DEL	US 36	CR 10A / N Old State Rd	Construct Left Turn Lanes on US 36	3	3	17	1	5		2
14	DEL	US 36	Lackey / CR 10	Upgrade Existing Signage	3	15	2	13	5	✓	3
20	DEL	SR 37	Channing St	Convert 4 Leg Intersection to RI-RO, Install PHB	3	9	1	4	16		4
6	DEL	US 23	Hills-Miller Rd	Add a RTL on EB Approach	3	12	7	8	9	✓	5

Timeframe

In addition to the Final Rank, improvements were categorized with an estimated implementation time frame. The purpose is to provide an additional piece of information in the project prioritization and decision making process. Several long term studies and/or projects have already been undertaken outside of this project. These include improvements at the US 36/SR 37 split ("The Point") as well as multiple studies at the I-71/US 36 interchange. These locations were not evaluated in detail as part of this study but are included in the evaluation matrix for comparison purposes.

Of the improvements recommended by Mott MacDonald as part of this strategic plan, all but one were considered short-term or medium-term. The one long-term recommendation was the segment improvements along SR 37. This was considered long-term because the recommendation also included improvements at the Channing Street and US 42 intersections. Short-term recommendations provided in this Strategic Plan ranged from upgrading signage to coordinating traffic signals while medium-term countermeasures included intelligent transportation system improvements (radar detection, queue warning system) and turn lane additions. Timeframe categorization is available for all recommended improvements in the evaluation matrix.

Table 7 - Evaluation Matrix Dashboard View

DEL-23/36/42 Freight Study Strategic Plan Evaluation Matrix																										
Study Location Information						Confirmed Issues			Recommendation	Project Status, Cost, and B/C Ratio						Analysis Rankings						Timeframe		
ID	County	Route	Log Point	Location	Type	Traffic Operations	Safety	Geometry	Proposed Improvement	Analyzed in Needs and Conditions Report?	Recommendation from Previous Study?	Programmed or Completed?	Total Estimated Cost	Final B/C Ratio	Project Funded?	Economic Analysis Rank	Safety Analysis Rank	Operational Analysis Rank	B/C Ratio Rank	Heavy Vehicle Utilization	Final Rank	Short Term	Medium Term	Long Term
1	DEL	US 23	0.00-10.63	DEL line to US 42	Segment	✓	✓				✓	✗	$0	0.00	✗						18			
2	DEL	US 23	11.89	US 36	Interchange	✓		✓	Signal Coordination w/ Henry St	✓		✗	$40,000	-	✗	3	15	7	13	11	13	●		
3	DEL	US 23	12.12	SR 37	Interchange	✓	✓		Signal Coordination w/ N Union St	✓		✗	$40,000	-	✗	3	15	7	13	10	11	●		
4	DEL	US 23	13.86	Panhandle Rd	Intersection		✓		Upgrade Existing Signage	✓		✗	$2,000	-	✗	3	15	2	13	9	9	●		
5	DEL	US 23	14.20	Big Lots/McDonald's	Intersection		✓		Install Radar Detection and Upgrade Signage	✓		✗	$192,000	-	✗	3	15	13	13	9	14		●	
6	DEL	US 23	14.37	Hills-Miller Rd	Intersection				Add a RTL on EB Approach	✓		✗	$300,000	1.82	✗	3	12	7	8	9	5		●	
7	DEL	US 23	16.25 -21.42	along Delaware Lake	Segment				Resurfacing		✓	✓	$0	0.00	✗						19		●	
8	DEL	US 23	21.42	SR 229 (Norton)	Intersection		✓		Convert 4 Leg Intersection to RCUT	✓		✗	$218,000	7.80	✗	11	13	26	2	1	16		●	
9	DEL	US 36	10.39 - 17.95	US 23 to I-71	Segment	✓	✓		Access Management Strategies	✓		✗	$0	-	✗						20			●
10	DEL	US 36	10.62	US 42 (Lake St)	Intersection	✓	✓	✓	William Street Widening		✓	✓	$695,800	4.17	✓	3	7	15	3	14				●
11	DEL	US 36	10.66	CSX Railroad	Structure				William Street Widening		✓	✓	$0	-	✓	0								●
12	DEL	US 36	11.26	"The Point" (36/37)	Intersection	✓	✓	✓	US 36/SR 37 Safety Project		✓	✓	$23,000,000	1.14	✓	3	4	2	10	6				●
13	DEL	US 36	11.70	SR 521	Intersection	✓	✓		US 36/SR 37 Safety Project		✓	✓	$0	-	✓	0								●
14	DEL	US 36	14.85	Lackey / CR 10	Intersection		✓		Upgrade Existing Signage	✓		✗	$2,000	-	✗	3	15	2	13	5	3	●		
15	DEL	US 36	15.99	CR 10A / N Old State Rd	Intersection		✓		Construct Left Turn Lanes on US 36	✓		✗	$439,000	9.21	✗	3	3	17	1	5	2		●	
16	DEL	US 36	17.07	Africa Rd	Intersection		✓		Upgrade Existing Signage	✓		✗	$2,000	-	✗	15	15	2	13	5	12	●		
17	DEL	US 36	17.95	I-71	Interchange	✓	✓		Interchange Modification Study		✓	✓	$0	0.00	✓									●
18	DEL	SR 37	10.48 - 11.44	US 23 to US 36	Segment	✓	✓	✓	Install Center TWLTL, Realignment at 37/42	✓		✗	$3,549,000	1.09	✗	3	1	11	11	15	8			●
19	DEL	SR 37	10.81	US 42 (Lake St)	Intersection	✓	✓	✓	Realign Existing Intersection	✓		✗	$928,000	0.29	✗	3	10	18	13	15	17		●	
20	DEL	SR 37	11.03	Channing St	Intersection		✓	✓	Convert 4 Leg Intersection to RI-RO, Install PHB	✓		✗	$229,000	3.81	✗	3	9	1	4	16	4		●	
21	MAD UNI DEL	US 42	12.81 - 25.15 0.00 - 9.89 0.00 - 7.29	I-70 to London Rd	Segment			✓			✓	✗	$0	0.00	✗						21			
22	MAD	US 42	12.98	I-70	Interchange		✓		Add Left Turn Signal Phasing at Both Ramps	✓		✗	$0	-	✗						22	●		
23	UNI	US 42	0.11	SR 161	Intersection						✓	✗	$0	0.00	✗						23			
24	UNI	US 42	4.20	Industrial Parkway	Intersection		✓	✓	Convert 4 Leg Intersection to a Roundabout	✓		✗	$1,354,000	1.97	✗	4	2	14	7	13	6		●	
25	UNI	US 42	4.58	US 33	Interchange	✓	✓		Construct Left Turn Lanes on Each Exit Ramp	✓		✗	$1,242,000	2.73	✗	4	10	2	5	7	1		●	
26	DEL	US 42	1.56	SR 257 / SR 745	Intersection		✓	✓	Construct Left Turn Lanes on All Approaches	✓		✗	$2,562,000	0.92	✗	3	5	27	12	3	15		●	
27	DEL	US 42	2.13	SR 257 / Riverside	Intersection		✓	✓	Construct Left Turn Lanes on US 42	✓		✗	$1,167,000	1.32	✗	3	6	15	9	6	7		●	
28	DEL	US 42	3.25	S. Section Line Rd	Intersection				Evaluate Recent Improvement		✓	✓	$0	-	✓							●		
29	DEL	US 42	4.87	Sawmill Pkwy	Intersection				Evaluate Recent Improvement		✓	✓	$0	-	✓							●		
30	DEL	US 42	7.28	US 23	Intersection			✓	Install Advance Queue Warning System	✓		✗	$52,000	2.63	✗	3	14	11	6	8	10		●	

Funding

Within the evaluation matrix, Mott MacDonald has identified potential funding sources for proposed improvements on the regional, state and federal funding levels. The identification of funding sources for individual proposed improvements is not a guarantee of funding, but is meant to show decision makers which funding sources may be applicable to specific recommended improvements. As of the date of this report, a new federal infrastructure bill was in the works and this may change the source and availability of funding.

Regional funding opportunities include Congestion Mitigation and Air Quality (CMAQ), Surface Transportation Block Grants (STBG), and Ohio Public Works Commission (OPWC). The study area of this report falls under OPWC Districts 11 and 17.

Potential funding sources administered by the state include Safety funding and Safe Routes to School (SRTS) funding. For example, SRTS funding may be applicable to the recommended pedestrian hybrid beacon on SR 37 due to the nature of the proposed crossing and proximity to Conger Elementary school. The City of Delaware has an approved School Travel Plan (completed in 2015) that could be amended if this recommendation is pursued. In addition, safety funding should be explored for recommendations at locations on the ODOT HSIP safety priority list and/or the SIP map locations. Specific recommendations include constructing a roundabout at the US 42/Industrial Parkway intersection, converting the US 23/SR 229 intersection to a full RCUT, and constructing left turn lanes on the US 42 approaches at the US 42/SR 257 intersection. All three of these improvements have a high potential for safety improvement, are on the ODOT HSIP safety priority list, and have a recommendation with a b/c ratio of over 1.0.

Several proposed improvements would qualify for federal discretionary programs including TIGER or INFRA funding, but not individually due to funding minimums. In this case, a combined project of several proposed improvements would be the best approach if seeking federal funding. An example would be the recommendations on the SR 37 corridor which include segment improvements as well as intersection improvements at US 42 and at Channing Street. These combined recommendations address a freight critical route that has several impediments. Coupled with the funded improvements at the US 36/SR 37 split (“The Point”), a strong case can be made for continuing improvements along SR 37.

Opportunities for funding are not limited to one single source and combining funding sources is an effective and often encouraged approach to achieving project implementation. An additional funding source that could be combined with other sources is the Preservation Funding Program if existing infrastructure is physically deteriorated enough to warrant replacement.

Appendix A
Proposed Improvement Cost Estimates

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 2 Location: US 23 @ US 36

Countermeasure #1: Ramp Reconfiguration

Item	Unit	Unit Cost	Quantity	Total $
PID 98141				$2,369,234
Item Total				*$2,370,000*
Conceptual Estimate Total				*$2,370,000*

Countermeasure #2: Coordinate Signals

Item	Unit	Unit Cost	Quantity	Total $
Retime Signal	Lump	$3,000	2	$6,000
Item Total				*$6,000*
Additional Quantities (30%)				$1,800
Design (10%)				$600
Contingency (20%)				$1,200
Conceptual Estimate Total				*$10,000*

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 3 Location: US 23 @ SR 37

Countermeasure #1: Coordinate Signals

Item	Unit	Unit Cost	Quantity	Total $
Retime Signal	Lump	$3,000	2	$6,000
Item Total				*$6,000*
Additional Quantities (30%)				$1,800
Design (10%)				$600
Contingency (20%)				$1,200
Conceptual Estimate Total				*$10,000*

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 25 Location: US 42 @ US 33

Countermeasure #1: Add Radar Detection

Item	Unit	Unit Cost	Quantity	Total $
Retime Signal	Lump	$3,000	1	$3,000
Add Radar Detection	Lump	$25,000	1	$25,000
Signal Ahead Signage	Lump	$500	4	$2,000
Item Total				*$30,000*
Additional Quantities (30%)				$9,000
Design (10%)				$3,000
Contingency (20%)				$6,000
Conceptual Estimate Total				*$48,000*

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 6 Location: US 23 @ Hills-Miller Rd

Countermeasure #1: Construct EB RTL

Item	Unit	Unit Cost	Quantity	Total $
Full Depth Pavement	Sq Yd	$90	1400	$126,000
Signage	Sign	$500	2	$1,000
Item Total				*$127,000*
Additional Quantities (30%)				$38,100
Design (10%)				$12,700
Contingency (20%)				$25,400
Conceptual Estimate Total				*$204,000*

Countermeasure #2: Add Radar Detection

Item	Unit	Unit Cost	Quantity	Total $
Retime Signal	Lump	$3,000	1	$3,000
Add Radar Detection	Lump	$25,000	1	$25,000
Signal Ahead Signage	Lump	$500	4	$2,000
Item Total				*$30,000*
Additional Quantities (30%)				$9,000
Design (10%)				$3,000
Contingency (20%)				$6,000
Conceptual Estimate Total				*$48,000*

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 8 Location: US 23 @ SR 229 (Norton)

Countermeasure #1: Protected/Permissive N-S Left Turn Phasing

Item	Unit	Unit Cost	Quantity	Total $
Retime Signal	Lump	$3,000	1	$3,000
Item Total				*$3,000*
Additional Quantities (30%)				$900
Design (10%)				$300
Contingency (20%)				$600
Conceptual Estimate Total				*$5,000*

Countermeasure #2: RCUT

Item	Unit	Unit Cost	Quantity	Total $
Full Depth Pavement	Sq Yd	$90	1500	$135,000
Signage	Sign	$500	2	$1,000
Item Total				*$136,000*
Additional Quantities (30%)				$40,800
Design (10%)				$13,600
Contingency (20%)				$27,200
Conceptual Estimate Total				*$218,000*

Countermeasure #2: Grade Separation

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 15 Location: US 36 @ CR 10A / N Old State Rd

Countermeasure #1: Install Left Turn Lanes

Item	Unit	Unit Cost	Quantity	Total $
Full Depth Pavement	Sq Yd	$90	3000	$270,000
Signage	Sign	$500	8	$4,000
Item Total				*$274,000*
Additional Quantities (30%)				$82,200
Design (10%)				$27,400
Contingency (20%)				$54,800
Conceptual Estimate Total				*$439,000*

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 18 Location: SR 37 from US 23 to US 36

Countermeasure #1: Install Center TWLTL w Roundabout at 37/42

Item	Unit	Unit Cost	Quantity	Total $
Full Depth Pavement	Sq Yd	$90	13250	$1,192,500
Install Roundabout at US 42	Sq Ft	$18	35000	$630,000
Remove Traffic Signal	Lump	$2,500	1	$2,500
Install Pedestrian Hybrid Beacon	Lump	$80,000	1	$80,000
Signage	Mile	$200,000	0.66	$132,576
4" Concrete Walk	Sq Ft	$7	35000	$245,000
Item Total				*$2,283,000*
Additional Quantities (30%)				$684,900
Design (10%)				$228,300
Contingency (20%)				$456,600
Conceptual Estimate Total				*$3,653,000*

Countermeasure #2: Install Center TWLTL w Conventional Realignment at 37/42

Item	Unit	Unit Cost	Quantity	Total $
Full Depth Pavement	Sq Yd	$90	18000	$1,620,000
Reconstruct Traffic Signal	Lump	$140,000	1	$140,000
Install Pedestrian Hybrid Beacon	Lump	$80,000	1	$80,000
Signage	Mile	$200,000	0.66	$132,576
4" Concrete Walk	Sq Ft	$7	35000	$245,000
Item Total				*$2,218,000*
Additional Quantities (30%)				$665,400
Design (10%)				$221,800
Contingency (20%)				$443,600
Conceptual Estimate Total				*$3,549,000*

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 19 Location: SR 37 @ US 42 (Lake St)

Countermeasu Realign Existing Intersection

Item	Unit	Unit Cost	Quantity	Total $
Full Depth Pavement	Sq Yd	$90	4500	$405,000
Reconstruct Traffic Signal	Lump	$140,000	1	$140,000
4" Concrete Walk	Sq Ft	$7	5000	$35,000
Item Total				*$580,000*
Additional Quantities (30%)				$174,000
Design (10%)				$58,000
Contingency (20%)				$116,000
Conceptual Estimate Total				*$928,000*

Countermeasure #1: Install Roundabout

Item	Unit	Unit Cost	Quantity	Total $
Install Roundabout	Sq Ft	$18	35000	$630,000
Item Total				*$630,000*
Additional Quantities (30%)				$189,000
Design (10%)				$63,000
Contingency (20%)				$126,000
Conceptual Estimate Total				*$1,008,000*

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 20 Location: SR 37 @ Channing St

Countermeasure #1: Right-In Right Out and PHB

Item	Unit	Unit Cost	Quantity	Total $
Full Depth Pavement	Sq Yd	$90	675	$60,750
Install PHB	Lump	$80,000	1	$80,000
Signage	Sign	$500	4	$2,000
Item Total				*$143,000*
Additional Quantities (30%)				$42,900
Design (10%)				$14,300
Contingency (20%)				$28,600
Conceptual Estimate Total				*$229,000*

Countermeasure #2: Close Channing, PHB

Item	Unit	Unit Cost	Quantity	Total $
Full Depth Pavement	Sq Yd	$90	315	$28,350
Install PHB	Lump	$80,000	1	$80,000
Signage	Sign	$500		$0
Item Total				*$109,000*
Additional Quantities (30%)				$32,700
Design (10%)				$10,900
Contingency (20%)				$21,800
Conceptual Estimate Total				*$175,000*

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 22 Location: US 42 @ I-70

Countermeasure #1:

Item	Unit	Unit Cost	Quantity	Total $
Item Total				*$0*
Additional Quantities (30%)				$0
Design (10%)				$0
Contingency (20%)				$0
Conceptual Estimate Total				*$0*

Countermeasure #2:

Item	Unit	Unit Cost	Quantity	Total $
				$0
Item Total				*$0*
Additional Quantities (30%)				$0
Design (10%)				$0
Contingency (20%)				$0
Conceptual Estimate Total				*$0*

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 24 Location: US 42 @ Industrial Parkway

Countermeasure #1: Left Turn Lanes on All Approaches

Item	Unit	Unit Cost	Quantity	Total $
Full Depth Pavement	Sq Yd	$90	13000	$1,170,000
Reconstruct Signal	Lump	$150,000	1	$150,000
Signage	Sign	$500	8	$4,000
Item Total				*$1,324,000*
Additional Quantities (30%)				$397,200
Design (10%)				$132,400
Contingency (20%)				$264,800
Conceptual Estimate Total				*$2,119,000*

Countermeasure #2: Install Roundabout

Item	Unit	Unit Cost	Quantity	Total $
Install Roundabout	Sq Ft	$18	47000	$846,000
Item Total				*$846,000*
Additional Quantities (30%)				$253,800
Design (10%)				$84,600
Contingency (20%)				$169,200
Conceptual Estimate Total				*$1,354,000*

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 25 Location: US 42 @ US 33

Countermeasure #1: Left Turn Lanes on Both Ramps

Item	Unit	Unit Cost	Quantity	Total $
Full Depth Pavement	Sq Yd	$90	8500	$765,000
Signage	Sign	$500	22	$11,000
Item Total				*$776,000*
Additional Quantities (30%)				$232,800
Design (10%)				$77,600
Contingency (20%)				$155,200
Conceptual Estimate Total				*$1,242,000*

Countermeasure #2: Left Turn Lanes on Both Ramps and Signalize

Item	Unit	Unit Cost	Quantity	Total $
Full Depth Pavement	Sq Yd	$90	8500	$765,000
Reconstruct Traffic Signal	Lump	$150,000	1	$150,000
Signage	Sign	$500	22	$11,000
Item Total				*$926,000*
Additional Quantities (30%)				$277,800
Design (10%)				$92,600
Contingency (20%)				$185,200
Conceptual Estimate Total				*$1,482,000*

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 26 Location: US 42 @ SR 257 / SR 745

Countermeasure #1: Left Turn Lanes on All Approaches

Item	Unit	Unit Cost	Quantity	Total $
Full Depth Pavement	Sq Yd	$90	16000	$1,440,000
Reconstruct Traffic Signal	Lump	$150,000	1	$150,000
Signage	Sign	$500	22	$11,000
Item Total				*$1,601,000*
Additional Quantities (30%)				$480,300
Design (10%)				$160,100
Contingency (20%)				$320,200
Conceptual Estimate Total				*$2,562,000*

Countermeasure #2: Left Turn Lanes on US 42 Only

Item	Unit	Unit Cost	Quantity	Total $
Full Depth Pavement	Sq Yd	$90	10000	$900,000
Reconstruct Traffic Signal	Lump	$150,000	1	$150,000
Signage	Sign	$500	16	$8,000
Item Total				*$1,058,000*
Additional Quantities (30%)				$317,400
Design (10%)				$105,800
Contingency (20%)				$211,600
Conceptual Estimate Total				*$1,693,000*

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 27 Location: US 42 @ SR 257 / Riverside

Countermeasure #1: Left Turn Lanes on All Approaches

Item	Unit	Unit Cost	Quantity	Total $
Full Depth Pavement	Sq Yd	$90	6500	$585,000
Reconstruct Traffic Signal	Lump	$140,000	1	$140,000
Signage	Sign	$500	8	$4,000
Item Total				*$729,000*
Additional Quantities (30%)				$218,700
Design (10%)				$72,900
Contingency (20%)				$145,800
Conceptual Estimate Total				*$1,167,000*

DEL-23-36-42 Freight Study Conceptual Cost Estimate

Location ID: 30 Location: US 42 @ US 23

Countermeasure #1: Install Advance Queue Warning System

Item	Unit	Unit Cost	Quantity	Total $
LED Sign	Lump	$10,000	1	$10,000
Loop Wire	Lump	$2,000	1	$2,000
Transmitter/Reciever	Lump	$7,500	1	$7,500
Item Total				*$20,000*
Contingency (30%)				$6,000
Conceptual Estimate Total				*$26,000*

Appendix B
Benefit Cost Analysis

ID	Location	Type	Improvement	Travel Time Savings	Operational Benefit	Delay Reduction	Estimated 20 Year Cost	B/C	Travel Time Savings Rank	Cost Rank	Operational Benefit Rank	Sum of Ranks	Final Rank
1	US 23 from DEL line to US 42	Segment											28
2	US 23 @ US 36	Interchange	Signal Coordination w/ Henry St	0	$0	0.0	$40,000	-	10	4	10	24	7
3	US 23 @ SR 37	Interchange	Signal Coordination w/ N Union St	0	$0	0.0	$40,000	-	10	4	10	24	7
4	US 23 @ Panhandle Rd	Intersection	Upgrade Existing Signage	0	$0	0.0	$2,000	-	10	1	10	21	2
5	US 23 @ Big Lots/McDonald's	Intersection	Install Radar Detection and Upgrade Signage	0	$0	0.0	$192,000	-	10	7	10	27	13
6	US 23 @ Hills-Miller Rd	Intersection	Add a RTL on EB Approach	1585	$255,768	1.4	$300,000	1.82	7	10	7	24	7
7	US 23 along Delaware Lake	Segment	Resurfacing						10	20	10	40	19
8	US 23 @ SR 229 (Norton)	Intersection	Convert 4 Leg Intersection to RCUT	-398	-$70,094	-0.9	$218,000	7.80	20	8	20	48	26
9	US 36 from US 23 to I-71	Segment	Access Management Strategies					-	10	20	10	40	19
10	US 36 @ US 42 (Lake St)	Intersection	William Street Widening	45	$7,546	0.1	$695,800	4.17	9	12	9	30	15
11	US 36 @ Bike Path	Structure	William Street Widening					-	10	20	10	40	19
12	US 36 @ "The Point" (36/37)	Intersection	US 36/SR 37 Safety Project	127534	$21,252,456	185.1	$23,000,000	1.14	1	19	1	21	2
13	US 36 @ SR 521	Intersection	US 36/SR 37 Safety Project	24797	$4,240,042	31.1		-	2	20	2	24	7
14	US 36 @ Lackey / CR 10	Intersection	Upgrade Existing Signage	0	$0	0.0	$2,000	-	10	1	10	21	2
15	US 36 @ CR 10A / N Old State Rd	Intersection	Construct Left Turn Lanes on US 36	0	$0	0.0	$439,000	9.21	10	11	10	31	17
16	US 36 @ Africa Rd	Intersection	Upgrade Existing Signage	0	$0	0.0	$2,000	-	10	1	10	21	2
17	US 36 @ I-71	Interchange	Interchange Modification Study						10	20	10	40	19
18	SR 37 from US 23 to US 36	Segment	Install Center TWLTL, Realignment at 37/42	5753	$956,254	14.4	$3,549,000	1.09	4	18	4	26	11
19	SR 37 @ US 42 (Lake St)	Intersection	Realign Existing Intersection	0	$0	0.0	$928,000	0.29	10	13	10	33	18
20	SR 37 @ Channing St	Intersection	Convert 4 Leg Intersection to RI-RO, Install PHB	3806	$636,665	14.4	$229,000	3.81	5	9	5	19	1
21	US 42 from I-70 to London Rd	Segment											28
22	US 42 @ I-70	Interchange	Add Left Turn Signal Phasing at Both Ramps					-	10	20	10	40	19
23	US 42 @ SR 161	Intersection											28
24	US 42 @ Industrial Parkway	Intersection	Convert 4 Leg Intersection to a Roundabout	3752	$610,537	11.7	$1,354,000	1.97	6	16	6	28	14
25	US 42 @ US 33	Interchange	Construct Left Turn Lanes on Each Exit Ramp	19203	$3,143,676	51.2	$1,242,000	2.73	3	15	3	21	2
26	US 42 @ SR 257 / SR 745	Intersection	Construct Left Turn Lanes on All Approaches	-195	-$32,184	-0.7	$2,562,000	0.92	19	17	19	55	27
27	US 42 @ SR 257 / Riverside	Intersection	Construct Left Turn Lanes on US 42	1048	$172,977	3.0	$1,167,000	1.32	8	14	8	30	15
28	US 42 @ S. Section Line Rd	Intersection	Evaluate Recent Improvement					-	10	20	10	40	19
29	US 42 @ Sawmill Pkwy	Intersection	Evaluate Recent Improvement					-	10	20	10	40	19
30	US 42 @ US 23	Intersection	Install Advance Queue Warning System	0	$0	0.0	$52,000	2.63	10	6	10	26	11

Red = Not Analyzed in N&C Report

Green = Improvement from Previous Study/Project
Orange = No Current Proposed Improvement

ID	Location	Type	Improvement	Expected Crash Frequency	Potential For Safety Improvement	Annual Crash Reduction	NPV of Safety Benefits	PSI Rank	Crash Reduction Rank	NPV Benefit Rank	Average Score	Safety Rank
1	US 23 from DEL line to US 42	Segment	0									15
2	US 23 @ US 36	Interchange	Signal Coordination w/ Henry St				$0					15
3	US 23 @ SR 37	Interchange	Signal Coordination w/ N Union St				$0					15
4	US 23 @ Panhandle Rd	Intersection	Upgrade Existing Signage									15
5	US 23 @ Big Lots/McDonald's	Intersection	Install Radar Detection and Upgrade Signage				$0					15
6	US 23 @ Hills-Miller Rd	Intersection	Add a RTL on EB Approach	7.809	-1.190	-0.888	$291,215	8	11	10	9.67	12
7	US 23 along Delaware Lake	Segment	Resurfacing									15
8	US 23 @ SR 229 (Norton)	Intersection	Convert 4 Leg Intersection to RCUT	11.758	-3.801	-0.158	$1,769,422	14	14	6	11.33	13
9	US 36 from US 23 to I-71	Segment	Access Management Strategies									15
10	US 36 @ US 42 (Lake St)	Intersection	William Street Widening	18.200	-3.400	-3.204	$2,903,470	13	6	3	7.33	7
11	US 36 @ Bike Path	Structure	William Street Widening									15
12	US 36 @ "The Point" (36/37)	Intersection	US 36/SR 37 Safety Project	12.815	2.979	-1.237	$696,688	1	7	8	5.33	4
13	US 36 @ SR 521	Intersection	US 36/SR 37 Safety Project	9.971	1.116	-0.896	$314,446	4	9	9	7.33	7
14	US 36 @ Lackey / CR 10	Intersection	Upgrade Existing Signage									15
15	US 36 @ CR 10A / N Old State Rd	Intersection	Construct Left Turn Lanes on US 36	11.383	-2.720	-5.464	$4,041,749	11	3	1	5.00	3
16	US 36 @ Africa Rd	Intersection	Upgrade Existing Signage									15
17	US 36 @ I-71	Interchange	Interchange Modification Study									15
18	SR 37 from US 23 to US 36	Segment	Install Center TWLTL, Realignment at 37/42	16.038	1.376	-6.001	$2,904,505	2	2	2	2.00	1
19	SR 37 @ US 42 (Lake St)	Intersection	Realign Existing Intersection	8.259	0.412	-0.791	$271,538	5	12	11	9.33	10
20	SR 37 @ Channing St	Intersection	Convert 4 Leg Intersection to RI-RO, Install PHB	1.536	0.344	-1.224	$235,881	6	8	13	9.00	9
21	US 42 from I-70 to London Rd	Segment	0									15
22	US 42 @ I-70	Interchange	Add Left Turn Signal Phasing at Both Ramps				$0					15
23	US 42 @ SR 161	Intersection	0									15
24	US 42 @ Industrial Parkway	Intersection	Convert 4 Leg Intersection to a Roundabout	12.777	-1.035	-6.133	$2,056,958	7	1	5	4.33	2
25	US 42 @ US 33	Interchange	Construct Left Turn Lanes on Each Exit Ramp	2.406	1.322	-0.371	$247,490	3	13	12	9.33	10
26	US 42 @ SR 257 / SR 745	Intersection	Construct Left Turn Lanes on All Approaches	12.966	-1.696	-4.279	$2,391,537	10	4	4	6.00	5
27	US 42 @ SR 257 / Riverside	Intersection	Construct Left Turn Lanes on US 42	12.377	-1.432	-4.084	$1,369,535	9	5	7	7.00	6
28	US 42 @ S. Section Line Rd	Intersection	Evaluate Recent Improvement									15
29	US 42 @ Sawmill Pkwy	Intersection	Evaluate Recent Improvement									15
30	US 42 @ US 23	Intersection	Install Advance Queue Warning System	14.651	-3.292	-0.894	$136,795	12	10	14	12.00	14

Red = Not Analyzed in N&C Report

Location: US 23 @ US 36 Location ID: 2

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Signal Control	18.4	-	-	-	-	-	-	-	-
	Single Signalized Intersection	38.5	-20.1	-8052	-$124,197	-$1,315,741	$2,369,234	20	$2,369,234	-0.56
	Signal Coordination w/ Henry St	18.4	0.0	0	$0	$0	$10,000	5	$40,000	0.00
	Realign US 23 NB Exit Ramp									

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)	
20	years
Discount Rate (i)	
7%	

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$0	$2,369,234	0.00
$0	$40,000	0.00

Traffic Volume (entering vehicles)		% Trucks
NB	675	7%
SB		
EB	502	4%
WB	672	7%
Total	1849	5.94%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
-$1,315,741	$2,369,234	0.00
$0	$40,000	0.00

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$15.42

Location: US 23 @ SR 37 Location ID: 3

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Signal Control	30.3	-	-	-	-	-	-	-	-
	Signal Coordination w/ N Union St	30.3	0.0	0	$0	$0	$10,000	5	$40,000	0.00
	Signal Ahead Signage	30.3	0.0	0	$0	$0	$1,000	5	$4,000	0.00

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)
20 years
Discount Rate (i)
7%

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$0	$40,000	0.00
$0	$4,000	0.00

Traffic Volume (entering vehicles)		% Trucks
NB		
SB	256	10%
EB	368	7%
WB	431	2%
Total	1055	5.82%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$0	$40,000	0.00
$0	$4,000	0

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$15.41

Location: US 23 @ Big Lots/McDonald's Location ID: 5

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Signal Control		-	-	-	-	-	-	-	-
	Install Radar Detection and Upgrade Signage		0.0	0	$0	$0	$48,000	5	$192,000	0.00

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)
20 years
Discount Rate (i)
7%

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$0	$192,000	0.00

Traffic Volume (entering vehicles)		% Trucks
NB	1383	9%
SB	1128	9%
EB	170	0%
WB		
Total	2681	8.68%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$0	$192,000	0.00

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$15.77

Location: US 23 @ Hills-Miller Rd Location ID: 6

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Signal Control	15.3	-	-	-	-	-	-	-	-
	Add a RTL on EB Approach	13.9	1.4	1585	$24,143	$255,768	$300,000	20	$300,000	0.85
	Install Radar Detection and Upgrade Signage	15.3	0.0	0	$0	$0	$48,000	10	$96,000	0.00

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)
20 years
Discount Rate (i)
7%

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$291,215	$300,000	0.97
$0	$96,000	0.00

Traffic Volume (entering vehicles)		% Trucks
NB	1430	9%
SB	1105	9%
EB	2690	0%
WB		
Total	5225	4.42%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$546,983	$300,000	1.82
$0	$96,000	0.00

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$15.23

Location: US 23 @ SR 229 (Norton) Location ID: 8

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Signal Control	9.9	-	-	-	-	-	-	-	-
	Protected/Permissive Left Turn Phasing	18.1	-8.2	-3626	-$60,282	-$638,630	$5,000	5	$20,000	-31.93
	Convert 4 Leg Intersection to RCUT	10.8	-0.9	-398	-$6,616	-$70,094	$218,000	20	$218,000	-0.32
	Grade Separation									

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)
20 years
Discount Rate (i)
7%

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$23,934	$20,000	1.20
$1,769,422	$218,000	8.12

Traffic Volume (entering vehicles)		% Trucks
NB	1011	16%
SB	850	16%
EB	74	10%
WB	106	13%
Total	2041	15.53%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
-$614,696	$20,000	0.00
$1,699,328	$218,000	7.80

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$16.62

Location: US 36 @ US 42 (Lake St) Location ID: 10

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Signal Control	29.4	-	-	-	-	-	-	-	-
	Increase Triangle Sight Distance and Signal V	29.3	0.1	45	$712	$7,546	$695,000	20	$695,000	0.01

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)
20 years
Discount Rate (i)
7%

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$2,903,470	$695,000	4.18

Traffic Volume (entering vehicles)		% Trucks
NB		
SB	140	4%
EB	1180	10%
WB	750	10%
Total	2070	9.59%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$2,911,016	$695,000	4.19

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$15.88

Location: US 36 @ "The Point" (36/37) Location ID: 12

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Signal Control	222.4	-	-	-	-	-	-	-	-
	Intersection Reconfiguration	37.3	185.1	127534	$2,006,081	$21,252,456	$695,000	20	$695,000	30.58

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)
20 years
Discount Rate (i)
7%

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$2,903,470	$695,000	4.18

Traffic Volume (entering vehicles)		% Trucks
NB	20	0%
SB	1020	6%
EB	1260	10%
WB	880	10%
Total	3180	8.38%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$24,155,926	$695,000	34.76

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$15.73

Location: US 36 @ SR 521 Location ID: 13

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Signal Control	74.9	-	-	-	-	-	-	-	-
	Intersection Improvements	43.8	31.1	24797	$400,230	$4,240,042	$695,000	20	$695,000	6.10

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)	
20	years
Discount Rate (i)	
7%	

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$2,903,470	$695,000	4.18

Traffic Volume (entering vehicles)		% Trucks
NB	270	2%
SB	390	8%
EB	1650	13%
WB	1370	13%
Total	3680	11.66%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$7,143,512	$695,000	10.28

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$16.14

Location: US 36 @ CR 10A / N Old State Rd Location ID: 15

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Stop Control	10.0	-	-	-	-	-	-	-	-
	Construct Left Turn Lanes on US 36	10.0	0.0	0	$0	$0	$439,000	20	$439,000	0.00
	RCUT	10.0	0.0	0	$0	$0	$1,375,000	20	$1,375,000	0.00
	Install Intersection Ahead Signage	10.0	0.0	0	$0	$0	$2,000	5	$8,000	0.00

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)
20 years
Discount Rate (i)
7%

Traffic Volume (entering vehicles)		% Trucks
NB	10	2%
SB	10	2%
EB	10	2%
WB	10	2%
Total	40	2.00%

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$14.93

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$4,041,749	$439,000	9.21
$3,327,500	$1,375,000	2.42
$2,000	$8,000	0.25

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$4,041,749	$439,000	9.21
$3,327,500	$1,375,000	2.42
$2,000	$8,000	0.25

Location: SR 37 from US 23 to US 36 Location ID: 18

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Configuration	45.7	-	-	-	-	-	-	-	-
	Install Center TWLTL, Realignment at 37/42	31.3	14.4	5753	$90,264	$956,254	$3,549,000	20	$3,549,000	0.27
	Install Center TWLTL, Roundabout at 37/42	40.0	5.7	2277	$35,729	$378,517	$3,653,000	20	$3,653,000	0.10

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)
20 years
Discount Rate (i)
7%

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$2,904,505	$3,549,000	0.82
$4,322,459	$3,653,000	1.18

Traffic Volume (entering vehicles)		% Trucks
NB	317	5%
SB	255	5%
EB	607	8%
WB	665	10%
Total	1844	8.06%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$3,860,759	$3,549,000	1.09
$4,700,976	$3,653,000	1.29

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$15.69

Location: SR 37 @ US 42 (Lake St) Location ID: 19

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Signal Control	30.3	-	-	-	-	-	-	-	-
	Realign Existing Intersection	30.3	0.0	0	$0	$0	$928,000	20	$928,000	0.00
	Convert 4 Leg Intersection to a Roundabout	30.3	0.0	0	$0	$0	$1,008,000	20	$1,008,000	0.00

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)
20 years
Discount Rate (i)
7%

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$271,538	$928,000	0.29
$1,711,675	$1,008,000	1.70

Traffic Volume (entering vehicles)		% Trucks
NB	317	5%
SB	255	5%
EB	607	8%
WB	665	10%
Total	1844	8.06%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$271,538	$928,000	0.29
$1,711,675	$1,008,000	1.70

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$15.69

Location: SR 37 @ Channing St Location ID: 20

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Signal Control	15.4	-	-	-	-	-	-	-	-
	Convert 4 Leg Intersection to RI-RO, Install P	1.0	14.4	3806	$60,097	$636,665	$229,000	20	$229,000	2.78
	Close Channing Approaches			0	$0	$0	$175,000	20	$175,000	0.00

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)	
20	years
Discount Rate (i)	
7%	

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$235,881	$229,000	1.03
$178,642	$175,000	1.02

Traffic Volume (entering vehicles)		% Trucks
NB	10	0%
SB	10	0%
EB	600	8%
WB	600	10%
Total	1220	8.85%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$872,546	$229,000	3.81
$178,642	$175,000	1.02

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$15.79

Location: US 42 @ I-70 Location ID: 22

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Signal Control		-	-	-	-	-	-	-	-
	Add Left Turn Signal Phasing		0.0	0	#DIV/0!	#DIV/0!	$0	5	$0	#DIV/0!

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)	
20	years
Discount Rate (i)	
7%	

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$0	$0	#DIV/0!

Traffic Volume (entering vehicles)		% Trucks
NB		
SB		
EB		
WB		
Total	0	#DIV/0!

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
#DIV/0!	$0	#DIV/0!

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	#DIV/0!

Location: US 42 @ Industrial Parkway Location ID: 24

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Signal Control	17.3	-	-	-	-	-	-	-	-
	Construct Left Turn Lanes on All Approaches	15.6	1.7	545	$8,374	$88,711	$2,119,000	20	$2,119,000	0.04
	Convert 4 Leg Intersection to a Roundabout	5.6	11.7	3752	$57,630	$610,537	$1,354,000	20	$1,354,000	0.45

Location ID:	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)
20 years
Discount Rate (i)
7%

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$2,356,737	$2,119,000	1.11
$2,056,958	$1,354,000	1.52

Traffic Volume (entering vehicles)		% Trucks
NB	387	2%
SB	187	2%
EB	349	7%
WB	557	8%
Total	1480	5.44%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$2,445,448	$2,119,000	1.15
$2,667,495	$1,354,000	1.97

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$15.36

Location: US 42 @ US 33 Location ID: 25

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Stop Control	61.7	-	-	-	-	-	-	-	-
	Construct Left Turn Lanes on Each Exit Ramp	10.5	51.2	19203	$296,741	$3,143,676	$1,242,000	20	$1,242,000	2.53
	Left Turn Lanes and Signalize	17.2	44.5	16690	$257,909	$2,732,296	$1,482,000	20	$1,482,000	1.84

Number of Periods
52 weeks per year
5 days per week
260
Daily Factor
3.0

Analysis Period (n)
20 years
Discount Rate (i)
7%

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$247,490	$1,242,000	0.20
-$541,255	$1,482,000	0

Traffic Volume (entering vehicles)		% Trucks
NB	400	6%
SB	490	10%
EB	226	5%
WB	615	4%
Total	1731	6.18%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$3,391,166	$1,242,000	2.73
$2,191,041	$1,482,000	1.48

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$15.45

Location: US 42 @ SR 257 / SR 745 Location ID: 26

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Signal Control	12.9	-	-	-	-	-	-	-	-
	Construct Left Turn Lanes on All Approaches	13.6	-0.7	-195	-$3,038	-$32,184	$2,562,000	20	$2,562,000	-0.01
	Construct Left Turn Lanes on US 42	13.4	-0.5	-140	-$2,170	-$22,988	$1,693,000	20	$1,693,000	-0.01

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)
20 years
Discount Rate (i)
7%

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$2,391,537	$2,562,000	0.93
$1,435,012	$1,693,000	0.85

Traffic Volume (entering vehicles)		% Trucks
NB	223	0%
SB	102	2%
EB	559	7%
WB	404	12%
Total	1288	6.96%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$2,359,353	$2,562,000	0.92
$1,412,024	$1,693,000	0.83

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$15.55

Location: US 42 @ SR 257 / Riverside Location ID: 27

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value Cost ($)	Service Life (yrs)	20 Year Cost ($)	Benefit / Cost Ratio
2017 PM	Existing Signal Control	26.8	-	-	-	-	-	-	-	-
	Construct Left Turn Lanes on US 42	23.8	3.0	1048	$16,328	$172,977	$1,167,000	20	$1,167,000	0.15

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)
20 years
Discount Rate (i)
7%

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$1,369,535	$1,167,000	1.17

Traffic Volume (entering vehicles)		% Trucks
NB	352	1%
SB	201	2%
EB	681	8%
WB	379	14%
Total	1613	7.13%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$1,542,512	$1,167,000	1.32

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$15.57

Location: US 42 @ US 23 Location ID: 30

Operations

Period	Condition	Delay (sec)	Delay Savings (sec)	Annual Savings (veh hrs)	Annual Savings ($)	Present Value Benefit ($)	Present Value	Service Life (yrs)	20 Year Cost ($)	Benefit /
2017 PM	Existing Signal Control	26.8	-	-	-	-	-	-	-	-
	Install Advance Queue Warning System	26.8	0.0	0	$0	$0	$26,000	10	$52,000	0.00

Number of Periods	
52	weeks per year
5	days per week
260	
Daily Factor	
3.0	

Analysis Period (n)
20 years
Discount Rate (i)
7%

Safety (From ECAT)

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$136,795	$52,000	2.63

Traffic Volume (entering vehicles)		% Trucks
NB	352	1%
SB	201	2%
EB	681	8%
WB	379	14%
Total	1613	7.13%

Combined Safety and Operations

Present Value Benefit ($)	Present Value Cost ($)	Benefit / Cost Ratio
-	-	-
$136,795	$52,000	2.63

Value of Travel Time ($/hour)	
Car	$14.68
Truck	$27.20
Weighted	$15.57

Appendix C
Safety Priority Rank Summary

Safety Priority Lists Table

Location ID	County	Route	Log Point	Location	HSIP Ranking Category	2015 HSIP	2016 HSIP	MORPC Rank?	SIP?	HRRR Approach?
1	DEL	US 23		DEL line to US 42						
2	DEL	US 23		US 36						
3	DEL	US 23		SR 37						
4	DEL	US 23		Panhandle Rd						
5	DEL	US 23	14.20	Big Lots/McDonald's	Urban Non Fwy	78	39		Red	
6	DEL	US 23	14.37	Hills-Miller Rd	Urban Non Fwy		303		Red	
7	DEL	US 23	18.20	along Delaware Lake	Rural Non Fwy	103	30		Red	
8	DEL	US 23	21.42	SR 229 (Norton)	Rural Int	265	115			
9	DEL	US 36		US 23 to I-71						
10	DEL	US 36		US 42 (Lake St)						
11	DEL	US 36		CSX Railroad						
12	DEL	US 36	11.26	"The Point" (36/37)					Red	
13	DEL	US 36	11.70	SR 521	Urban Non Fwy	151	253		Blue	
14	DEL	US 36	14.85	Lackey / CR 10	Rural Int	30	27		Blue	Yes
15	DEL	US 36	15.99	CR 10A / N Old State Rd						Yes
16	DEL	US 36	17.07	Africa Rd	Rural Int	107	142			
17	DEL	US 36	17.95	I-71	Rural Non Fwy	1	1		Red	
18	DEL	SR 37		US 23 to US 36						
19	DEL	SR 37		US 42 (Lake St)						
20	DEL	SR 37		Channing St						
21	Multi	US 42		I-70 to London Rd						
22	MAD	US 42	12.98	I-70	Rural Fwy		58		Red	
23	UNI	US 42		SR 161						
24	UNI	US 42	4.20	Industrial Parkway	Rural Int	82	133	Union County #1		Yes
25	UNI	US 42	4.58	US 33	Rural Fwy	66	17		Red	
26	DEL	US 42	1.56	SR 257 / SR 745	Rural Int	264	272			
27	DEL	US 42	2.11	SR 257 / Riverside	Rural Int	250	235			
28	DEL	US 42		S. Section Line Rd						
29	DEL	US 42		Sawmill Pkwy						
30	DEL	US 42		US 23						

	Gray Locations were identified in the Existing and Future Conditions Report, but were not analyzed further in the Needs and Conditions Report. In some cases this was because these locations were part of ongoing projects or studies.
2015 HSIP	2015 HSIP Rankings were published by ODOT in 2016 and use 2013 to 2015 crash data.
2016 HSIP	2016 HSIP Rankings were published by ODOT in 2017 and use 2014 to 2016 crash data.
MORPC Rank	MORPC Top 100 intersection locations based on crash severity, frequency, crash rate, and daily traffic. No study locations appeared on this list. In the case of location ID 24: this intersection appears as the highest priority intersection in the Union County portion of the MORPC region.
SIP	Safety Integrated Project locations. Red locations are designated by ODOT as high priority locations for safety improvements and potential safety funding. Blue locations are designated by ODOT as candidate locations for low cost/short term safety improvements.
HRRR	High Risk Rural Roads. This column indicates whether a specific study intersection has one or more approaches designated by ODOT as High Risk Rural Road segments.

MOTT
MACDONALD

www.mottmac.com