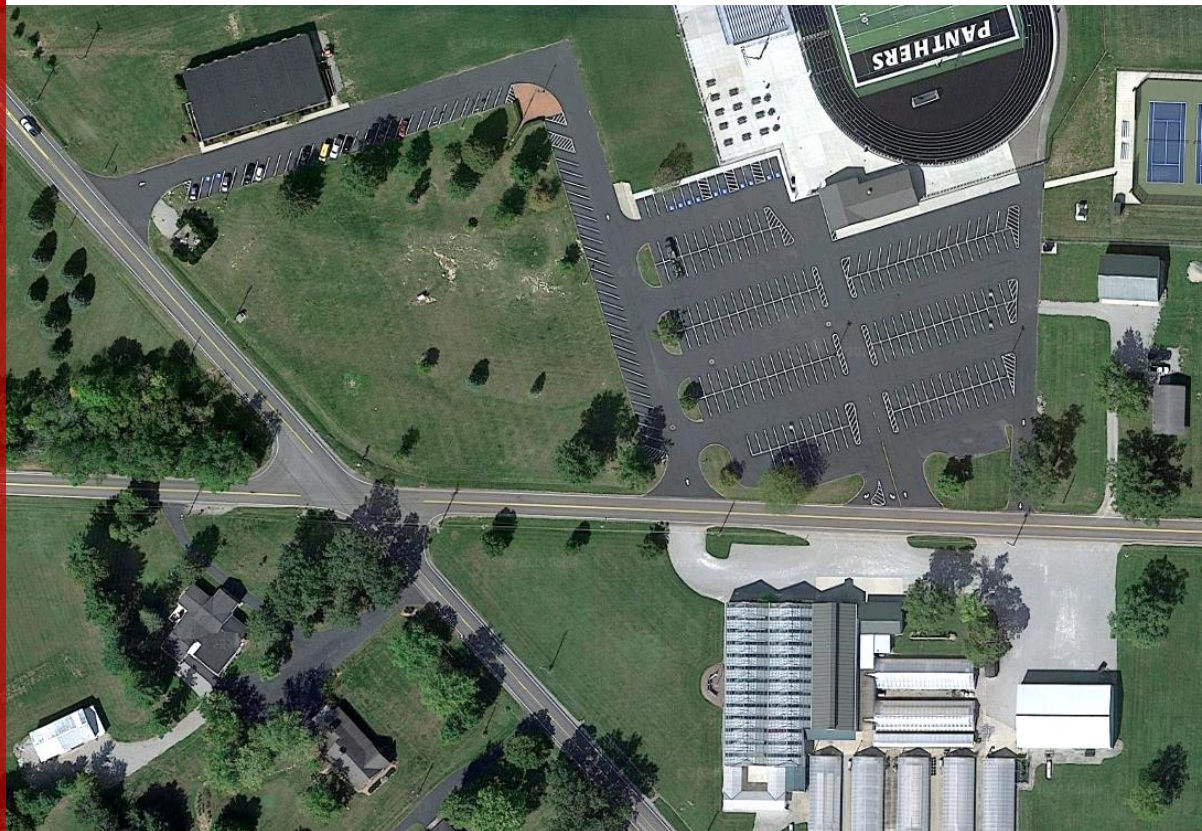


SR-41 & Bloomingburg New Holland Rd (CR-27) Safety Study

Final Report

December 27, 2024



**Prepared for:
Ohio Valley Regional Development Commission &
Fayette County Engineer**

Table of Contents

I. Executive Summary	1
A. Purpose and Need.....	1
B. Overview of Safety Issues	1
C. Recommended Countermeasures and Related Costs	1
II. Purpose and Need	2
III. Existing Conditions	5
A. Land Use.....	5
B. Roadway Conditions	5
C. Intersection Conditions.....	5
D. ODOT School Zone Safety Audit and Work Order	6
E. Data Collection.....	6
F. Traffic Volume Development.....	7
IV. Existing Conditions Analysis	7
A. Capacity Analysis.....	7
B. Turn Lane Warrant Analysis and Length Calculations	7
C. Sight Distance Analysis.....	8
D. Signal Warrant Analysis	8
E. All-Way Stop-Control Analysis	8
V. Crash Data	8
A. Crash Data Summary.....	8
B. Probable Causes.....	11
C. Safety Analysis	11
VI. Countermeasures	12
A. Short-Term Countermeasures	12
B. Medium-Term Countermeasure	13
C. Long-Term Countermeasure.....	15
D. Countermeasure for Future Consideration	17
VII. Benefit-Cost Analysis	17
VIII. Recommendations.....	18

List of Appendices

- Appendix A** – ODOT School Zone Safety Audit and Work Order
- Appendix B** – Count Data, TFMS Growth Rate Outputs, and Volume Calculations
- Appendix C** – Existing Conditions Capacity Analysis
- Appendix D** – Turn Lane Length Calculations
- Appendix E** – Sight Distance Analysis
- Appendix F** – Signal Warrant and AWSC Analysis
- Appendix G** – HSM Outputs
- Appendix H** – Proposed Conditions Capacity Analysis
- Appendix I** – Cost Estimate
- Appendix J** – Benefit-Cost Analysis

I. Executive Summary

A. Purpose and Need

The purpose of this study is to analyze existing conditions of the study area and identify potential countermeasures to reduce crash frequency and severity. The study limits include the intersection of SR-41 & CR-27 (Bloomingburg-New Holland Road) and extend approximately 500' on each intersection approach. The intersection of SR-41 & Bloomingburg-New Holland Road has been identified as a priority intersection by the Fayette County Engineer's Office.

B. Overview of Safety Issues

Crash data was obtained from ODOT Transportation Information Mapping System (TIMS) for six complete years, 2018-2023. There were 32 crashes in the study area during the six-year study period. Of the 32 crashes that occurred at the intersection, 14 were injury crashes (43.75%) and 18 were property damage only crashes (56.25%). The primary crash type was angle crashes (62.50%), followed by the secondary crash type of rear end crashes (15.63%).

C. Recommended Countermeasures and Related Costs

Below is a brief overview of the recommended countermeasures. See section VI Countermeasures for further details.

Short-term countermeasures:

- Increase stop sign visibility
- Install/upgrade intersection and stop ahead warning signs (recently installed)
- Install "Cross Traffic Does Not Stop" plaques (recently installed)

Medium-term countermeasure:

- Install warranted turn lanes

Long-term countermeasure:

- Install a roundabout

Countermeasure for future consideration:

- Install pedestrian/bicycle infrastructure

The estimated cost for the warranted turn lane installation is \$1,877,200 and the roundabout installation is \$5,445,700. The expected annual crash adjustment shows a decrease in crashes for both projects. The roundabout is expected to mitigate more crashes compared to the turn lane installation project. The turn lane installation project has a benefit-cost ratio of 1.01, but the roundabout project has a benefit-cost ratio less than 1.0.

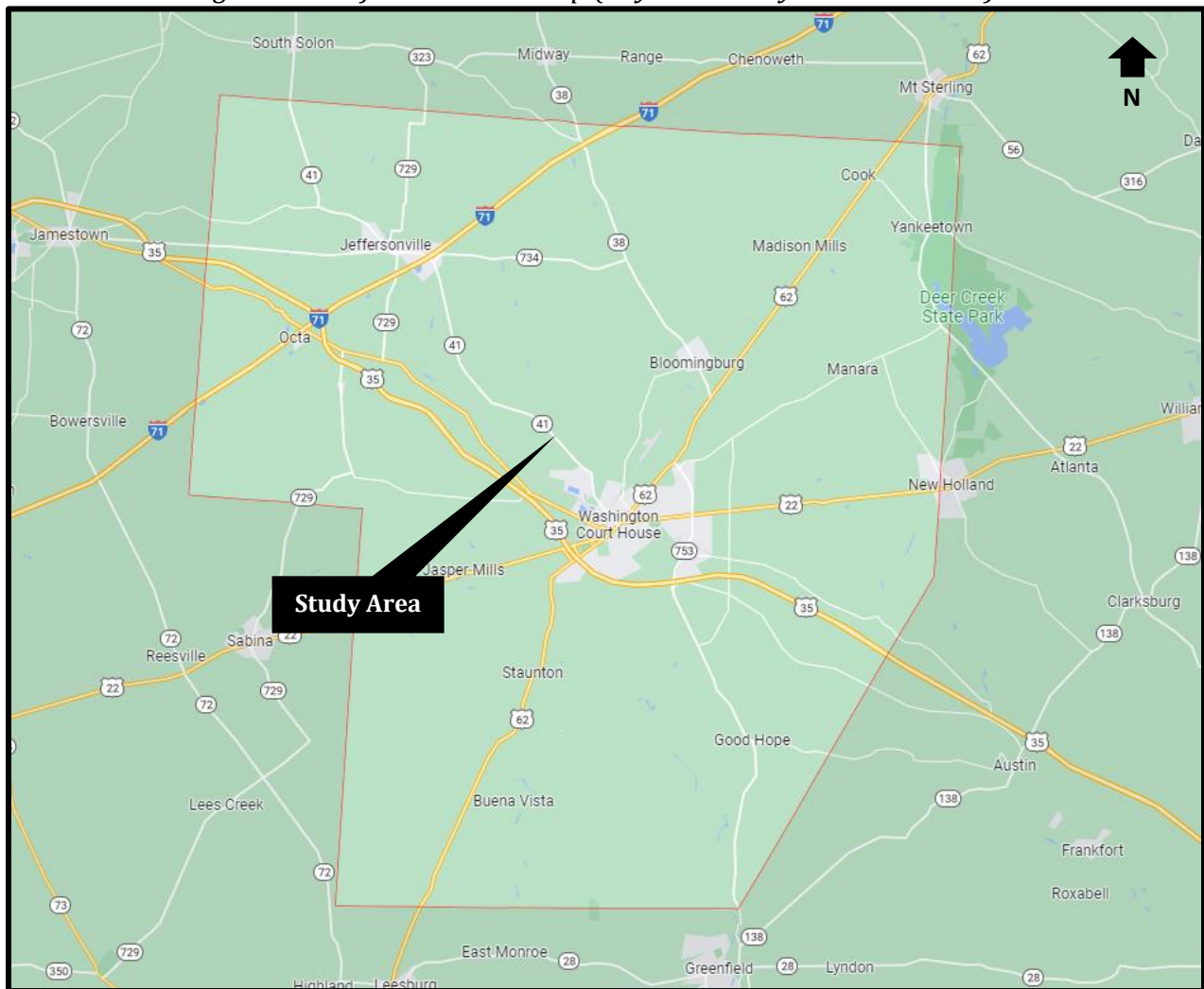
The warranted turn lane additions could be considered. However, this is also not expected to mitigate the primary crash concern. A roundabout is the remaining available option to reduce angle crashes occurring at the intersection. Even though the proposed roundabout is costly and results in an unfavorable benefit-cost ratio, it is still recommended a roundabout be further considered for implementation. The intersection experiences a high frequency of angle crashes which result in injury or fatality. The implementation of a roundabout is expected to mitigate this primary crash type. If desired, formal safety funding could be pursued for this improvement.

II. Purpose and Need

The purpose of this study is to analyze existing conditions of the study area and identify potential countermeasures to reduce crash frequency and severity. The study limits include the intersection of SR-41 & CR-27 (Bloomingburg-New Holland Road)¹ and extend approximately 500' on each intersection approach.

The intersection of SR-41 & Bloomingburg-New Holland Road has been identified as a priority intersection by the Fayette County Engineer's Office. A project location map is provided in **Figure 1**, a surrounding area map is provided in **Figure 2**, and a study intersection map is provided in **Figure 3**.

Figure 1 - Project Location Map (Fayette County outlined in red)



¹ Referred to as "SR-41 & Bloomingburg-New Holland Road" throughout the report.

Figure 2 – Surrounding Area Map

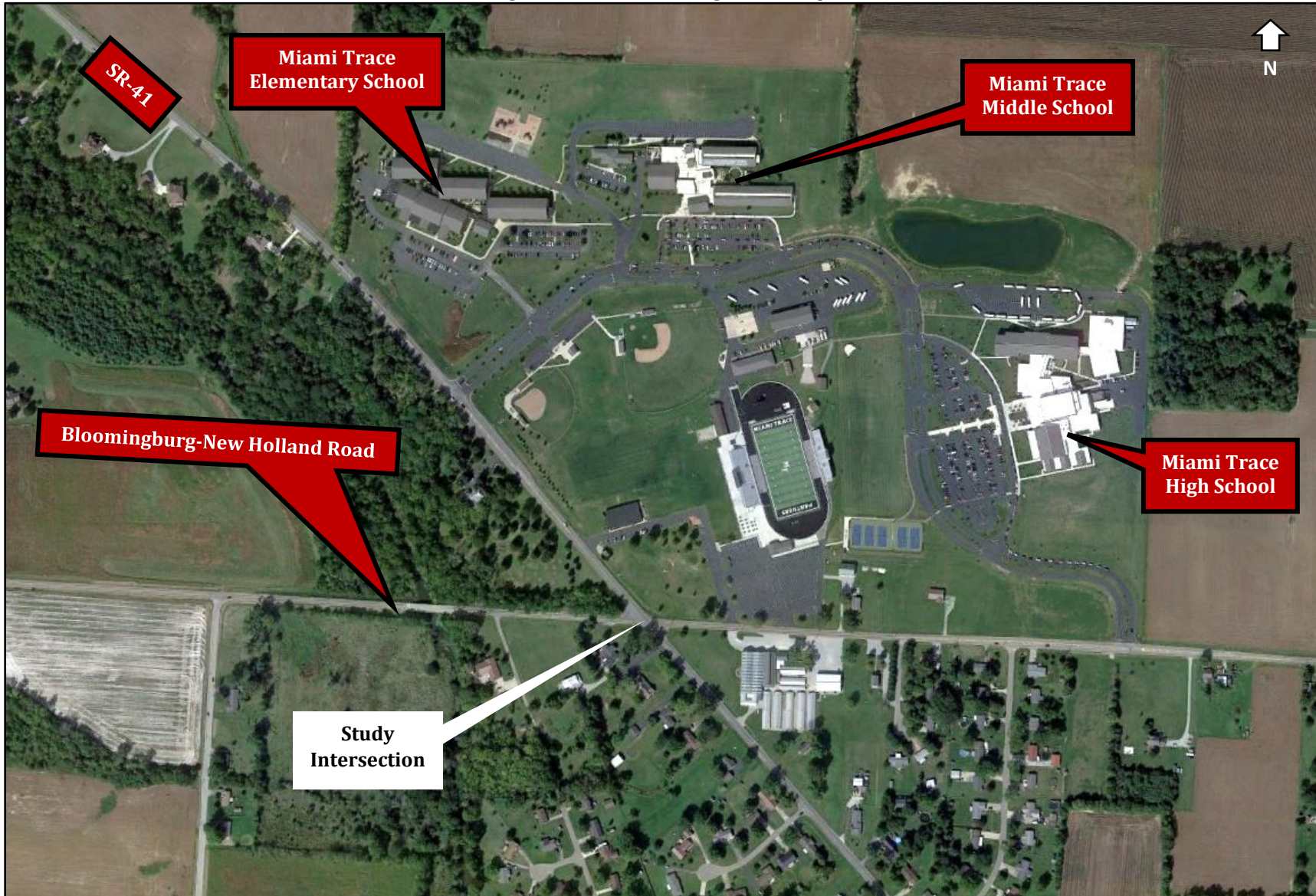


Figure 3 – Study Intersection Map



III. Existing Conditions

A. Land Use

The study area is north of the Washington Court House city limits. The area surrounding the study intersection includes residential single-family homes, a school campus, a plant nursery, and undeveloped land. The Miami Trace Local School District campus, which includes elementary, middle, and high schools, is in the northeast quadrant. McClish's Plants Plus Greenhouses is in the southeast quadrant. Single-family homes are in the southwest quadrant and undeveloped land is in the northwest quadrant of the intersection.

B. Roadway Conditions

SR-41

SR-41 serves as a north-south connector linking the cities of Troy, Springfield, and Washington Court House. SR-41 does not have a posted speed limit inside of the study area with the exception of the school zone, which is posted at 20 MPH during restricted hours. A speed limit of 55 MPH is assumed for SR-41. SR-41 is classified as an Urban Major Collector south of Bloomingburg-New Holland Road and a Rural Major Collector north of Bloomingburg-New Holland Road. The study area falls on the border of the adjusted urbanized area, so the analysis assumes SR-41 has an urban classification unless otherwise noted. It generally has a two-lane typical section with one-foot paved and one-foot gravel shoulders on both sides of the road throughout the study area. Raised pavement markers (RPMs) are present along SR-41. No roadway lighting, guardrail, curb, gutter, rumble strips/stripes, or sidewalk are present.

Bloomingburg-New Holland Road

Bloomingburg-New Holland Road is an east-west roadway that connects Old US-35 to Old SR-38. The roadway has a posted speed limit of 45 MPH except for the school zone during restricted hours. Bloomingburg-New Holland Road is classified as a Minor Collector and has a two-lane typical section with a 0–1-foot paved shoulder. The road falls along the border of the adjusted urbanized area throughout the study area, so it is assumed that the roadway has an urban classification unless otherwise noted. RPMs are present along Bloomingburg-New Holland Road throughout the study area. The roadway generally has no roadway lighting, curb, gutter, rumble strips/stripes, or sidewalk. Guardrail is present on the north side of the roadway on the western edge of the study area.

C. Intersection Conditions

SR-41 & Bloomingburg-New Holland Road is a four-leg intersection with all single-lane approaches. The Bloomingburg-New Holland Road approaches are stop controlled while the SR-41 approaches are free-flow. An intersection skew angle of approximately 44 degrees is present. The intersection configuration can be seen in **Figure 3**.

Both Bloomingburg-New Holland Road approaches to the study intersection have a single stop sign with post reflector on the right side of the road. Signage along Bloomingburg-New Holland Road for eastbound traffic includes a stop ahead warning sign with signpost reflector located approximately 570' west of the intersection, two school speed limit signs (located approximately 850' and 300' west of the intersection), and a 45 MPH speed limit

sign located approximately 180' east of the intersection. Signage for westbound traffic includes a stop ahead warning sign with signpost reflector located approximately 815' east of the intersection and a school speed limit sign located 615' east of the intersection.

Signage approaching the study intersection along SR-41 includes informational signs reading 'Eber' located approximately 375' north of the intersection facing southbound traffic and approximately 350' south of the intersection facing northbound traffic. A school ahead warning sign is also located approximately 550' south of the study intersection. SR-41 marker signs with directional signs (north and south) are located approximately 375' north of the intersection and approximately 30' south of the intersection. The post for the SR-41 south marker sign also includes hospital directions. At the intersection, a street sign for Bloomingburg-New Holland (CR-27) is located in the northeast corner of the intersection along with a school speed limit sign and flashing beacons facing northbound traffic. An 'End School Speed Limit' sign is also mounted on the back of the beacon pedestal for southbound traffic.

D. ODOT School Zone Safety Audit and Work Order

ODOT District 6 conducted a school zone safety audit in April 2024. The audit provided the following recommendations:

- Cross traffic does not stop (W4-4P) plaques be installed below the stop signs on eastbound and westbound approaches of Bloomingburg-New Holland Road
- Stop bars added for both the eastbound and westbound approaches of Bloomingburg-New Holland Road
- Cross Road (W2-1) signs be installed on SR-41 in both the northbound and southbound directions in advance of Bloomingburg-New Holland Road
- Lane Use Control (L-T) (R3-H8ba) sign on SR-41 at beginning of taper of southbound left turn lane for school access
- Lane Use Control (T-R) (R3-H8bb) sign on SR-41 at beginning of taper of northbound right turn lane for school access

ODOT indicated these recommendations have been installed during the time of this safety study. The school zone safety audit and work order are provided in **Appendix A**.

E. Data Collection

Turning movement counts were collected at the study intersection from 6 AM – 7 PM on Wednesday, May 8, 2024 while school was in session. The only events on the school calendar that day included Cincinnati Playhouse at the elementary school, a band concert at the high school, pizza with the principal at the middle school, and the Washington DC trip for the middle school. Count data is provided in **Appendix B**.

F. Traffic Volume Development

The ODOT Transportation Forecasting Monitoring System (TFMS) was used to obtain linear, annual growth rates for the study intersection. A growth rate of 0.5% for the intersection was utilized to be conservative.

Peak hour to design hour adjustments were applied to the 2024 count data. A Design Year of 2044 is assumed for analysis purposes. The adjusted 2024 count data was projected to 2044 using the 0.5% growth rate. Count data, peak hour to design hour adjustment factor tables, TFMS growth rate outputs, and volume calculations are provided in **Appendix B**.

IV. Existing Conditions Analysis

A. Capacity Analysis

Highway Capacity Software (HCS) version 2023 was used to conduct capacity analysis of the existing intersection configuration. AM and PM peak hour volumes for adjusted 2024 (Existing Year) and 2044 (Design Year) were used for this analysis.

Existing conditions capacity analysis results for 2024 and 2044 are provided in **Table 1**. In general, a level of service (LOS) of D for the overall intersection, approaches, and individual movements is considered acceptable. Detailed existing conditions capacity results are provided in **Appendix C**.

Table 1 – Existing Conditions Capacity Analysis Results

Movement	2024				2044			
	AM		PM		AM		PM	
	Delay ^a	LOS ^b	Delay ^a	LOS ^b	Delay ^a	LOS ^b	Delay ^a	LOS ^b
EB	C	24.4	C	23.8	D	31.6	D	29.4
WB	B	13.5	C	18.9	B	14.2	C	22.4
NB Left	A	7.9	A	8.4	A	8.0	A	8.6
SB Left	A	7.7	A	7.8	A	7.8	A	7.9

a – Average total delay in seconds per vehicle

b – Level of service (LOS)

Overall, the existing conditions analysis shows LOS/delay is currently acceptable and is expected to continue to be acceptable with expected growth.

B. Turn Lane Warrant Analysis and Length Calculations

Turn lane warrant analysis and length calculations were developed according to the methodologies in the ODOT Location and Design (L&D) Manual. A design speed of 5 MPH above the posted speed limit (60 MPH for SR-41 and 50 MPH for Bloomingburg-New Holland Road) was assumed for each approach and used for the analysis.

Turn lane warrant analysis was conducted for northbound and southbound left and right turn lanes. Calculated turn lane lengths are inclusive of a 50' diverging taper. A summary of the results is provided in **Table 2**. The full turn lane length analysis can be found in **Appendix D**.

Table 2 - Turn Lane Length Summary

Turn Lane	2024	2044
SR-41 NBL	Not Warranted	Warranted - 345'
SR-41 NBR	Not Warranted	Not Warranted
SR-41 SBL	Warranted - 345'	Warranted - 345'
SR-41 SBR	Warranted - 345'	Warranted - 345'

As shown in **Table 2**, a 345' northbound left, southbound left, and southbound right turn lane are all warranted by the design year.

C. Sight Distance Analysis

Horizontal intersection sight distance for minor street approaches were evaluated per methodologies in the ODOT L&D Manual. Exhibits showing sight triangles for each turning movement for each approach can be found in **Appendix E**. Based on these analyses, sight distance is acceptable for all turning movements.

D. Signal Warrant Analysis

A signal warrant analysis was conducted at the study intersection according to methodologies listed in the Ohio Manual of Uniform Traffic Control Devices (OMUTCD). Analyses were conducted for 2024 and 2044 volumes, with and without right turn reductions (RTR). The results show a traffic signal is not warranted per ODOT standards with either current traffic volumes or projected 2044 volumes. The full signal warrant analysis can be seen in **Appendix F**.

E. All-Way Stop-Control Analysis

An all-way stop-control (AWSC) analysis was performed at the study intersection per the OMUTCD using 2024 count data. The results show the AWSC criteria is not met based on traffic volumes or by crash history. The full warrant analysis can be seen in **Appendix F**.

V. Crash Data

A. Crash Data Summary

Crash data was obtained from ODOT TIMS for six complete years (2018-2023). A total of 33 crashes were obtained. The OH-1 report for each documented crash was reviewed to correct information, where necessary, and properly locate crashes within the study limits.

The original crash data query included 33 crashes, which was adjusted to 32 after reviewing and relocating crashes. **Table 3** shows a breakdown of the crash data. Crash data for the study area was plotted on an aerial map to identify crash patterns and probable causes. The crash diagram for the study area is shown in **Figure 4**.

Table 3 - Crash Statistics

Crash Year	Number	Percent
2018	8	25.0%
2019	8	25.0%
2020	2	6.3%
2021	5	15.6%
2022	3	9.4%
2023	6	18.8%

Crash Severity	Number	Percent
Injury Crash	14	43.7%
Property Damage Crash	18	56.3%

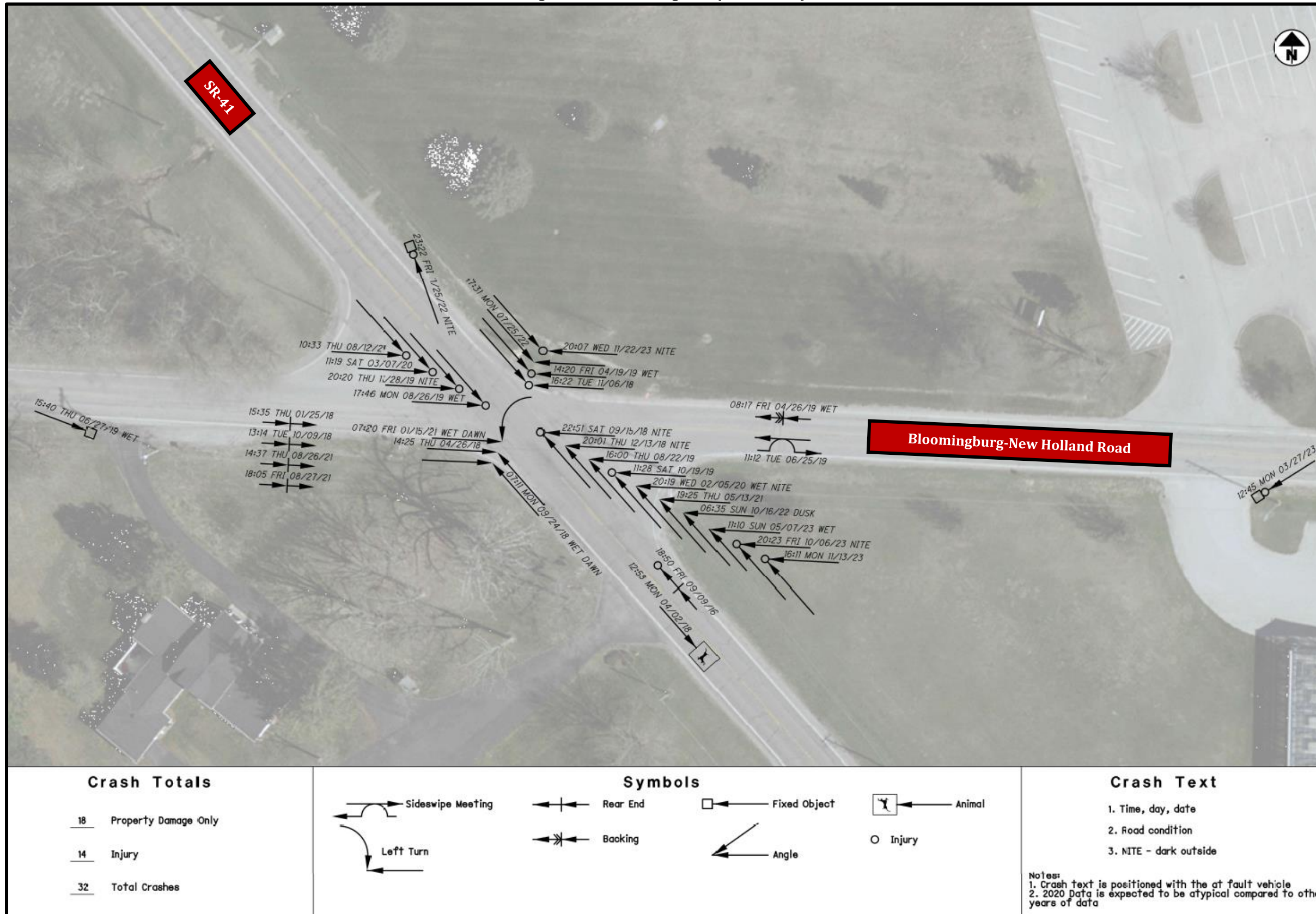
Crash Type	Number	Percent
Angle	20	62.5%
Rear End	5	15.6%
Fixed Object	3	9.4%
Sideswipe - Meeting	1	3.1%
Backing	1	3.1%
Animal	1	3.1%
Left Turn	1	3.1%

Road Condition	Number	Percent
Dry	23	71.9%
Wet	9	28.1%

Hour of Day	Number	Percent
6:00 AM	1	3.1%
7:00 AM	2	6.3%
8:00 AM	1	3.1%
10:00 AM	1	3.1%
11:00 AM	4	12.5%
12:00 PM	2	6.3%
1:00 PM	1	3.1%
2:00 PM	3	9.4%
3:00 PM	2	6.3%
4:00 PM	3	9.4%
5:00 PM	3	9.4%
6:00 PM	1	3.1%
7:00 PM	1	3.1%
8:00 PM	5	15.6%
10:00 PM	1	3.1%
11:00 PM	1	3.1%

Day of Week	Number	Percent
Sunday	2	6.3%
Monday	6	18.8%
Tuesday	3	9.4%
Wednesday	2	6.3%
Thursday	9	28.1%
Friday	7	21.9%
Saturday	3	9.4%

Figure 4 – Crash Diagram (2018-2023)



B. Probable Causes

Noteworthy crash patterns in the study area are summarized with supporting details and probable causes as follows:

- **Angle Crashes**
 Angle crashes were the most prevalent crash type at the study intersection. A total of 20 angle crashes were reported. Angle crashes represent 62.50% of the total crashes, significantly higher than the statewide average of 20.9%. 12 crashes involved northbound vehicles (10 involving westbound vehicles and two involving eastbound vehicles) while the remaining eight involved southbound vehicles (four involving westbound vehicles and four involving eastbound vehicles). 11 angle crashes resulted in possible injury, and nine in property damage only. It should be noted that seven of the eight angle crashes involving a southbound vehicle resulted in a possible injury.
- **Rear End Crashes**
 Rear end crashes were the second most prevalent crash type at the study intersection. A total of five rear end crashes were reported. Rear end crashes represent 15.63% of the total crashes, lower than the statewide average of 25.0%. All but one of the rear end crashes occurred on the eastbound approach to the intersection. The only rear end crash to involve a possible injury occurred on the northbound approach.

C. Safety Analysis

The Highway Safety Manual (HSM) predictive method for rural intersections was applied to the study area to determine the potential for safety improvement. The results presented in **Table 4** show the expected crash frequency calculated using HSM predictive method with cleaned crash data and existing conditions for the study area elements.

Table 4 - HSM Results for Existing Conditions for All Crashes (shown in crashes/year)

Predicted Average Crash Frequency	3.9113
Expected Average Crash Frequency - Existing Conditions	4.0559
Expected Excess Crashes	0.1446
Potential for Improvement	Yes

The results conclude the expected crash frequency is greater than the predicted crash frequency for the study intersection. This suggests the intersection experiences more average crashes per year than its peers and has a potential to reduce crashes based on HSM methodology. Overall, improvements can be implemented to mitigate future crashes. HSM output reports are provided in **Appendix G**.

VI. Countermeasures

The following section addresses possible countermeasures to mitigate the prevalent crash types in the study area. The countermeasures listed may be independent solutions and are not necessarily recommended to be implemented concurrently.

A. Short-Term Countermeasures

Increase Stop Sign Visibility

The existing stop signs could be upgraded to oversized or LED flashing stop signs posted on both sides of the road. This would increase stop sign visibility. This upgrade to the stop signs would increase driver awareness of the intersection and possible conflicts ahead. See **Figure 5**. Note, most of the crashes at the intersection are due to failure to yield, not failure to stop. Per the ODOT Traffic Engineering Manual (TEM) 201-3.3, LED flashing stop sign installation is reserved for locations with a failure to stop crash pattern. Drivers are generally able to see the stop signs, so the addition of oversized or LED flashing signage will likely have minimal impacts. However, installation of oversized or LED flashing stop signs instead could still be considered to improve general safety in the study area at a low cost.

Figure 5 – LED Flashing Stop Sign



Install/Upgrade Intersection and Stop Ahead Warning Signs

Consider installing new, dual intersection warning signs (W2-1) on the northbound and southbound approaches and a second stop ahead sign (W3-1) on both the eastbound and westbound approaches. Additionally, these signs could be considered for an upgrade to LED flashing signs, as could the existing stop ahead signs on the eastbound and westbound approaches. These would increase driver awareness of the intersection and possible conflicts. However, they would not address the failure to yield angle crashes prevalent at the study intersection. Note, intersection warning signs (W2-1) were installed on the northbound and southbound approaches per the ODOT District 6 work order provided in **Appendix A**.

Install “Cross Traffic Does Not Stop” Plaques

Install a “Cross Traffic Does Not Stop” plaque (W4-4P) below each existing stop sign. The OMUTCD states this may be used when engineering judgment indicates that conditions are present that are causing or could cause drivers to misinterpret the intersection as AWSC. These signs would increase driver awareness of the intersection and clearly indicate that the intersection is not operating under AWSC. This may not address the failure to yield angle crashes prevalent at the intersection as it is unclear if drivers incorrectly perceive the intersection as AWSC. Note, “Cross Traffic Does Not Stop” plaques (W4-4P) were installed below each existing stop sign per the ODOT District 6 work order provided in **Appendix A**.

B. Medium-Term Countermeasure

Install Warranted Turn Lanes

The installation of the warranted northbound left, southbound left, and southbound right turn lanes may be considered for implementation at this intersection. Both southbound turn lanes are warranted in the existing condition and the northbound turn lane is expected to be warranted by the 2044 design year. Based on the crash history, this improvement could mitigate one northbound rear end crash that resulted in injury. However, the turn lanes are not expected to address the failure to yield angle crashes prevalent at the study intersection and are not needed for capacity reasons.

Capacity analysis was conducted using HCS with 2024 and 2044 traffic volumes to assess the capacity of the turn lane installation. LOS and vehicle delay results are summarized in **Table 5**. Detailed capacity analysis results are provided in **Appendix H**.

Table 5 – Warranted Turn Lane Installation Capacity Analysis Results

Movement	2024				2044			
	AM		PM		AM		PM	
	Delay ^a	LOS ^b	Delay ^a	LOS ^b	Delay ^a	LOS ^b	Delay ^a	LOS ^b
EB	C	22.3	C	20.1	D	27.6	C	23.3
WB	B	13.4	C	18.5	B	14.1	C	21.6
NB Left	A	7.9	A	8.4	A	8.0	A	8.6
SB Left	A	7.7	A	7.8	A	7.8	A	7.9

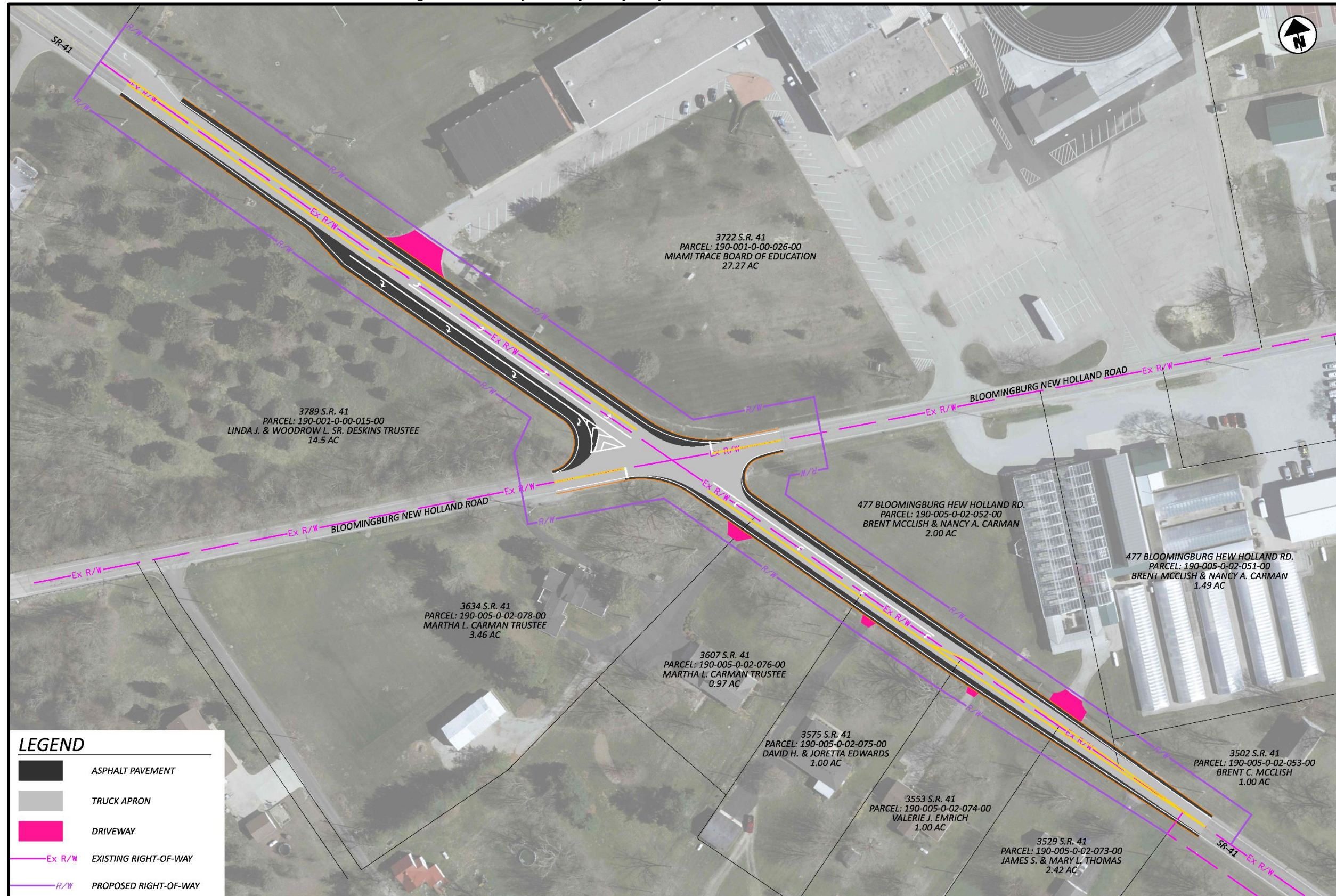
a – Average total delay in seconds per vehicle

b – Level of service (LOS)

Overall, the analysis shows minimal capacity improvement compared to the existing conditions.

A conceptual, planning-level layout of the proposed warranted turn lane installation is provided in **Figure 6**.

Figure 6 – Conceptual Layout of Proposed Warranted Turn Lane Installation



C. Long-Term Countermeasure

Install a Roundabout

A roundabout should be considered for implementation at this intersection. The FHWA Office of Safety identified roundabouts as a Proven Safety Countermeasure because of their ability to greatly reduce the types of crashes that result in serious injury or fatality. By reducing the number and severity of conflict points at the intersection, and because of the lower speeds of vehicles moving through the intersection, roundabouts have been proven to be a safer intersection type. Roundabouts are generally becoming more common throughout Ohio. It is anticipated that traffic driving through the intersection will be familiar with roundabouts.

Capacity analysis was conducted using HCS with 2024 and 2044 traffic volumes to assess the capacity of the proposed roundabout installation. LOS and vehicle delay results are summarized in **Table 6**. Detailed roundabout capacity analysis results are provided in **Appendix H**.

Table 6 – Roundabout Capacity Analysis Results

Movement	2024				2044			
	AM		PM		AM		PM	
	Delay ^a	LOS ^b	Delay ^a	LOS ^b	Delay ^a	LOS ^b	Delay ^a	LOS ^b
EB	5.8	A	6.0	A	6.3	A	6.5	A
WB	4.8	A	4.4	A	5.0	A	4.5	A
NB	5.4	A	5.0	A	5.8	A	5.3	A
SB	5.4	A	8.0	A	5.7	A	8.8	A

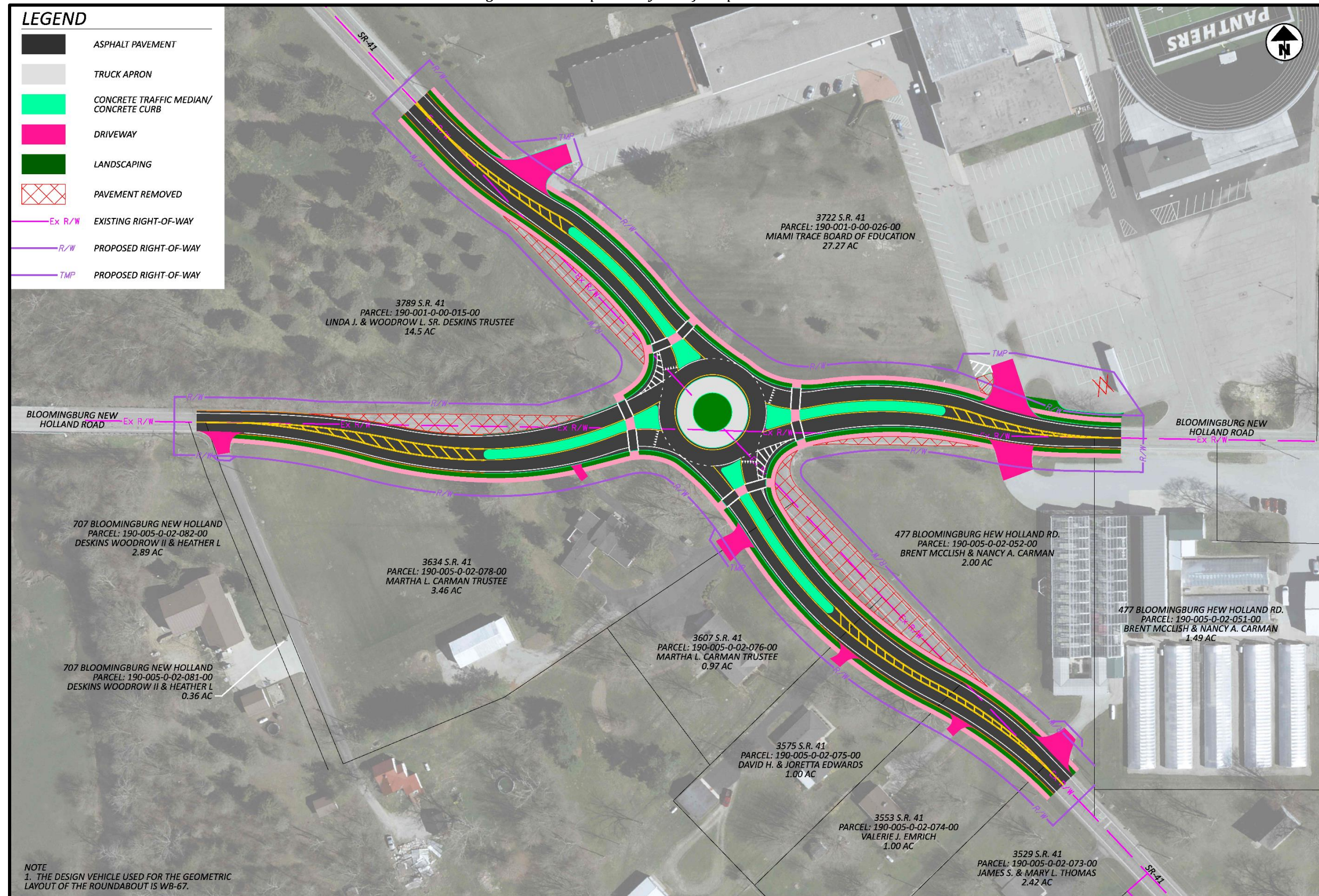
a – Average total delay in seconds per vehicle

b – Level of service (LOS)

Capacity analysis shows that a single circulating lane roundabout with single lane approaches will operate with acceptable LOS through 2044. The results also show a notable capacity improvement compared to existing conditions.

A conceptual, planning-level layout of the proposed roundabout configuration is provided in **Figure 7**. The roundabout should be designed to ensure that any needed trucks/farm equipment would be able to traverse the roundabout.

Figure 7 – Conceptual Layout of Proposed Roundabout



D. Countermeasure for Future Consideration

Install Pedestrian/Bicycle Infrastructure

Consideration may be given to installing pedestrian infrastructure, such as sidewalks or a shared-use path (SUP), at the study intersection and extending outside the study area. All Miami Trace School District schools are currently located in the northeast corner of this intersection and the complementary land use of residential single-family homes and neighborhoods are located on the south side of Bloomingburg-New Holland Road. The addition of a SUP or sidewalk network and connection of the existing neighborhoods to the school campus would encourage alternative modes of travel to the schools, which would reduce the amount of vehicular traffic. It is recommended that pedestrian infrastructure be included with the implementation of intersection improvements. Sidewalk installations are shown in the conceptual layout of the proposed roundabout in **Figure 7**. Connections extending outside the study area can be considered with future projects. ODOT Safe Routes to School funding could be considered, if the installation is not included in an intersection improvement project.

VII. Benefit-Cost Analysis

Benefit-cost analysis is a tool used to determine the financial benefits of a project by comparing the net present value (NPV) of a project to the NPV of the safety benefit provided by the project. Benefit-cost values greater than one indicate a positive return on the original investment. Preferred countermeasures are those having the highest NPV of safety benefits.

Benefit-cost analyses for the recommended medium- and long-term countermeasures were prepared using the ODOT Economic Crash Analysis Tool (ECAT). Crash modification factors (CMF) were applied for the proposed improvements. This analysis does not account for all recommended improvements and only includes countermeasures that have CMF values.

Cost estimates were prepared for the medium- and long-term countermeasures. The construction cost estimates assume the following:

- 15% engineering design
- 30% contingency
- 10% environmental, geotechnical, federal requirements
- 11.3% inflation rate for an estimated 2026 construction year
- Right-of-way costs
- Utility relocation costs not included

The estimated cost for the countermeasures is summarized in **Table 7**. Detailed cost estimates are included in **Appendix I**.

Table 7 – Cost Estimates

Countermeasure	Total
Turn Lanes	\$1,877,200
Roundabout	\$5,445,700

The proposed improvements fundamentally change the conditions of the base safety performance function. For this reason, a separate HSM analysis was conducted of the proposed conditions and compared to the existing conditions.

Table 8 summarizes the benefit-cost analysis results. Detailed benefit-cost analysis reports from ECAT are included in **Appendix J**.

Table 8 - Benefit-Cost Analysis

	Countermeasure	
	Turn Lanes	Roundabout
Expected Annual Crash Adjustment	-2.162	-2.724
NPV of Project	\$1,686,613.90	\$4,892,813.70
NPV of Safety Benefit	\$1,697,841.76	\$2,964,402.37
Benefit-Cost Ratio	1.01	0.61

The expected annual crash adjustment shows a decrease in crashes for both countermeasure projects. The roundabout is expected to mitigate more crashes compared to the turn lane installation project. The turn lane installation project has a benefit-cost ratio of 1.01, but the roundabout project has a benefit-cost ratio less than 1.0. This indicates the ECAT methods predict the cost of the roundabout project is not justified based on the calculated value of safety benefits to be obtained. This shows the roundabout project would not have a positive return on the original investment and crashes are expected to be reduced.

VIII. Recommendations

Even though the proposed roundabout is costly and results in an unfavorable benefit-cost ratio, it is still recommended a roundabout be further considered for implementation. The intersection experiences a high frequency of angle crashes which result in injury or fatality. The implementation of a roundabout is expected to mitigate this primary crash type.

Available low-cost, short-term countermeasures are not expected to reduce the primary crash concern. Signalization and AWSC conversion are not warranted since the intersection does not meet the required volume thresholds. The warranted turn lane additions could be considered. However, this is also not expected to mitigate the primary crash concern.

A roundabout is the remaining available option to reduce angle crashes occurring at the intersection. If desired, formal safety funding could be pursued for this improvement.