TUS-250-2.223 Traffic Study

Intersection of US 250 & SR 21 in Tuscarawas County

ODOT District 11
Office of Planning
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Department of Transportation

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1 EXECUTIVE SUMMARY

1.1 BACKGROUND:

The study location is the intersection of US Route 250 and State Route 21 located in Tuscarawas County (ODOT District 11). The intersection is a T-type intersection with stop-control on the eastbound approach of US 250 only. A previous study at this intersection in 2014 evaluated the speed limits. As per that study, speed limits on all approaches were reduced to 50 MPH. Additionally, a Traffic Impact Study was conducted in 2018 for a new ProVia window plant. From that study, the intersection of US 250 & SR 21 was found to require traffic signal control or a modern roundabout to provide an acceptable level-of-service (LOS).

1.2 PURPOSE & NEED:

The intersection of US 250 and SR 21 is not currently ranked on ODOT's Highway Safety Improvement Program (HSIP) priority lists. However, there has been an upward trend in crashes in recent years. This intersection is on the 2022 Traffic Operations System Analysis Tool (TOAST) maps as part of the #1 ranked location for congestion on an Urban Non-Freeway in District 11. The intersection has a current LOS D and is predicted to have an LOS F by the time a project could be built in 2028. The purpose of this report is to re-analyze this intersection based on the 2018 Traffic Impact Study and recommend a countermeasure that best mitigates the safety and congestion issues.

1.3 SUMMARY OF ALTERNATIVES:

Constructing a traffic signal at this intersection would also require the lengthening of the storage lane and tapers on Westbound US 250. Construction of this alternative would cost approximately $1,449,056.86. A new signal provides a B/C ratio of -0.17 and would likely increase crashes by 1.103 crashes per year. However, it is anticipated that the severity of the crashes would go down due to the new most frequent crash type being rear-end type crashes. The LOS for the intersection would improve from LOS F in the opening year to LOS E.

Constructing a single-lane roundabout would cost approximately $3,006,063.27. This alternative provides a positive B/C ratio of +0.31 and should reduce crashes by 0.973 crashes per year. The LOS for the intersection would also improve from LOS F in the opening year to LOS B.

1.4 RECOMMENDED COUNTERMEASURE & RELATED COSTS:

The preferred countermeasure is to convert this T-intersection to a modern single-lane roundabout. In total, the construction of a single-lane roundabout would cost approximately $3,006,063.27. Although this option costs more than the traffic signal, a roundabout provides a better B/C ratio. The roundabout B/C ratio is a +0.31, where the traffic signal is a -0.17. This means the signal will have a negative impact on safety at the intersection and crashes would increase, while it is anticipated a roundabout would reduce crashes. Additionally, congestion at this intersection improves from a LOS F in the opening year to a LOS B with a roundabout, and to a LOS E with a traffic signal. Therefore, the roundabout alternative is better at both increasing safety and reducing congestion at the intersection.

2 PURPOSE & NEED

This study analyzes the intersection of US 250 and SR 21 in Tuscarawas County, Ohio. This intersection is not currently ranked on ODOT's HSIP priority lists. However, there was a large upward trend in 2021 and 2022, indicating this location could be on the lists in the near future. This intersection is, however, on the 2022 TOAST maps as part of the #1 ranked location for congestion on an Urban Non-Freeway in District 11. The US 250 corridor from SLM 1.610 (0.613 miles West of our intersection) to SLM 5.632 (IR 77 Interchange) ranks #1 overall (for all roadway categories) for District 11 in the southbound direction, and #6 overall for the northbound direction. See ***Appendix E*** for TOAST score and ranking maps. The purpose of this report is to analyze the crash trends at this location and recommend countermeasures to mitigate any safety or congestion issues.

3 EXISTING CONDITIONS

3.1 BACKGROUND

The study location is the intersection of US 250 and SR 21 in Tuscarawas County, Ohio and under the jurisdiction of ODOT District 11. US 250 is a two-lane, undivided asphalt roadway classified by ODOT as Urban Principal Arterial Other with a statutory speed of 50 miles per hour oriented in an east-west direction. SR 21 is also a two-lane, undivided asphalt roadway classified by ODOT as an Urban Principal Arterial Other with a statutory speed of 50 miles per hour oriented in a north-south direction. The land use in the proximity of this intersection is a combination of residential, commercial, manufacturing, and agricultural. US 250 intersects SR 21 at a T-type intersection, with stop control on the eastbound approach of US 250 only. The westbound approach of US 250 does not have a dedicated left-turn lane but does have an "escape lane" to allow traffic northbound onto SR 21 to by-pass vehicles turning left. The southbound approach of SR 21 has a drop-out lane for right-turns onto US 250 westbound. This drop-out lane intersects US 250 westbound with a yield sign. There are no exclusive turn lanes on the eastbound approach to the intersection.

As per ODOTs MS2 Transportation Data Management System, traffic counts were last recorded in April 2022. Per MS2, current average annual daily traffic (AADT) volumes for the westbound approach of US 250 were 11,657 vehicles per day with 14% (1,606 vehicles per day) daily truck traffic. The eastbound approach of US 250 is 6,491 vehicles per day with 13% (871 vehicles per day) daily truck traffic. The southbound approach of SR 21 is 5,474 vehicles per day with 9% (504 vehicles per day) daily truck traffic. Additionally, turning movement counts (TMC) for the intersection were taken on October 26, 2023, and are included in ***Appendix D*** of this report.

This intersection has been under study previously in 2014 to evaluate the speed limits on each approach to the intersection. As per the recommendation of that study, the speed limit on each approach of the intersection was reduced from 55 MPH to 50 MPH.

In August 2023, the village of Strasburg reached out to ODOT District 11 about safety concerns at this intersection. Although the intersection is not within the corporation limits of Strasburg, the intersection is only 0.86 miles to the north of the village and serves as the main corridor in and out of the village. All traffic headed north out of Strasburg goes through this intersection. In addition, the

village expressed that it has seen an increase in both passenger vehicle and truck traffic through town and this intersection since the construction of a new manufacturing facility for ProVia just north of the intersection. ProVia constructed this large 337,380 S.F. window manufacturing plant with access to both US 250 and SR 21 in 2019. As per ODOT permitting standards, a Traffic Impact Analysis was performed for this project and is discussed further in ***Section 5 Summary of Supplemental Traffic Studies***.

3.2 EXISTING CONDITIONS DIAGRAM

An existing conditions diagram representing the most important physical features along each roadway segment is shown in ***Appendix B***. The diagram shows each approach to the intersection, including all pertinent traffic control devices, such as signs and pavement markings, at their approximate locations.

3.3 PHYSICAL CONDITIONS WRITE-UP

The topography near the intersection of US 250 and SR 211 is level. The westbound alignment of US 250 as it approaches the intersection is tangent. The eastbound alignment of US 250 as it approaches the intersection is a 43°15' curve to the left. The southbound alignment of SR 21 as it approaches the intersection is a 1°30' curve to the left.

The design standard for stopping sight distance (SSD) at 50 mph is 425 feet. Field observations estimate the SSD on the three approaches to the intersection as shown in *Table 1*. SSD meets and exceeds the minimums for the through movement at this intersection. However, due to the horizontal curvature leading into the intersection, the US 250 EB approach with a stop condition is near the SSD minimum. When there is oncoming traffic, westbound US 250 vehicles can also block the view of eastbound vehicles approaching the intersection. In this situation, SSD could be even less and potentially not meet the standard.

US 250 WB Approach	>2,000 FT
US 250 EB Approach	480 FT
SR 21 SB Approach	1,150 FT

Table 1 - Stopping Sight Distances at the Intersection of US 250 & SR21

The base condition for intersection sight distance (ISD) for passenger cars making a left-turn from a stop onto a 50 MPH roadway is 555 feet. For passenger cars making a right-turn from a stop onto a 50 MPH roadway, the ISD is 480 feet. ISD is met at this location. Field observations estimating the ISDs for each leg of US 250 eastbound are shown in *Table 2*:

US 250 EB Approach, Looking North	1,300 FT
US 250 EB Approach, Looking South	950 FT

Table 2 - Intersection Sight Distances at the Intersection of US 250 & SR 21

The lane widths on all approaches to the intersection are 12 feet. Based on field observations, the pavement at the intersection and along each approach of the intersection appears to be in good condition with some aging and cracking. The pavement markings also appear to be in good condition. Both US 250 and SR 21 are marked with a double-yellow center line and white edge lines.

There are passing zones headed eastbound on US 250 on the south leg of the intersection, and there is a passing zone for westbound US 250 on the west leg of the intersection. There is a stop bar along the US 250 eastbound stop-controlled approach. There is a channelized line separating the left-turn and through traffic on the westbound US 250 approach (south leg).

Each approach to the intersection also contains route marker signs and additional traffic control safety devices. Both the westbound US 250 (south leg) and southbound SR 21 (north leg) approaches have dual "Side Road Ahead" (W2-2) warning signs with supplemental street name plaques (M2-1). The eastbound US 250 approach (west leg) has dual "Left Turn Ahead" (W1-1) warning signs with "15 MPH" advisory speed plaques, dual "Stop Sign Ahead" (W3-1) warning signs, a large one direction night arrow (W1-6) warning sign, and dual stop signs (R1-1) at the intersection.

There is currently no highway lighting at the intersection.

The physical conditions described above, including all the safety features approaching the intersection are documented with photographs in ***Appendix A*** and the "Existing Conditions Diagram" in ***Appendix B***.

4 HIGHWAY CAPACITY ANALYSIS OF EXISTING CONDITIONS

The *Highway Capacity Manual* defines capacity as the maximum suitable flow rate which vehicles reasonably can be expected to traverse a point during a specified time period. Capacity uses the measure of efficiency, Level-of-Service (LOS), to describe the traffic performance at intersections. LOS is defined for the overall intersection delay of signalized intersections. An acceptable LOS for a signalized intersection is considered to be LOS D or better (i.e. A, B, C, or D). Any signalized intersection or approach with a LOS of E or F is considered substandard and may need solutions to improve the operational performance.

At unsignalized intersections, the LOS is defined by the control delay for the movement that must yield right-of-way. It may be typical for stop-controlled minor streets to experience long delays during peak periods, while the majority of the traffic through the intersection on the major street travel unimpeded.

The procedures outlined in the *Highway Capacity Manual; 6th Edition* were used as guidelines for the analysis of the study area intersection. This manual provides procedures for the analysis of both signalized and unsignalized intersections. LOS categories for travel delay range from LOS A (best) to F (worst) as shown in *Table 3*.

Level of Service	Signalized Intersetion Control Delay (sec/veh)	Unsignalized Intersection Control Delay (sec/veh)	Intersection LOS Description
A	≤ 10.0	≤ 10.0	Free flow, insignificant delays.
B	10.1 - 20.0	10.1 - 15.0	Stable operation, minimal delays.
C	20.1 - 35.0	15.1 - 25.0	Stable operation, acceptable delays.
D	35.1 - 55.0	25.1 - 35.0	Restricted flow, common delays.
E	55.1 - 80.0	35.1 - 50.0	Maximum capacity, extended delays. Volumes at or near capacity. Long queues form upstream from intersection.
F	> 80.0	> 50.0	Forced flow, excessive delays. Represents jammed conditions. Intersection operates below capacity with low volumes. Queues may block upstream conditions.

LOS analysis was completed with the use of the Highway Capacity Software (HCS). The analysis was performed using the existing 2-way stop controlled conditions for the current year (2024), opening year (2028), and design year (2048). Copies of the HCS analysis outputs for each analysis scenario and year are shown in ***Appendix F***. These results are summarized in *Table 4*. Note that free flow conditions do not have a LOS since they have no movements to delay them.

For the current year 2024, capacity analysis indicates US 250 westbound approach (south leg) left turn currently operates at a LOS A during both the AM and PM peaks. The US 250 eastbound approach (west leg) operates at an LOS B during the AM peak and LOS D during the PM peak.

For the opening year 2028, capacity analysis indicates US 250 westbound approach (south leg) left turn operates at a LOS A during both the AM and PM peaks. The US 250 eastbound approach (west leg) operates at an LOS C during the AM peak and LOS F during the PM peak.

For the design year 2048, capacity analysis indicates US 250 westbound approach (south leg) left turn operates at a LOS A during both the AM and PM peaks. The US 250 eastbound approach (west leg) operates at an LOS E during the AM peak and LOS F during the PM peak.

2-Way Stop Control (Existing Conditions)				
Location	**Traffic Control**	**Movement**	**AM Peak LOS (Delay)**	**PM Peak LOS (Delay)**
Current Year - 2024				
US 250 & SR 21	Stop Sign	Eastbound (West Leg)	B (13.6)	D (27.7)
		Westbound Thru (South Leg)	-	-
		Westbound Left (South Leg)	A (4.1)	A (4.2)
		Southbound (North Leg)	-	-
Opening Year - 2028				
US 250 & SR 21	Stop Sign	Eastbound (West Leg)	C (24.5)	F (576.3)
		Westbound Thru (South Leg)	-	-
		Westbound Left (South Leg)	A (5.1)	A (6.6)
		Southbound (North Leg)	-	-
Design Year - 2048				
US 250 & SR 21	Stop Sign	Eastbound (West Leg)	E (49.1)	F (1053.0)
		Westbound Thru (South Leg)	-	-
		Westbound Left (South Leg)	A (5.6)	A (7.6)
		Southbound (North Leg)	-	-
(XX.X) = Average Vehicle Delay in Seconds per Vehicle				

Table 3 - Summary of Existing Conditions LOS

5 CRASH DATA & ANALYSIS

5.1 CRASH DATA SUMMARIES, GRAPHS, & TABLES

A total of twenty-eight (28) crashes occurred near the intersection of US 250 and SR 21 for the study period between January 1, 2020, and September 1, 2023. Crash data in the form of tables and charts from these years can be seen in ***Appendix C.*** This data was compiled and analyzed using the Geographical Crash Analysis Tool (GCAT) and Crash Analysis Module (CAM).

5.2 COLLISION DIAGRAM

Appendix C also includes a Collision Diagram of all twenty-eight crashes that occurred near the intersection of US 250 and SR 21 between January 1, 2020, and September 1, 2023.

5.3 CRASH ANALYSIS

Of the twenty-eight (28) total crashes that occurred at the intersection, 25% (7) resulted in suspected injury and the remaining 75% (21) resulted in property damage only. There were no fatalities within the study time frame. Fatal crashes were also checked back through 2013 and there were no additional fatalities at this intersection.

Crash Severity	Crashes	%
(2) Serious Injury Suspected	1	3.57%
(3) Minor Injury Suspected	6	21.43%
(5) PDO/No Injury	21	75.00%
Grand Total	28	100.00%

Table 4 - Crash Severity

The most prominent types of crashes that occurred at the intersection were rear end (14) and left turn (9) crashes, representing 82.14% of all crashes. The other crash types were right turn, head on, sideswipe - passing, fixed object, and overturning.

Crash Type	Crashes	%
Rear End	14	50.00%
Left Turn	9	32.14%
Right Turn	1	3.57%
Head On	1	3.57%
Sideswipe - Passing	1	3.57%
Fixed Object	1	3.57%
Overturning	1	3.57%
Grand Total	28	100.00%

Table 5 - Types of Crashes

The primary contributing factors for the crashes were “following too closely/assured clear distance ahead” (14) and “failure to yield” (8). These factors combined were 78.57% of all the crashes. The remaining 21.43% of crashes were attributed to “load shifting/falling/spilling” (2), “improper turn” (2), “improper start from a parked position” (1), and “unsafe speed” (1).

Unit 1 Contributing Factor	Crashes	%
Following Too Closely/ACDA	14	50.00%
Failure to Yield	8	28.57%
Load shifting/Falling/Spilling	2	7.14%
Improper Turn	2	7.14%
Improper Start from a Parked Position	1	3.57%
Unsafe Speed	1	3.57%
Grand Total	28	100.00%

Table 6 - Contributing Factors

The most common crash type and contributing factor are related. All the rear-end crashes were contributed to “following too closely/assured clear distance ahead.” Most of these crashes (10, or 71.43%) occurred on the US 250 eastbound approach (west leg) at the intersection. All ten of these crashes occurred on dry pavements. The other four rear-end crashes also occurred on dry pavements. Two of the rear-end crashes occurred when it was dark, the twelve others occurred during daylight.

The second most common type of crash was left turn collisions. Seven of the nine left turn crashes (77.78%) occurred on the US 250 westbound approach (south leg) of the intersection when a vehicle was making the left turn to stay on US 250 westbound. The primary contributing factor for all the left turn crashes was “failure to yield,” “improper turn,” and “load shifting/falling/spilling.” Four of the left crashes occurred during daylight, four occurred when it was dark, and one occurred during

dawn/dusk. Two of the left turn crashes occurred on icy roads, while the other seven occurred on dry roads.

There were a total of twenty-one (75%) crashes that occurred related to the intersection. Along with the seventeen crashes stated above, the remaining four crashes directly related to the intersection were one sideswipe-passing, one overturning, one fixed object, and one other. The sideswipe passing crash occurred when a semi-truck turning left onto SR 21 struck another vehicle that was traveling west on US 250. The overturning crash occurred when a semi-truck tried to make the left turn to stay on US 250 westbound and overturned when the load on its trailer shifted. The fixed object crash occurred when a southbound vehicle on SR 21 attempted to make the right turn onto US 250 westbound and went off the left side of the roadway striking a ditch. The other crash occurred when a ladder fell off a vehicle traveling through the intersection and struck a vehicle stopped in the left turn lane.

71.43% (20) of all crashes occurred during daylight, while the remaining 28.57% (8) of crashes occurred during dark or dimly lit hours of the day.

Light Condition	Crashes	%
Daylight	20	71.43%
Dark - Roadway Not Lighted	7	25.00%
Dawn/Dusk	1	3.57%
Grand Total	28	100.00%

Table 7 - Light Condition

92.86% (26) of all crashes occurred on dry pavement, while the remaining 7.14% (2) of crashes occurred on icy pavement.

Road Condition	Crashes	%
Dry	26	92.86%
Ice	2	7.14%
Grand Total	28	100.00%

Table 8 - Road Condition

In only one crash (3.57%) was a driver cited for unsafe speed as a contributing factor to the crash. The remaining 96.43% (27) of crashes stated an estimated speed at or near the posted speed limit.

Speed Related	Crashes	%
No	27	96.43%
Yes	1	3.57%
Grand Total	28	100.00%

Table 9 - Speed Related

7.14% (2) of the crashes were related to construction work zones, while the remaining 92.86% (26) of crashes were not work zone related.

Work Zone Related	Crashes	%
No	26	92.86%
Yes	2	7.14%
Grand Total	28	100.00%

Table 10 – Construction Work Zones

Impaired driving due to alcohol and/or drugs was not suspected in any of the 28 crashes.

Crashes happened during most hours of the day, on every day of the week, and in almost every month of the year. The highest number of crashes were on Thursdays (9), from 3:00-5:00 PM (8), and in September (5). The lowest number of crashes was on Sunday (1). There were no crashes from midnight to 5:00 AM, 7:00-8:00 AM, 9:00-10:00 AM, or 9:00-11:00 PM. There were also no crashes in January, March, or May.

5.4 CRASH CONCLUSIONS

Out of the 28 crashes occurring within the vicinity of the intersection, twenty-one crashes (75%) were directly related to the operation of the intersection.

The most common crash type and contributing factor was rear-end crashes as the result of "following too closely/assured clear distance ahead." Most of these crashes (10, or 71.43%) occurred on the US 250 eastbound approach (west leg) and were directly related to the intersection operation.

The second most common type of crash was left turn collisions resulting from "failure to yield," "improper turn," and "load shifting/falling/spilling." Seven of the nine left turn crashes (77.78%) occurred on the US 250 westbound approach (south leg) of the intersection when a vehicle was making the left turn to stay on US 250 westbound.

The lack of highway lighting may have contributed to some of the crashes.

Excessive speed did not appear to be a major contributing factor.

Slippery pavement condition did not appear to be a major contributing factor.

Construction work zones did not appear to be a major contributing factor.

There were no noticeable trends due to the time of the crash.

6 SUMMARY OF SUPPLEMENTAL TRAFFIC STUDIES

In 2014, ODOT District 11 studied the speed limits surrounding the intersection of US 250 & SR 21. As per the findings of the speed zone studies, it was recommended to reduce the speeds on all three approaches to 50 MPH. This is journalized with revision #60413 on US 250 from SLM 1.38 (SR 93) to SLM 2.22 (SR 21), revision #60414 on US 250 from SLM 2.22 (SR21) to SLM 3.08 (Strasburg NCL), and revision # 60415 on SR 21 from SLM 0.00 (US 250) to SLM 0.49 (RJ Corman RR).

In 2018, ProVia performed a Traffic Impact Study to evaluate the impacts of constructing a new 337,380 S.F. window manufacturing plant with access to both US 250 and SR 21. The full study is included in ***Appendix K***. The study found that for the 2019 no-build condition, the intersection of US 250 and SR 21 already required signal control or modern roundabout improvements in order to provide acceptable levels of service (LOS). For the signal control option, the improvements also included lengthening the US 250 westbound left turn lane to provide adequate storage capacity. Per the study, they recommended evaluating this intersection on a periodic basis until a traffic signal or roundabout may be justified. Additionally, the LOS were found to be better for the roundabout than

the signal, but both improvements were found to have adequate capacity for both the opening year 2019 and design year 2039.

7 PROPOSED COUNTERMEASURE EVALUATION

As per the recommendation of the ProVia Traffic Impact Study, the following two (2) countermeasures are being considered and analyzed using both Highway Capacity Software and the Highway Safety Manual methodologies within ODOT's Economic Crash Analysis Tool (ECAT):

1. Construct a traffic signal and lengthen the left-turn lane on Westbound US 250 (south leg of the intersection).
2. Construct a modern single-lane roundabout.

From the findings of the crash analysis, new highway lighting is also being evaluated as part of the two above countermeasures to help mitigate nighttime crashes.

The ECAT analysis results using the Highway Safety Manual method for the existing condition and each countermeasure are included in the "Project Safety Performance Reports" in ***Appendix J***. ECAT was also used to perform a benefit-cost analysis for each of the proposed countermeasures. The "Safety Benefit Cost Analysis" reports are included in ***Appendix J***.

For the benefit-cost analysis for each countermeasure, the present value of each fatal and incapacitating injury (KA) crash was valued at $484,544. Non-incapacitating injury (B) crashes were valued at $69,135, possible injury (C) crashes were valued at $46,860, and property-damage only (O) crashes were valued at $0. These values were developed with crash data & consumer price index data to include monetary losses associated with medical care, emergency services, property damage, and lost productivity. They are considered the current standard for ODOT.

7.1 INSTALL A TRAFFIC SIGNAL & LENGTHEN LEFT TURN LANE ON WESTBOUND US 250

The *Ohio Manual of Uniform Traffic Control Devices (OMUTCD)* contains nine (9) warrants for investigating the need for a traffic signal at a particular intersection. The nine warrants are as follows:

1. Eight-Hour Vehicular Volume
2. Four-Hour Vehicular Volume
3. Peak Hour
4. Pedestrian Volume
5. School Crossing
6. Coordinated Signal System
7. Crash Experience
8. Roadway Network
9. Intersection near At-Grade Railroad Crossings

The satisfaction of a signal warrant (or warrants) may indicate the need for the installation of a traffic signal. However, meeting a warrant does not necessarily mean a traffic signal is required to be

installed. Engineering judgement should be exercised to evaluate both the benefits and negative impacts before installing a traffic signal.

For this report, a traffic signal warrant analysis was completed using the turning movement data in ***Appendix D***. The traffic signal warrant analysis is included in ***Appendix G***. For this location, Warrant's 4 (pedestrian volumes), 5 (school crossing), 6 (coordinated signal system), 8 (roadway network), and 9 (intersection near at-grade railroad crossing) were not applicable. The other four (4) warrants were applicable. Based on Warrant 2 for Four-Hour Vehicular Volumes and Warrant 3 for Peak Hour delay a traffic signal **is warranted** for this intersection. Warrant 1 for Eight-Hour Vehicular Volume and Warrant 7 for Crash Experience were not satisfied.

As per the recommendation of the ProVia study, the storage capacity of the westbound US 250 (south leg) was re-evaluated. Left turn lane warrant calculations for 2-lane, high speed highways are shown in ***Appendix H*** using the peak hour turning movement data from ***Appendix D***. The left turn lane **is warranted** for both the AM and PM peaks. Due to the high volumes of traffic heading west on US 250 out of Strasburg, the required storage capacity here is 495'. The taper leading into the storage would also need to be 600' to meet current design standards. Traffic is split nearly 50/50 on this approach between turning left and going straight through the intersection. Therefore, constructing an appropriately sized left-turn lane is crucial for minimizing congestion and allowing slowing or stopped vehicles to get out of the traveling lane as they near the intersection. Additionally, constructing the necessary taper, pavement widening, and pavement markings for the left-turn lane would help delineate the intersection to enhance safety and give additional advanced warning for traffic.

7.1.1 Traffic Signal Capacity Analysis

Highway capacity software was used to analyze the LOS and delays for the traffic signal alternative in both the opening and design years. The results of this analysis are included in ***Appendix F*** and are summarized in *Table 12*.

In the opening year 2028, capacity analysis indicates US 250 westbound approach (south leg) would operate at an LOS B during the AM peak and LOS C during the PM peak. The US 250 eastbound approach would operate at an LOS C during the AM peak and LOS F during the PM peak. The SR 21 southbound approach would operate at an LOS C during the AM peak and LOS D during the PM peak. The overall intersection LOS would be a LOS C during the AM peak and LOS E during the PM peak.

In the design year 2048, capacity analysis indicates US 250 westbound approach (south leg) would operate at an LOS B during the AM peak and LOS D during the PM peak. The US 250 eastbound approach would operate at an LOS D during the AM peak and LOS F during the PM peak. The SR 21 southbound approach would operate at an LOS C during the AM peak and LOS E during the PM peak. The overall intersection LOS would be a LOS C during the AM peak and LOS F during the PM peak.

Proposed Traffic Signal				
Location	**Traffic Control**	**Movement**	**AM Peak LOS (Delay)**	**PM Peak LOS (Delay)**
Opening Year - 2028				
US 250 & SR 21	Signal	Eastbound (West Leg)	C (34.6)	F (110.9)
		Westbound (South Leg)	B (11.9)	C (31.8)
		Southbound (North Leg)	C (22.4)	D (45.3)
Design Year - 2048				
US 250 & SR 21	Signal	Eastbound (West Leg)	D (44.7)	F (184.8)
		Westbound (South Leg)	B (16.1)	D (52.7)
		Southbound (North Leg)	C (24.8)	E (75.4)
(XX.X) = Average Vehicle Delay in Seconds per Vehicle				

Table 11 - Summary of Proposed Traffic Signal LOS

7.1.2 Traffic Signal Safety Analysis

The Highway Safety Manual Analysis using ECAT was utilized to analyze the safety benefits for the traffic signal alternative. The results of this analysis are included in ***Appendix J***.

Although a signal is warranted, the expected crash rate increases by approximately 64% with the installation of a traffic signal at this location. The number of expected crashes annually on each leg of the intersection, $N_{expected}$, with a traffic signal is 2.8098. This is an increase in total expected crashes of 3.3087 crashes per year for the whole intersection.

7.1.3 Traffic Signal Costs

A preliminary plan and cost estimate for the traffic signal alternative is included in ***Appendix I***. A traffic signal could be constructed without acquiring any additional right-of-way. This includes both temporary and permanent. The additional widening of US 250 to gain storage capacity would occur solely on the southeast side of the intersection. The estimated construction cost for installation of a new signal and all the required hardware is $250,000. Annual maintenance and energy costs for operating the signal are an additional $5,000 every year. Adding highway lighting would cost approximately $75,000. It would cost $412,411 to construct the required earthwork, new pavement, and traffic control. In total, the traffic signal alternative is estimated to cost $1,449,056.86. This total project cost also includes $147,482.20 for contingencies, $309,712.62 for engineering design, and $254,451.04 for inflation.

7.2 Construct Single-lane Roundabout

Modern single-lane roundabouts are great for traffic calming, reducing vehicle conflict points, and minimizing overall delay at intersections. They are very popular in countries across the world and are becoming increasingly popular in the United States, and Ohio, in particular. ODOT already owns the property to the northwest corner of this intersection. This makes the roundabout alternative very feasible without needing to acquire land from adjacent property owners. The only right-of-way that would be needed would be temporary. This temporary right-of-way would be used to realign and tie-in the adjacent property owner driveways.

ROUNDABOUT CAPACITY ANALYSIS

Highway capacity software was used to analyze the LOS and delays for the roundabout alternative in both the opening and design years. The results of this analysis are included in ***Appendix F*** and summarized in *Table 13*.

In the opening year 2028, capacity analysis indicates US 250 westbound approach (south leg) would operate at an LOS A during the AM peak and LOS A during the PM peak. The US 250 eastbound approach would operate at an LOS A during the AM peak and LOS B during the PM peak. The SR 21 southbound approach would operate at an LOS A during the AM peak and LOS A during the PM peak.

In the design year 2048, capacity analysis indicates US 250 westbound approach (south leg) would operate at an LOS A during the AM peak and LOS A during the PM peak. The US 250 eastbound approach would operate at an LOS A during the AM peak and LOS C during the PM peak. The southbound SR 21 approach would operate at an LOS A during the AM peak and LOS B during the PM peak.

Proposed Roundabout				
Location	**Traffic Control**	**Movement**	**AM Peak LOS (Delay)**	**PM Peak LOS (Delay)**
Opening Year - 2028				
US 250 & SR 21	Roundabout	Eastbound (West Leg)	A (6.9)	B (12.2)
		Westbound (South Leg)	A (5.0)	A (6.6)
		Southbound (North Leg)	A (5.5)	A (9.2)
Design Year - 2048				
US 250 & SR 21	Roundabout	Eastbound (West Leg)	A (7.7)	C (16.9)
		Westbound (South Leg)	A (5.4)	A (7.5)
		Southbound (North Leg)	A (5.9)	B (11.4)
(XX.X) = Average Vehicle Delay in Seconds per Vehicle				

Table 12 - Summary of Single-lane Roundabout LOS

7.2.1 ROUNDABOUT SAFETY ANALYSIS

The Highway Safety Manual Analysis using ECAT was utilized to analyze the safety benefits for the roundabout alternative. The results of this analysis are included in ***Appendix J***.

The roundabout alternative reduces the expected crash rate by approximately 57%. The number of expected crashes annually on each leg of the intersection, $N_{expected}$, with a roundabout is 0.7342. This would reduce the total number of crashes at the intersection by 2.9181 crashes per year.

7.2.2 ROUNDABOUT COSTS

A preliminary plan and cost estimate for the roundabout alternative are included in ***Appendix I***. This preliminary plan is just one roundabout configuration that could work. If the roundabout alternative receives funding, other configurations should be evaluated during the initial stages of design to determine what the ideal configuration at this location is.

These two major cost drivers for the roundabout are pavements and MOT, costing $1,144,415 and $200,000 respectively. Adding highway lighting would cost approximately $75,000. The roundabout construction costs are currently estimated at $1,632,137.00. To build the project in 2028, the total project cost is $3,006,063.27 and includes $330.427.40 for contingencies, $495,641.10 for engineering design, and $527,857.77 for inflation.

8 CONCLUSIONS

Summaries of the level-of-service for the existing conditions, proposed traffic signal, and proposed roundabout are shown in *Table 14* and *Table 15.* The roundabout alternative provides the least amount of delay and best LOS at the intersection for both the opening and design years.

Opening Year - 2028			
Traffic Control	**Movement**	**AM Peak LOS (Delay)**	**PM Peak LOS (Delay)**
Stop Sign (Existing Conditions)	Eastbound (West Leg)	C (24.5)	F (576.3)
	Westbound Thru (South Leg)	-	-
	Westbound Left (South Leg)	A (5.1)	A (6.6)
	Southbound (North Leg)	-	-
Traffic Signal	Eastbound (West Leg)	C (34.6)	F (110.9)
	Westbound (South Leg)	B (11.9)	C (31.8)
	Southbound (North Leg)	C (22.4)	D (45.3)
Roundabout	Eastbound (West Leg)	A (6.9)	B (12.2)
	Westbound (South Leg)	A (5.0)	A (6.6)
	Southbound (North Leg)	A (5.5)	A (9.2)

Table 13 - Opening Year - 2028 LOS Summary

Design Year - 2048			
Traffic Control	**Movement**	**AM Peak LOS (Delay)**	**PM Peak LOS (Delay)**
Stop Sign (Existing Conditions)	Eastbound (West Leg)	E (49.1)	F (1053.0)
	Westbound Thru (South Leg)	-	-
	Westbound Left (South Leg)	A (5.6)	A (7.6)
	Southbound (North Leg)	-	-
Traffic Signal	Eastbound (West Leg)	D (44.7)	F (184.8)
	Westbound (South Leg)	B (16.1)	D (52.7)
	Southbound (North Leg)	C (24.8)	E (75.4)
Roundabout	Eastbound (West Leg)	A (7.7)	C (16.9)
	Westbound (South Leg)	A (5.4)	A (7.5)
	Southbound (North Leg)	A (5.9)	B (11.4)

Table 14 - Design Year - 2048 LOS Summary

A summary of the safety benefits for the proposed highway lighting, the proposed traffic signal, and the proposed roundabout are shown in *Table 16*. The roundabout alternative provides the highest crash reduction and a positive B/C ratio. The proposed highway lighting also provides a crash reduction and a positive B/C ratio. The proposed traffic signal predicts to increase crashes and has a negative B/C ratio.

Safety Benefits Summary						
#	**Countermeasure**	**Net Present Cost**	**Net Present Benefit**	**B/C Ratio**	**Expected Annual Crash Adjustment**	**$N_{crashes}$**
	Existing Conditions	-	-	-	-	*1.7069*
1	Install a New Traffic Signal & Lengthen Left-turn Lane Storage	$1,449,056.86	-$260,845	-0.17	+1.1029	2.8098
2	Construct a Single-lane Roundabout	$3,006,063.27	$936,169	+0.31	-0.9727	0.7342

Table 15 - Summary of Safety Benefits

9 RECOMMENDATION

Although a traffic signal is warranted and would improve the delay at the intersection, analysis shows that installing a signal would increase predicted traffic crashes and does not have a positive benefit-to-cost ratio. Therefore, installation of a traffic signal is not recommended at this time.

The recommended countermeasure at this location to reduce congestion and improve safety is to convert the T-intersection to a modern single-lane roundabout. In total, the construction of a single-lane roundabout with new highway lighting would cost approximately $3,006,063.27. Although this option costs more than the traffic signal, a roundabout provides a better benefit-to-cost ratio. The roundabout B/C ratio is a +0.31 and should reduce crashes by 0.973 crashes per year. Additionally, congestion at this intersection drastically improves from a LOS F in the opening year to a LOS B with a roundabout.

APPENDIX A

Photographs

Figure 1 - US 250 Westbound Approach to Intersection

Figure 2 - US 250 Looking Eastbound from Intersection

Figure 3 - US 250 Eastbound Approach to Intersection

Figure 4 - US 250 Looking Westbound from Intersection

Figure 5 - SR 21 Southbound Approach to Intersection

Figure 6 - SR 21 Looking North from Intersection

Figure 7 - US 250 Eastbound at Intersection Looking North

Figure 8 - US 250 Eastbound at Intersection Looking South

APPENDIX B

Existing Conditions Diagram & Right-of-Way Sheets

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	TUS-250-2.22	SIGN PLAN	CALCULATED RDA / CHECKED DAH	0 80 / 40 160 HORIZONTAL SCALE IN FEET

Y:\GROUPS\planning\Traffic Safety Analysis\TUS\TUS 250 2.223 SR 21 Intersection\2023\TUS 250 2.223 Safety Study 2023\TUS 250 & SR 21 Sign.dgn 21-DEC-2023 9:35PM dhoffma1

2	TUS-250-2.22	SIGN PLAN	CALCULATED RDA / CHECKED DAH	0 80 / 40 160 HORIZONTAL SCALE IN FEET

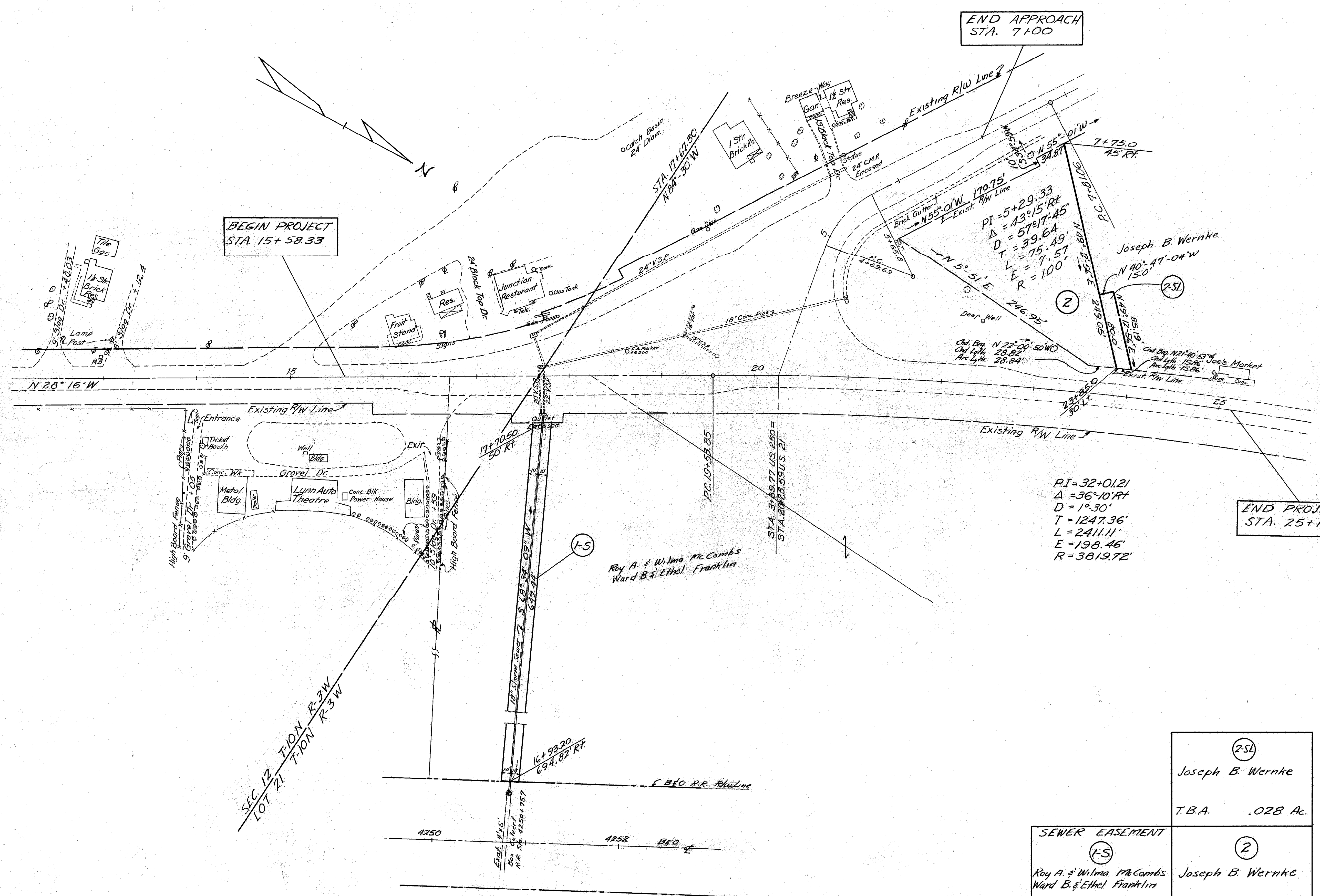
FRANKLIN TWP. T-10-N R-3-W
SECT. 12 & LOT 21

FED. RD. DIVISION	STATE	PROJECT
2	OHIO	

16/16

TUS-21-38.17
TUS-250-2.16
RIGHT OF WAY PLAN

1/1



SEWER EASEMENT	
1-S	
Roy A. & Wilma McCombs Ward B. & Ethel Franklin	

2-SL	
Joseph B. Wernke	
T.B.A.	.028 Ac.

2	
Joseph B. Wernke	
T.B.A.	.574 Ac.

SCALE 1"=50'
Completion Date Jan 29, 1957
Revisions:

APPENDIX C

Crash Data & Collision Diagram

TUS-250-2.223 (2020-2023)

Crash Summary Sheet

Fatalities	0
Serious Injuries	1
Other Injuries	8

Crashes Per Year	7.00
Fatal and All Injury Crashes	7
Percent Injury	25.0%
Equivalent PDO Index Value	3.79

Crash Severity	Crashes	%
(2) Serious Injury Suspected	1	3.57%
(3) Minor Injury Suspected	6	21.43%
(5) PDO/No Injury	21	75.00%
Grand Total	28	100.00%

Year	Crashes	%
2020	4	14.29%
2021	10	35.71%
2022	10	35.71%
2023	4	14.29%
Grand Total	28	100.00%

Day of Week	Crashes	%
(1) Sunday	1	3.57%
(2) Monday	3	10.71%
(3) Tuesday	5	17.86%
(4) Wednesday	3	10.71%
(5) Thursday	9	32.14%
(6) Friday	3	10.71%
(7) Saturday	4	14.29%
Grand Total	28	100.00%

Crash Type	Crashes	%
Rear End	14	50.00%
Left Turn	9	32.14%
Right Turn	1	3.57%
Head On	1	3.57%
Sideswipe - Passing	1	3.57%
Fixed Object	1	3.57%
Overturning	1	3.57%
Grand Total	28	100.00%

Hour of Day	Crashes	%
5	2	7.14%
6	3	10.71%
8	2	7.14%
10	1	3.57%
11	2	7.14%
12	1	3.57%
13	1	3.57%
14	3	10.71%
15	4	14.29%
16	4	14.29%
17	1	3.57%
18	1	3.57%
19	1	3.57%
20	1	3.57%
23	1	3.57%
Grand Total	28	100.00%

Month	Crashes	%
2	4	14.29%
4	2	7.14%
6	3	10.71%
7	4	14.29%
8	3	10.71%
9	5	17.86%
10	1	3.57%
11	3	10.71%
12	3	10.71%
Grand Total	28	100.00%

TUS-250-2.223 (2020-2023)

Crash Summary Sheet

Weather Condition	Crashes	%
Clear	16	57.14%
Cloudy	9	32.14%
Snow	2	7.14%
Fog, Smog, Smoke	1	3.57%
Grand Total	28	100.00%

Road Condition	Crashes	%
Dry	26	92.86%
Ice	2	7.14%
Grand Total	28	100.00%

Light Condition	Crashes	%
Daylight	20	71.43%
Dark - Roadway Not Lighted	7	25.00%
Dawn/Dusk	1	3.57%
Grand Total	28	100.00%

Number of Units	Crashes	%
2	25	89.29%
1	2	7.14%
3	1	3.57%
Grand Total	28	100.00%

ODOT Location	Crashes	%
T-Intersection	14	50.00%
Not An Intersection	10	35.71%
Data Not Valid or Not Provided	4	14.29%
Grand Total	28	100.00%

Work Zone Related	Crashes	%
No	26	92.86%
Yes	2	7.14%
Grand Total	28	100.00%

Alcohol Related	Crashes	%
No	28	100.00%
Grand Total	28	100.00%

Drug Related (Inc. Marijuana)	Crashes	%
No	28	100.00%
Grand Total	28	100.00%

Contour	Crashes	%
Curve Grade	1	3.57%
Curve Level	2	7.14%
Straight Grade	2	7.14%
Straight Level	23	82.14%
Grand Total	28	100.00%

Marijuana Related	Crashes	%
No	28	100.00%
Grand Total	28	100.00%

Roadway Departure	Crashes	%
No	26	92.86%
Yes	2	7.14%
Grand Total	28	100.00%

Older Driver (65+)	Crashes	%
No	20	71.43%
Yes	8	28.57%
Grand Total	28	100.00%

Intersection Related	Crashes	%
Yes	22	78.57%
No	6	21.43%
Grand Total	28	100.00%

Young Driver (15-25)	Crashes	%
No	12	42.86%
Yes	16	57.14%
Grand Total	28	100.00%

Speed Related	Crashes	%
No	27	96.43%
Yes	1	3.57%
Grand Total	28	100.00%

Motorcycle Involved	Crashes	%
No	27	96.43%
Yes	1	3.57%
Grand Total	28	100.00%

TUS-250-2.223 (2020-2023)

Crash Summary Sheet

Unit 1 Summary

Unit 1 Pre-Crash Action	Crashes	%
Straight Ahead	14	50.00%
Making Left Turn	10	35.71%
Slowing or Stopped In Traffic	2	7.14%
Entering Traffic Lane	1	3.57%
Negotiating a Curve	1	3.57%
Grand Total	28	100.00%

Unit 1 Contributing Factor	Crashes	%
Following Too Closely/ACDA	14	50.00%
Failure to Yield	8	28.57%
Load shifting/Falling/Spilling	2	7.14%
Improper Turn	2	7.14%
Improper Start From a Parked Position	1	3.57%
Unsafe Speed	1	3.57%
Grand Total	28	100.00%

Unit 1 Object Struck	Crashes	%
Nothing Struck	27	96.43%
Ditch	1	3.57%
Grand Total	28	100.00%

Unit 1 Traffic Control	Crashes	%
No Control	16	57.14%
Stop Sign	11	39.29%
Yield Sign	1	3.57%
Grand Total	28	100.00%

Unit 1 Posted Speed	Crashes	%
50	20	71.43%
55	8	28.57%
Grand Total	28	100.00%

Unit 1 Direction From	Crashes	%
West	11	39.29%
South	8	28.57%
Southeast	3	10.71%
Northwest	3	10.71%
North	2	7.14%
East	1	3.57%
Grand Total	28	100.00%

Unit 1 Direction To	Crashes	%
West	9	32.14%
East	9	32.14%
Southeast	3	10.71%
South	3	10.71%
North	2	7.14%
Northwest	2	7.14%
Grand Total	28	100.00%

TUS-250-2.223 (2020-2023)

Crash Summary Sheet

Unit 1 Summary

Unit 1 Type	Crashes	%
Passenger Car	8	28.57%
Sport Utility Vehicle	7	25.00%
Passenger Van (minivan)	4	14.29%
Pick up	4	14.29%
Semi-Tractor	2	7.14%
Motorcycle 2 Wheeled	1	3.57%
Van (9-15 Seats)	1	3.57%
Single Unit Truck	1	3.57%
Grand Total	28	100.00%

Unit 1 Special Function	Crashes	%
None	28	100.00%
Grand Total	28	100.00%

TUS-250-2.223 (2020-2023)
Crash Summary Sheet

Unit 2 Summary

Unit 2 Pre-Crash Action	Crashes	%
Slowing or Stopped In Traffic	16	57.14%
Straight Ahead	9	32.14%
	2	7.14%
Making Right Turn	1	3.57%
Grand Total	28	100.00%

Unit 2 Contributing Factor	Crashes	%
None	26	92.86%
	2	7.14%
Grand Total	28	100.00%

Unit 2 Direction From	Crashes	%
	2	7.14%
East	1	3.57%
North	9	32.14%
Northwest	4	14.29%
South	1	3.57%
Southeast	2	7.14%
West	9	32.14%
Grand Total	28	100.00%

Unit 2 Direction To	Crashes	%
	2	7.14%
East	9	32.14%
North	1	3.57%
Northwest	2	7.14%
South	10	35.71%
Southeast	3	10.71%
West	1	3.57%
Grand Total	28	100.00%

Unit 2 Type	Crashes	%
Passenger Car	14	50.00%
Sport Utility Vehicle	6	21.43%
Pick up	4	14.29%
	2	7.14%
Semi-Tractor	1	3.57%
Passenger Van (minivan)	1	3.57%
Grand Total	28	100.00%

Unit 2 Special Function	Crashes	%
None	26	92.86%
	2	7.14%
Grand Total	28	100.00%

U.S. 250

S.R. 21

8-28-23/R.E./DRY/PD

8-23-22/SS/DRY/PD

8-25-22/O.T./DRY/I

9-10-20/L.T./DRY/PD
2-8-21/L.T./DRY/PD
2-9-21/L.T./ICE/I
11-23-21/L.T./DRY/PD
12-8-21/L.T./ICE/PD
6-23-22/L.T./DRY/I
7-28-22/L.T./DRY/PD

4-13-21/N-COL/DRY/I

2-28-20/R.E./DRY/PD
6-27-20/R.E./DRY/PD
11-9-20/R.E./DRY/PD
2-24-21/R.E./DRY/I
2-24-21/R.E./DRY/I
12-23-21/R.E./DRY/PD
9-6-22/R.E./DRY/PD
10-14-22/R.E./DRY/PD
11-6-22/R.E./DRY/PD
7-6-23/R.E./DRY/PD

12-20-21/O/DRY/PD

4-18-22/R.E./DRY/PDV

7-29-21/A/DRY/I

7-12-23/R.E./DRY/I

6-17-22/A/DRY/PD

8-27-22/R.E./DRY/PD
9-4-23/R.E./DRY/PD

LEGEND

2020 - 2023

DESCRIPTION = DATE/TYPE OF CRASH/ROAD CONDITION/CRASH SEVERITY

N-COL = NON-COLLISION
SS = SIDESWIPE
R.E. = REAR END
L.T. = LEFT TURN
A = ANGLE
O.T. = OVERTURN
O = OTHER

PD = PROPERTY DAMAGE
I = INJURY
F = FATAL

HORIZONTAL SCALE IN FEET
0 40 80 160

CALCULATED RDA
CHECKED DAH

COLLISION DIAGRAM

TUS-250-2.22

1

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APPENDIX D

Turning Movement Data & Forecasted Traffic Volumes

Ohio Department of Transportation - Safety
1980 West Broad Street
Mail Stop 5160
Columbus, Ohio, United States 43223
+16147528099 David.Hoffman@dot.ohio.gov
Office of Traffic Engineering

Count Name: TUS-250-2.223
Site Code:
Start Date: 10/26/2023

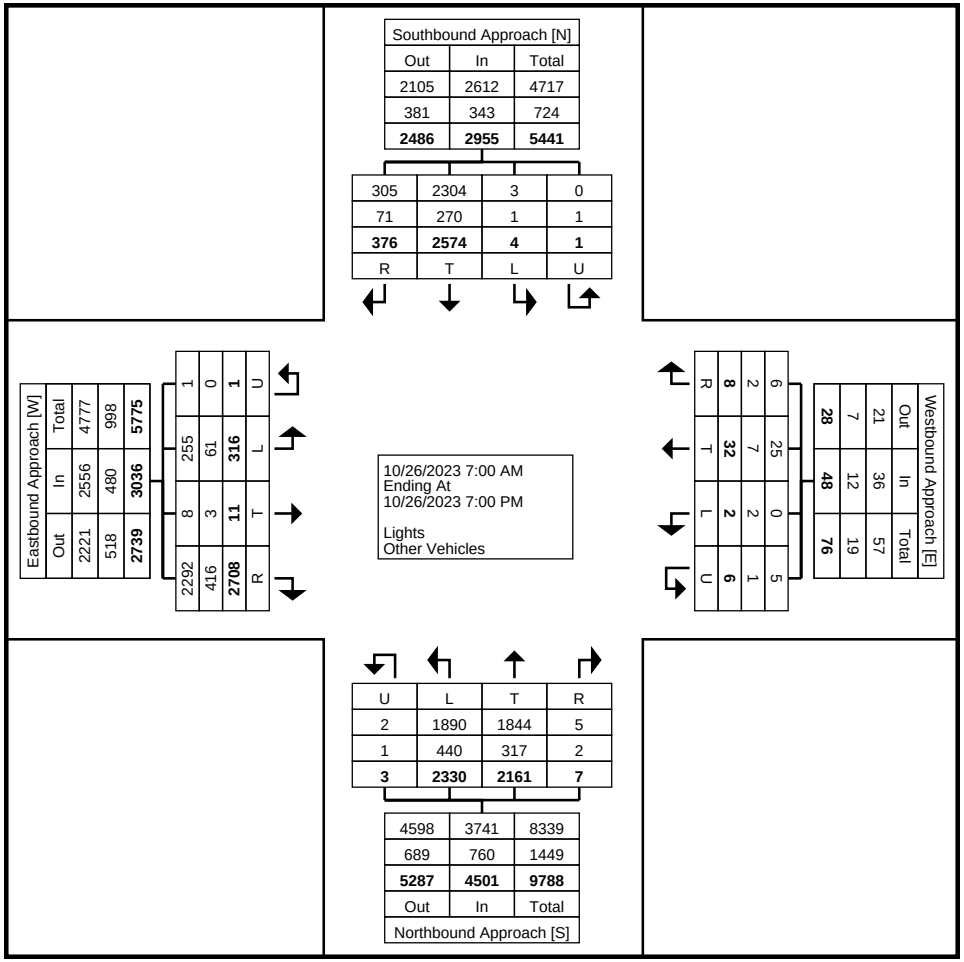
Turning Movement Data

Start Time	Southbound Approach Southbound					Westbound Approach Westbound					Northbound Approach Northbound					Eastbound Approach Eastbound					
	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Int. Total
7:00 AM	4	53	0	0	57	0	0	0	0	0	0	37	40	0	77	25	1	11	0	37	171
7:15 AM	8	45	0	0	53	0	0	0	0	0	0	50	61	0	111	53	0	9	0	62	226
7:30 AM	10	54	0	0	64	0	0	0	0	0	0	42	48	0	90	51	0	6	0	57	211
7:45 AM	14	49	0	0	63	0	0	0	0	0	0	46	34	0	80	49	1	4	0	54	197
Hourly Total	36	201	0	0	237	0	0	0	0	0	0	175	183	0	358	178	2	30	0	210	805
8:00 AM	9	55	0	0	64	0	0	0	0	0	0	45	31	0	76	32	1	6	0	39	179
8:15 AM	6	37	0	0	43	0	0	0	0	0	1	32	46	0	79	43	0	4	0	47	169
8:30 AM	3	36	1	0	40	0	0	0	0	0	1	30	47	0	78	56	0	8	0	64	182
8:45 AM	4	36	0	0	40	0	0	0	0	0	0	30	39	0	69	35	0	5	0	40	149
Hourly Total	22	164	1	0	187	0	0	0	0	0	2	137	163	0	302	166	1	23	0	190	679
9:00 AM	5	35	0	0	40	0	0	0	0	0	0	29	35	0	64	43	0	2	0	45	149
9:15 AM	9	32	0	0	41	0	1	0	0	1	0	41	44	0	85	48	0	2	0	50	177
9:30 AM	6	32	0	0	38	0	0	0	0	0	0	30	50	0	80	50	0	5	0	55	173
9:45 AM	4	43	0	0	47	1	0	0	0	1	1	23	37	0	61	45	0	5	0	50	159
Hourly Total	24	142	0	0	166	1	1	0	0	2	1	123	166	0	290	186	0	14	0	200	658
10:00 AM	8	37	0	0	45	0	1	0	0	1	0	32	47	0	79	34	0	7	0	41	166
10:15 AM	11	41	0	0	52	0	0	0	0	0	0	34	37	0	71	43	0	6	0	49	172
10:30 AM	7	36	0	0	43	0	0	0	0	0	0	35	34	0	69	48	0	11	0	59	171
10:45 AM	13	45	0	0	58	0	0	0	0	0	0	48	49	0	97	51	0	5	0	56	211
Hourly Total	39	159	0	0	198	0	1	0	0	1	0	149	167	0	316	176	0	29	0	205	720
11:00 AM	15	60	0	0	75	0	3	0	0	3	0	30	44	0	74	46	0	1	0	47	199
11:15 AM	8	55	0	0	63	0	0	0	1	1	0	46	42	0	88	38	1	6	0	45	197
11:30 AM	17	48	0	0	65	1	1	0	0	2	0	45	42	0	87	39	0	3	0	42	196
11:45 AM	13	40	0	0	53	1	0	1	0	2	0	48	30	0	78	48	0	3	0	51	184
Hourly Total	53	203	0	0	256	2	4	1	1	8	0	169	158	0	327	171	1	13	0	185	776
12:00 PM	3	49	0	0	52	0	2	0	0	2	0	46	46	0	92	40	0	3	0	43	189
12:15 PM	11	39	0	0	50	0	2	0	0	2	0	38	40	0	78	56	0	5	0	61	191
12:30 PM	11	49	0	0	60	1	3	0	2	6	1	43	42	0	86	46	0	6	0	52	204
12:45 PM	10	57	0	0	67	0	2	0	0	2	0	38	52	0	90	53	0	4	0	57	216
Hourly Total	35	194	0	0	229	1	9	0	2	12	1	165	180	0	346	195	0	18	0	213	800
1:00 PM	4	53	1	0	58	0	1	1	0	2	0	49	39	1	89	49	0	11	0	60	209
1:15 PM	5	40	0	0	45	0	1	0	1	2	0	50	49	0	99	65	1	11	1	78	224
1:30 PM	6	61	0	0	67	0	1	0	0	1	0	46	60	0	106	61	0	5	0	66	240
1:45 PM	7	62	0	0	69	0	1	0	0	1	0	44	55	0	99	60	1	6	0	67	236
Hourly Total	22	216	1	0	239	0	4	1	1	6	0	189	203	1	393	235	2	33	1	271	909

2:00 PM	15	82	0	0	97	0	0	0	1	1	1	54	54	0	109	64	0	12	0	76	283
2:15 PM	7	72	0	0	79	0	0	0	0	0	1	53	48	0	102	61	1	11	0	73	254
2:30 PM	8	110	0	0	118	1	0	0	0	1	0	59	75	0	134	71	0	2	0	73	326
2:45 PM	11	61	0	0	72	0	0	0	0	0	0	50	50	0	100	83	1	12	0	96	268
Hourly Total	41	325	0	0	366	1	0	0	1	2	2	216	227	0	445	279	2	37	0	318	1131
3:00 PM	10	70	1	0	81	0	0	0	0	0	1	57	57	0	115	76	0	9	0	85	281
3:15 PM	6	74	0	0	80	0	0	0	0	0	0	54	67	0	121	69	0	12	0	81	282
3:30 PM	5	84	0	0	89	0	0	0	0	0	0	57	78	0	135	91	0	7	0	98	322
3:45 PM	6	65	0	0	71	0	0	0	0	0	0	51	82	0	133	88	1	10	0	99	303
Hourly Total	27	293	1	0	321	0	0	0	0	0	1	219	284	0	504	324	1	38	0	363	1188
4:00 PM	10	64	0	0	74	0	1	0	0	1	0	60	65	1	126	74	0	6	0	80	281
4:15 PM	11	88	0	0	99	0	1	0	0	1	0	58	71	0	129	73	0	11	0	84	313
4:30 PM	3	93	0	0	96	1	1	0	0	2	0	65	62	0	127	85	0	7	0	92	317
4:45 PM	7	52	0	0	59	0	1	0	0	1	0	62	49	0	111	101	0	5	0	106	277
Hourly Total	31	297	0	0	328	1	4	0	0	5	0	245	247	1	493	333	0	29	0	362	1188
5:00 PM	6	67	0	1	74	0	4	0	0	4	0	71	49	1	121	104	1	9	0	114	313
5:15 PM	11	50	0	0	61	0	1	0	0	1	0	58	55	0	113	86	1	8	0	95	270
5:30 PM	8	57	0	0	65	0	0	0	0	0	0	48	46	0	94	73	0	9	0	82	241
5:45 PM	4	41	0	0	45	1	1	0	0	2	0	52	37	0	89	45	0	6	0	51	187
Hourly Total	29	215	0	1	245	1	6	0	0	7	0	229	187	1	417	308	2	32	0	342	1011
6:00 PM	5	48	1	0	54	0	0	0	1	1	0	40	41	0	81	46	0	5	0	51	187
6:15 PM	6	38	0	0	44	0	0	0	0	0	0	35	42	0	77	39	0	5	0	44	165
6:30 PM	5	41	0	0	46	1	1	0	0	2	0	38	48	0	86	34	0	4	0	38	172
6:45 PM	1	38	0	0	39	0	2	0	0	2	0	32	34	0	66	38	0	6	0	44	151
Hourly Total	17	165	1	0	183	1	3	0	1	5	0	145	165	0	310	157	0	20	0	177	675
Grand Total	376	2574	4	1	2955	8	32	2	6	48	7	2161	2330	3	4501	2708	11	316	1	3036	10540
Approach %	12.7	87.1	0.1	0.0	-	16.7	66.7	4.2	12.5	-	0.2	48.0	51.8	0.1	-	89.2	0.4	10.4	0.0	-	-
Total %	3.6	24.4	0.0	0.0	28.0	0.1	0.3	0.0	0.1	0.5	0.1	20.5	22.1	0.0	42.7	25.7	0.1	3.0	0.0	28.8	-
Lights	305	2304	3	0	2612	6	25	0	5	36	5	1844	1890	2	3741	2292	8	255	1	2556	8945
% Lights	81.1	89.5	75.0	0.0	88.4	75.0	78.1	0.0	83.3	75.0	71.4	85.3	81.1	66.7	83.1	84.6	72.7	80.7	100.0	84.2	84.9
Other Vehicles	71	270	1	1	343	2	7	2	1	12	2	317	440	1	760	416	3	61	0	480	1595
% Other Vehicles	18.9	10.5	25.0	100.0	11.6	25.0	21.9	100.0	16.7	25.0	28.6	14.7	18.9	33.3	16.9	15.4	27.3	19.3	0.0	15.8	15.1

Ohio Department of Transportation - Safety
1980 West Broad Street
Mail Stop 5160
Columbus, Ohio, United States 43223
+16147528099 David.Hoffman@dot.ohio.gov
Office of Traffic Engineering

Count Name: TUS-250-2.223
Site Code:
Start Date: 10/26/2023



Turning Movement Data Plot

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Count Name: TUS-250-2.223
Site Code:
Start Date: 10/26/2023

Turning Movement Peak Hour Data (7:15 AM)

Start Time	Southbound Approach Southbound					Westbound Approach Westbound					Northbound Approach Northbound					Eastbound Approach Eastbound					
	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Int. Total
7:15 AM	8	45	0	0	53	0	0	0	0	0	0	50	61	0	111	53	0	9	0	62	226
7:30 AM	10	54	0	0	64	0	0	0	0	0	0	42	48	0	90	51	0	6	0	57	211
7:45 AM	14	49	0	0	63	0	0	0	0	0	0	46	34	0	80	49	1	4	0	54	197
8:00 AM	9	55	0	0	64	0	0	0	0	0	0	45	31	0	76	32	1	6	0	39	179
Total	41	203	0	0	244	0	0	0	0	0	0	183	174	0	357	185	2	25	0	212	813
Approach %	16.8	83.2	0.0	0.0	-	0.0	0.0	0.0	0.0	-	0.0	51.3	48.7	0.0	-	87.3	0.9	11.8	0.0	-	-
Total %	5.0	25.0	0.0	0.0	30.0	0.0	0.0	0.0	0.0	0.0	0.0	22.5	21.4	0.0	43.9	22.8	0.2	3.1	0.0	26.1	-
PHF	0.732	0.923	0.000	0.000	0.953	0.000	0.000	0.000	0.000	0.000	0.000	0.915	0.713	0.000	0.804	0.873	0.500	0.694	0.000	0.855	0.899
Lights	30	176	0	0	206	0	0	0	0	0	0	160	144	0	304	153	1	20	0	174	684
% Lights	73.2	86.7	-	-	84.4	-	-	-	-	-	-	87.4	82.8	-	85.2	82.7	50.0	80.0	-	82.1	84.1
Other Vehicles	11	27	0	0	38	0	0	0	0	0	0	23	30	0	53	32	1	5	0	38	129
% Other Vehicles	26.8	13.3	-	-	15.6	-	-	-	-	-	-	12.6	17.2	-	14.8	17.3	50.0	20.0	-	17.9	15.9

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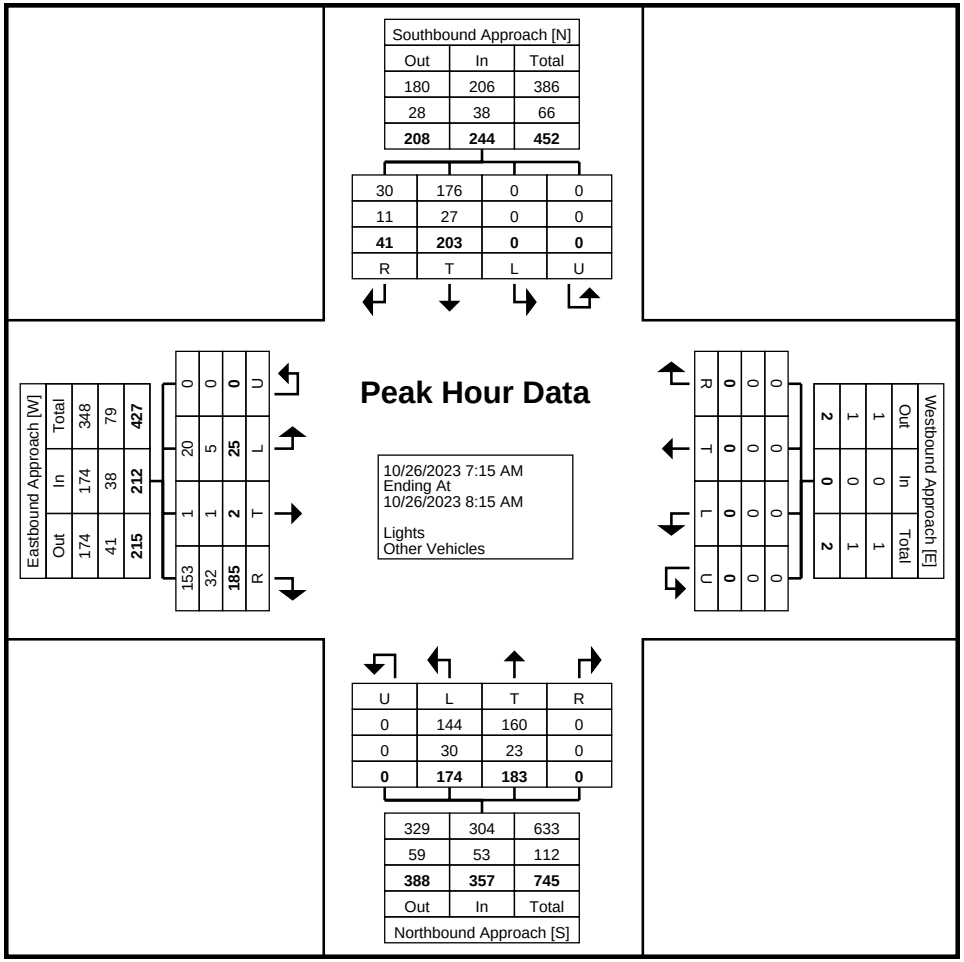

Turning Movement Peak Hour Data Plot (7:15 AM)

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Site Code:
Start Date: 10/26/2023

Turning Movement Peak Hour Data (4:15 PM)

Start Time	Southbound Approach Southbound					Westbound Approach Westbound					Northbound Approach Northbound					Eastbound Approach Eastbound					
	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Int. Total
4:15 PM	11	88	0	0	99	0	1	0	0	1	0	58	71	0	129	73	0	11	0	84	313
4:30 PM	3	93	0	0	96	1	1	0	0	2	0	65	62	0	127	85	0	7	0	92	317
4:45 PM	7	52	0	0	59	0	1	0	0	1	0	62	49	0	111	101	0	5	0	106	277
5:00 PM	6	67	0	1	74	0	4	0	0	4	0	71	49	1	121	104	1	9	0	114	313
Total	27	300	0	1	328	1	7	0	0	8	0	256	231	1	488	363	1	32	0	396	1220
Approach %	8.2	91.5	0.0	0.3	-	12.5	87.5	0.0	0.0	-	0.0	52.5	47.3	0.2	-	91.7	0.3	8.1	0.0	-	-
Total %	2.2	24.6	0.0	0.1	26.9	0.1	0.6	0.0	0.0	0.7	0.0	21.0	18.9	0.1	40.0	29.8	0.1	2.6	0.0	32.5	-
PHF	0.614	0.806	0.000	0.250	0.828	0.250	0.438	0.000	0.000	0.500	0.000	0.901	0.813	0.250	0.946	0.873	0.250	0.727	0.000	0.868	0.962
Lights	24	288	0	0	312	1	6	0	0	7	0	238	204	0	442	342	1	31	0	374	1135
% Lights	88.9	96.0	-	0.0	95.1	100.0	85.7	-	-	87.5	-	93.0	88.3	0.0	90.6	94.2	100.0	96.9	-	94.4	93.0
Other Vehicles	3	12	0	1	16	0	1	0	0	1	0	18	27	1	46	21	0	1	0	22	85
% Other Vehicles	11.1	4.0	-	100.0	4.9	0.0	14.3	-	-	12.5	-	7.0	11.7	100.0	9.4	5.8	0.0	3.1	-	5.6	7.0

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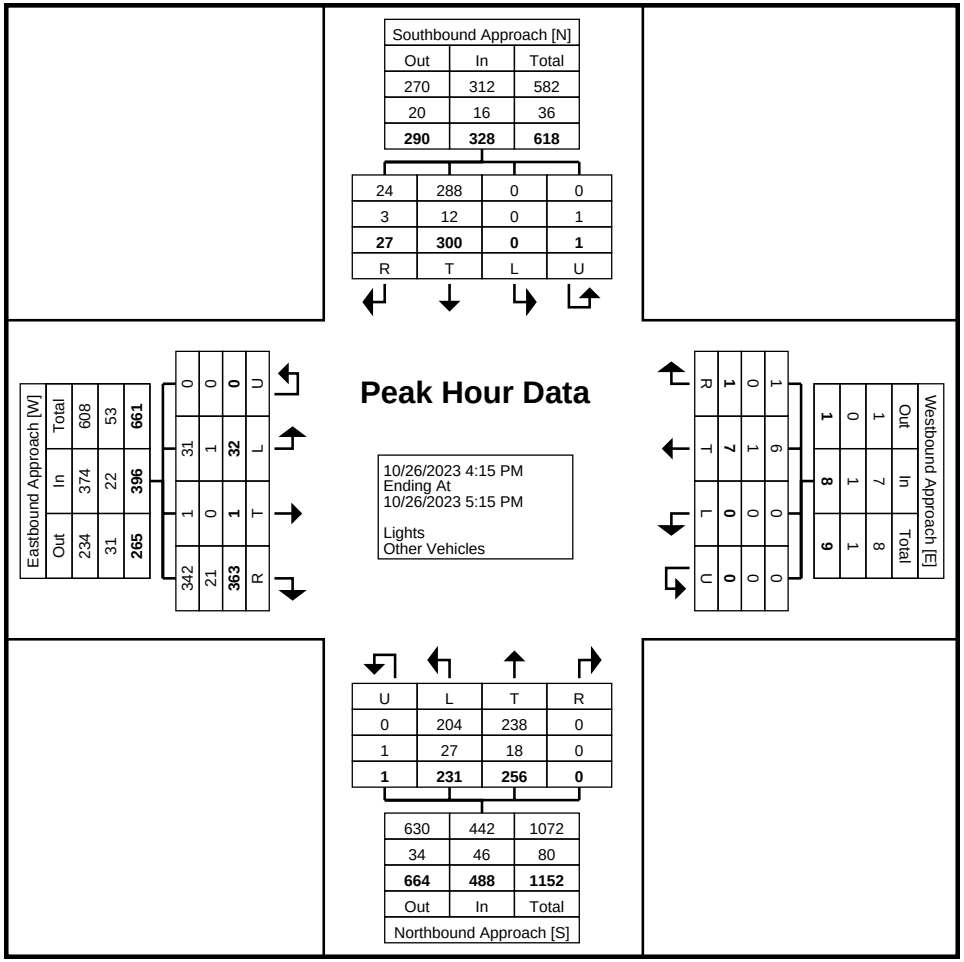


Turning Movement Peak Hour Data Plot (4:15 PM)

TFMS - Intersection Forecast Report

Forecast Summary

Project Id	Project Name
	TUS-250-2.223

Project Description
Intersection of US 250 & SR 21 in Tuscarawas County

Model Version	Script Date	Script Version
2023.1900	4/14/2020 5:30:19 PM	2020.001

Username	Email Address
David.Hoffman	David.Hoffman@dot.ohio.gov

*Users of this data need to be aware that there are limitations to the forecasts generated by this product that make it suitable only for roadway design projects which are low risk.

Road Name	2028 AADT	2048 AADT	K%	DHV30	D%	T24%	TD%
SR21	7,000	7,250	11.3	820	51	9.2	7.1
US250	7,600	8,950	13.6	1220	52	13.4	14.1
US250	12,900	14,400	11.7	1680	59	13.8	10.8

The values in parentheses have been overridden.

Pivot Count Date: 10/26/2023

TFMS - Intersection Forecast Report

Segment Information

Approach	Segment ID	LRS ID	BMP	Midpoint	EMP	Length	Latitude	Longitude
SB	1997	STUSSR00021**C	0.000	0.735	1.470	1.470	40.6354169968046	-81.5476862829678
EB	1998	STUSUS00250**C	1.379	1.801	2.223	0.844	40.6280234069577	-81.5529806907375
NB	1999	STUSUS00250**C	2.223	2.771	3.319	1.096	40.6183250241984	-81.5405886266438

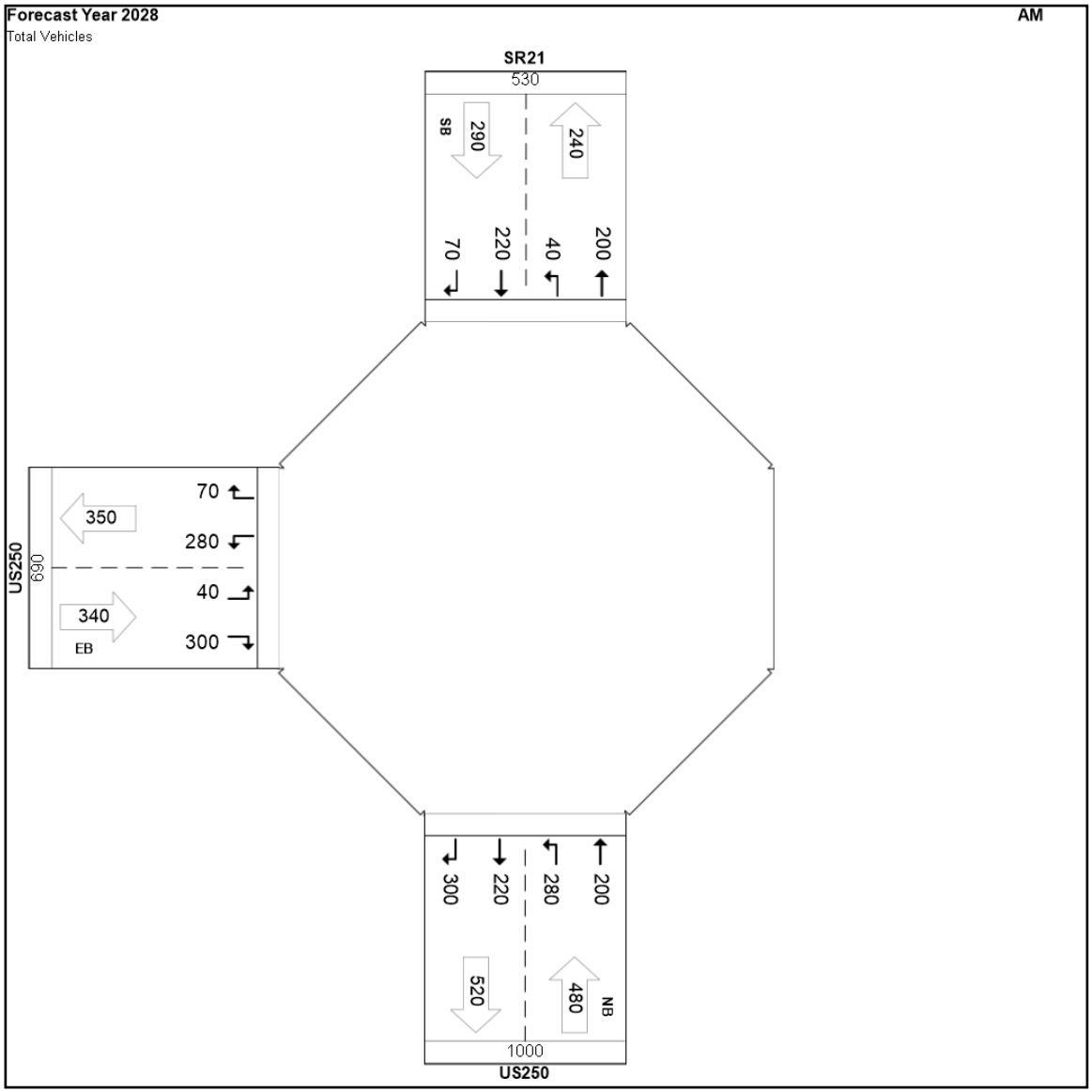
Target Value Summary

Approach	Adt Growth Rate	Adt Growth	2028 AADT	2048 AADT	2028 AM	2048 AM	2028 PM	2048 PM
SB	0.200	14.000	7,050	7,300	530	550	790	820
EB	0.900	66.000	7,650	9,000	700	820	1,050	1,200
NB	0.600	75.000	12,900	14,400	1,000	1,100	1,500	1,700

The values in parentheses have been overridden.

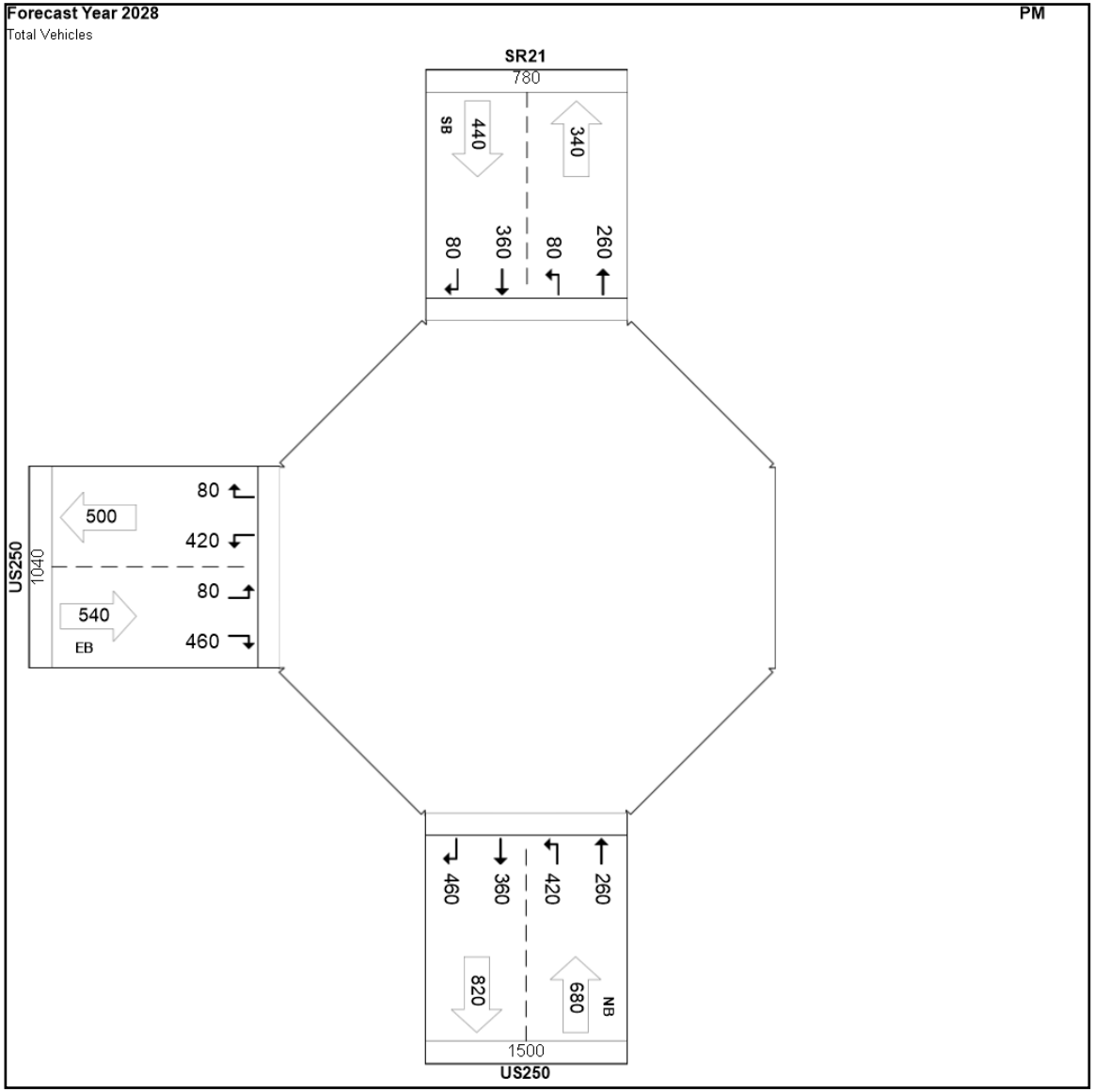
TFMS - Intersection Forecast Report

Opening Year AM



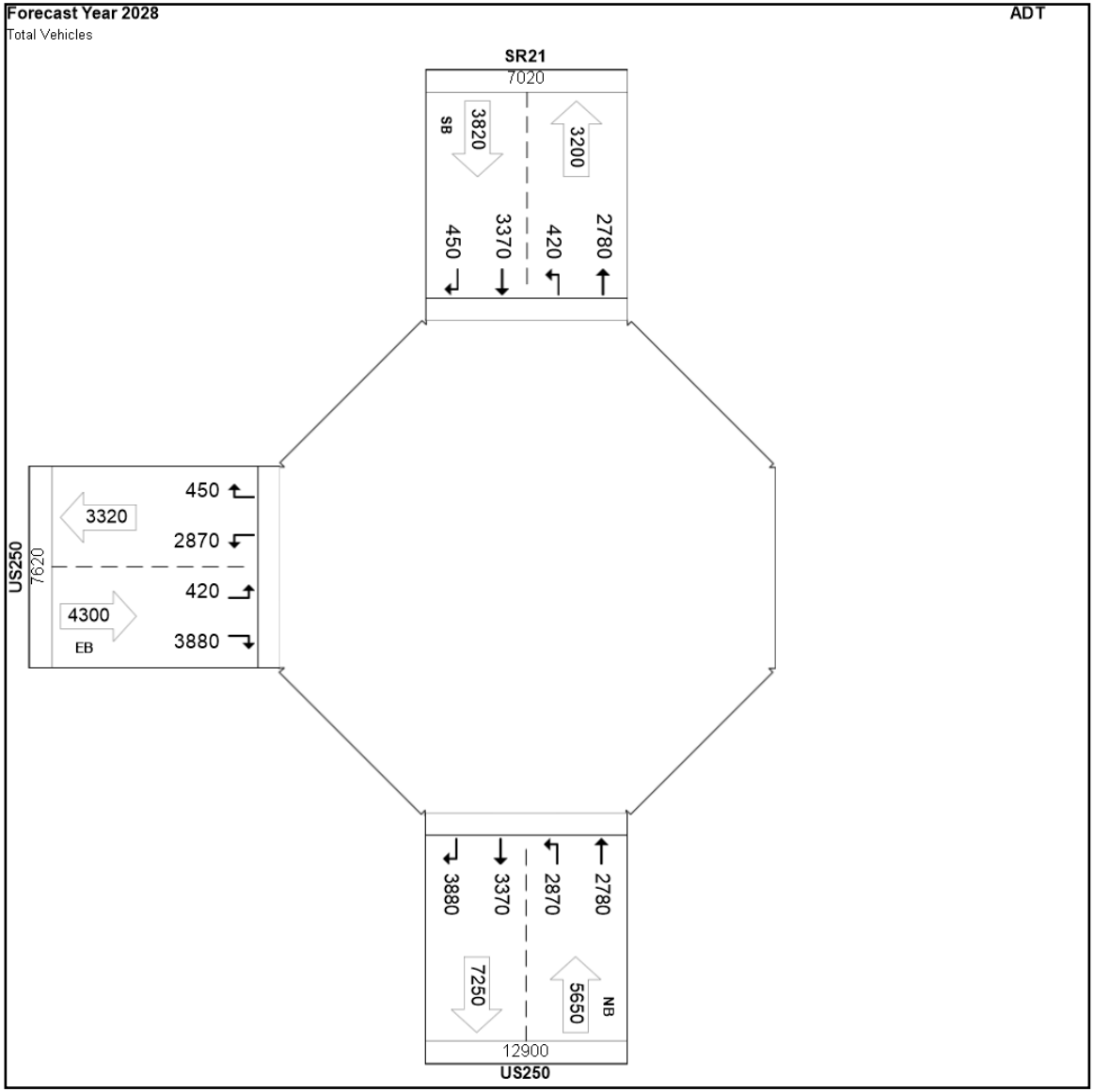
TFMS - Intersection Forecast Report

Opening Year PM



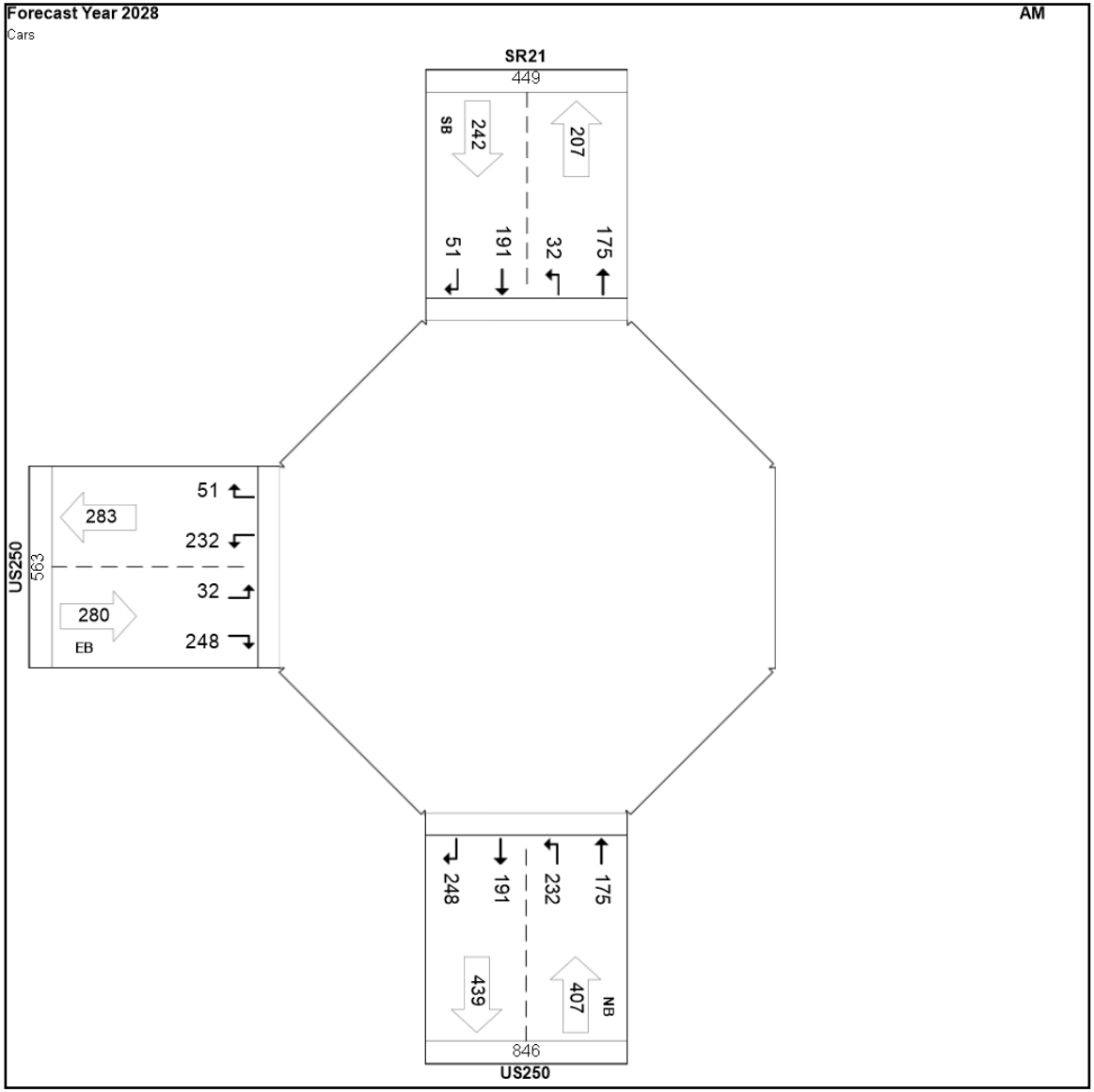
TFMS - Intersection Forecast Report

Opening Year ADT



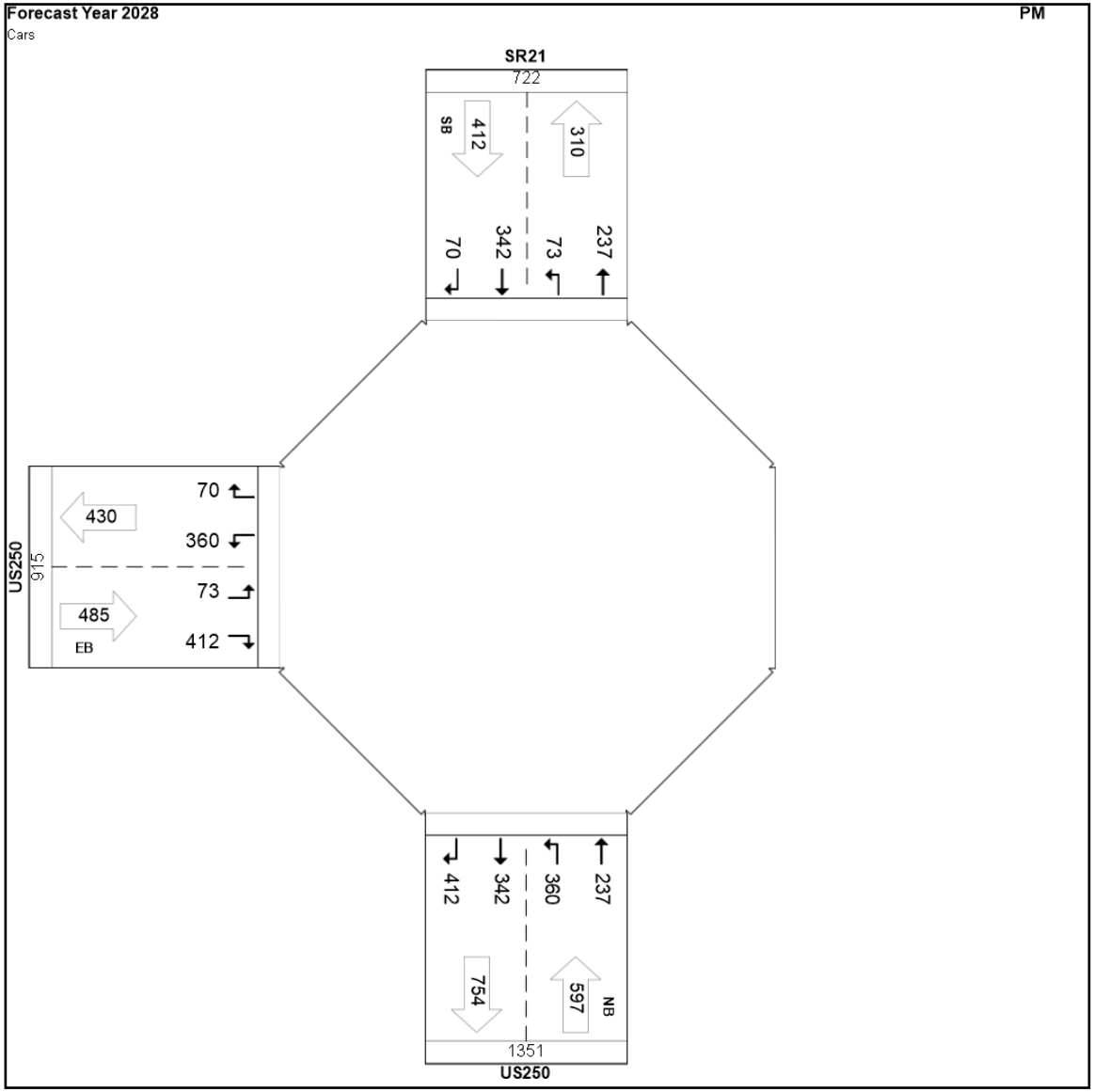
TFMS - Intersection Forecast Report

Opening Year Cars AM



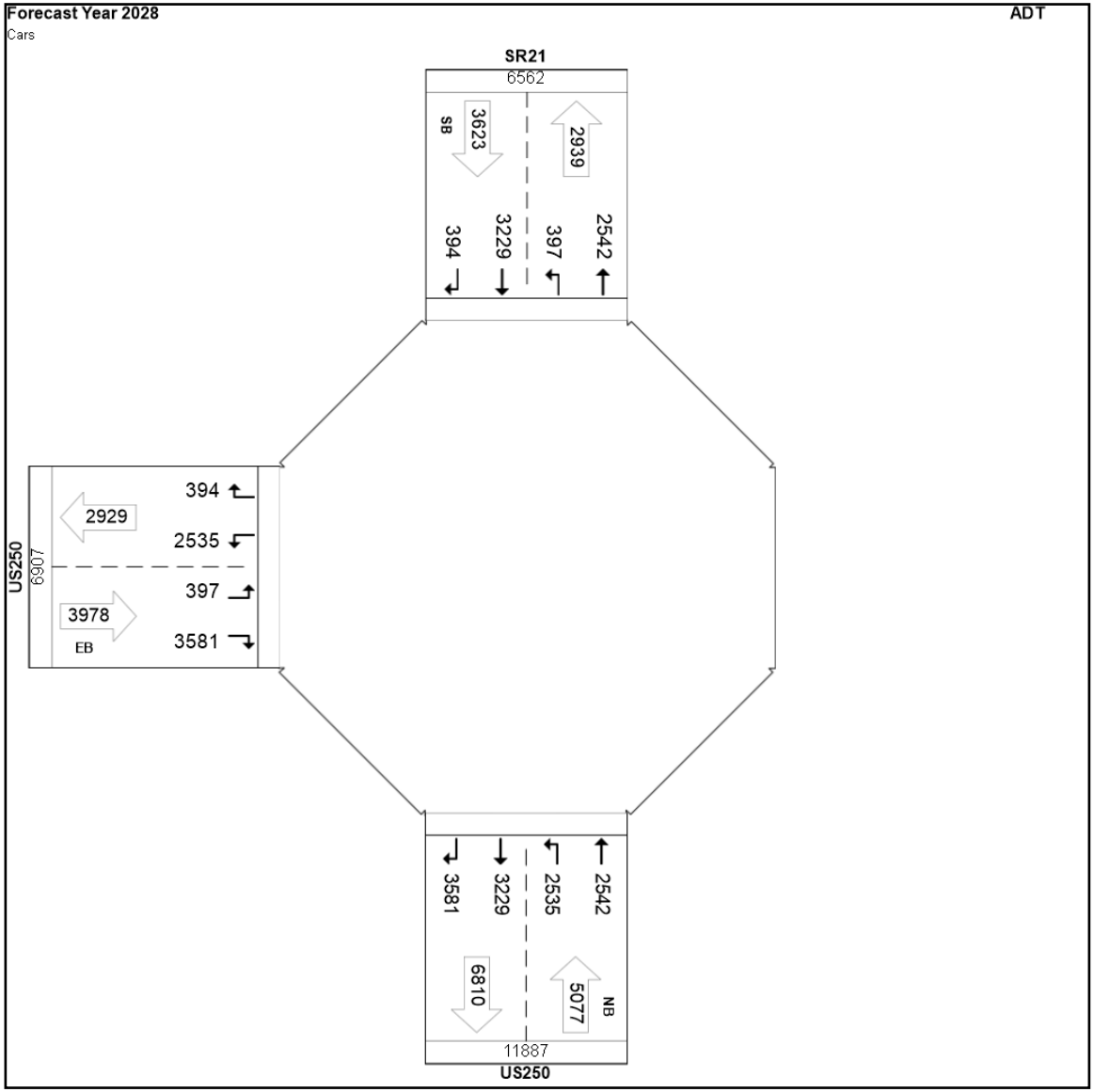
TFMS - Intersection Forecast Report

Opening Year Cars PM



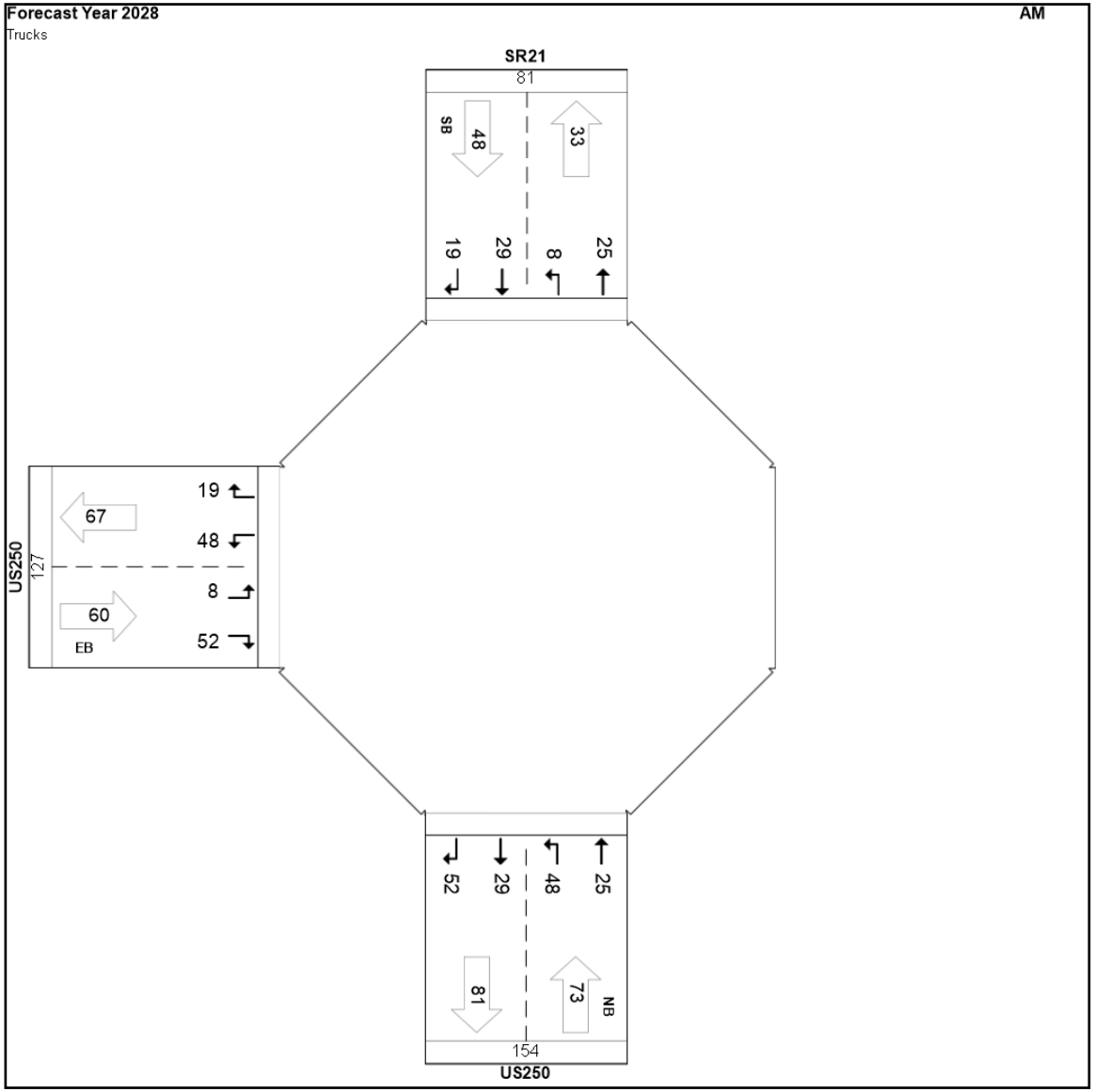
TFMS - Intersection Forecast Report

Opening Year Cars ADT

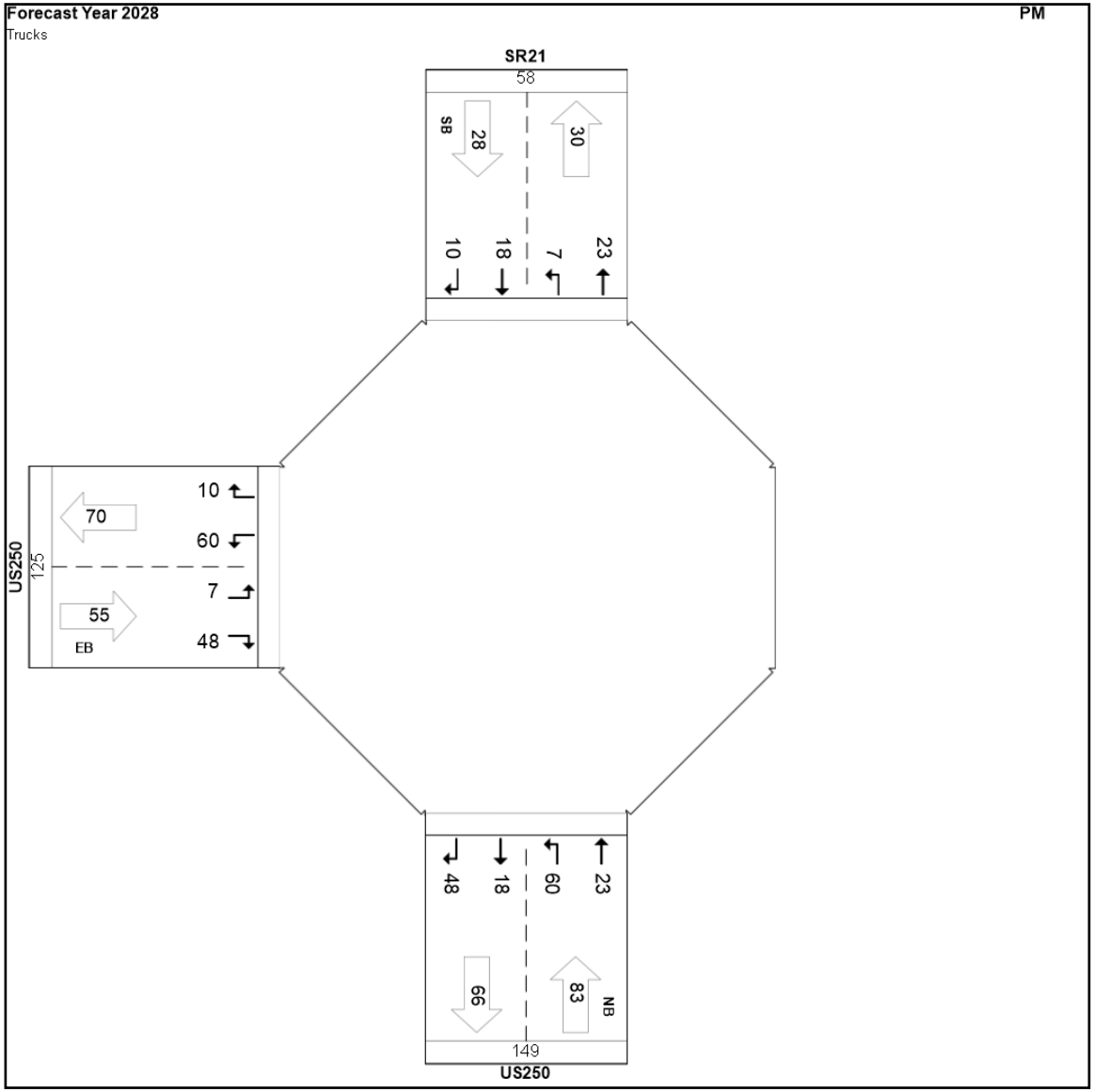


TFMS - Intersection Forecast Report

Opening Year Trucks AM

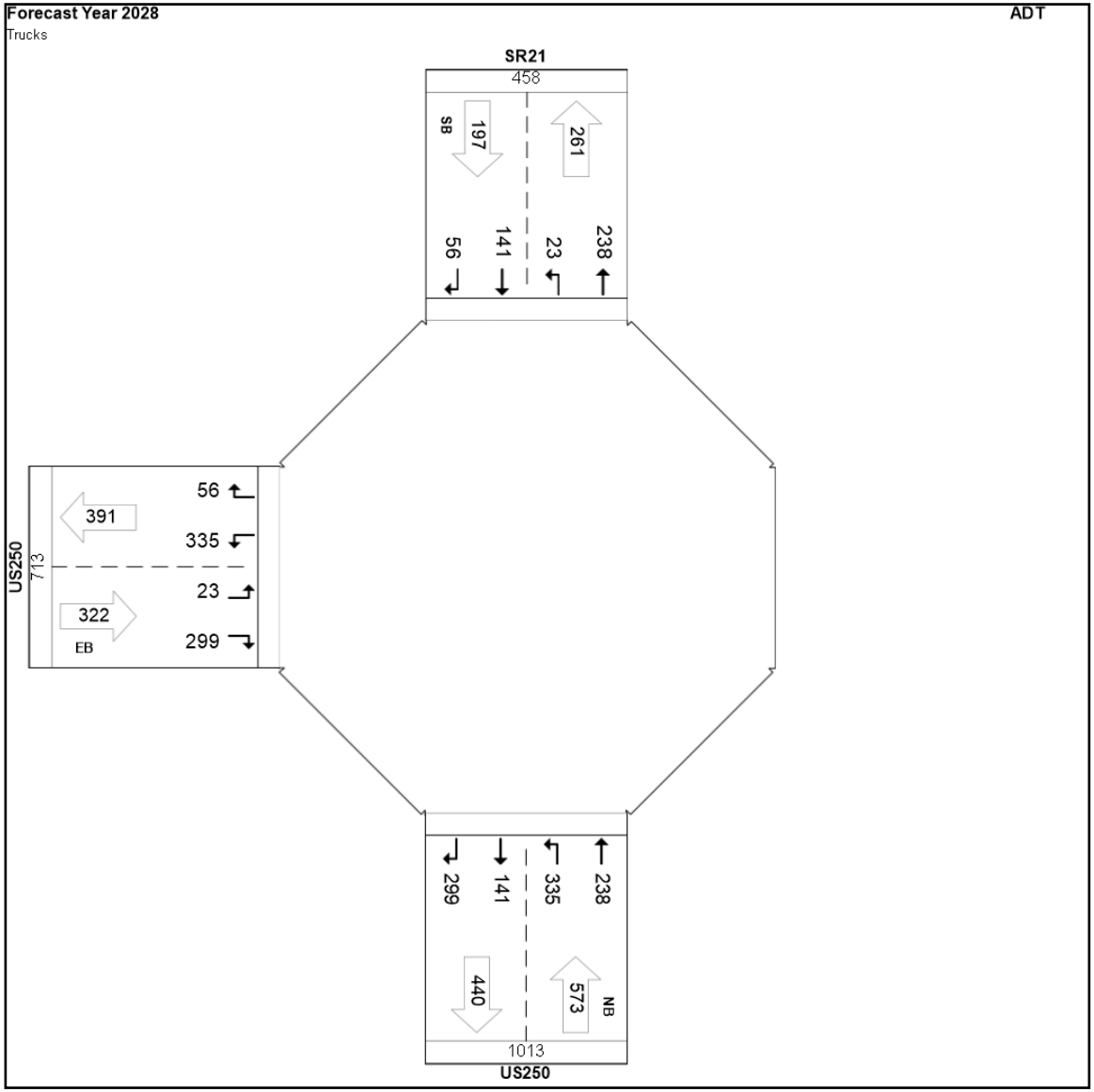


Opening Year Trucks PM



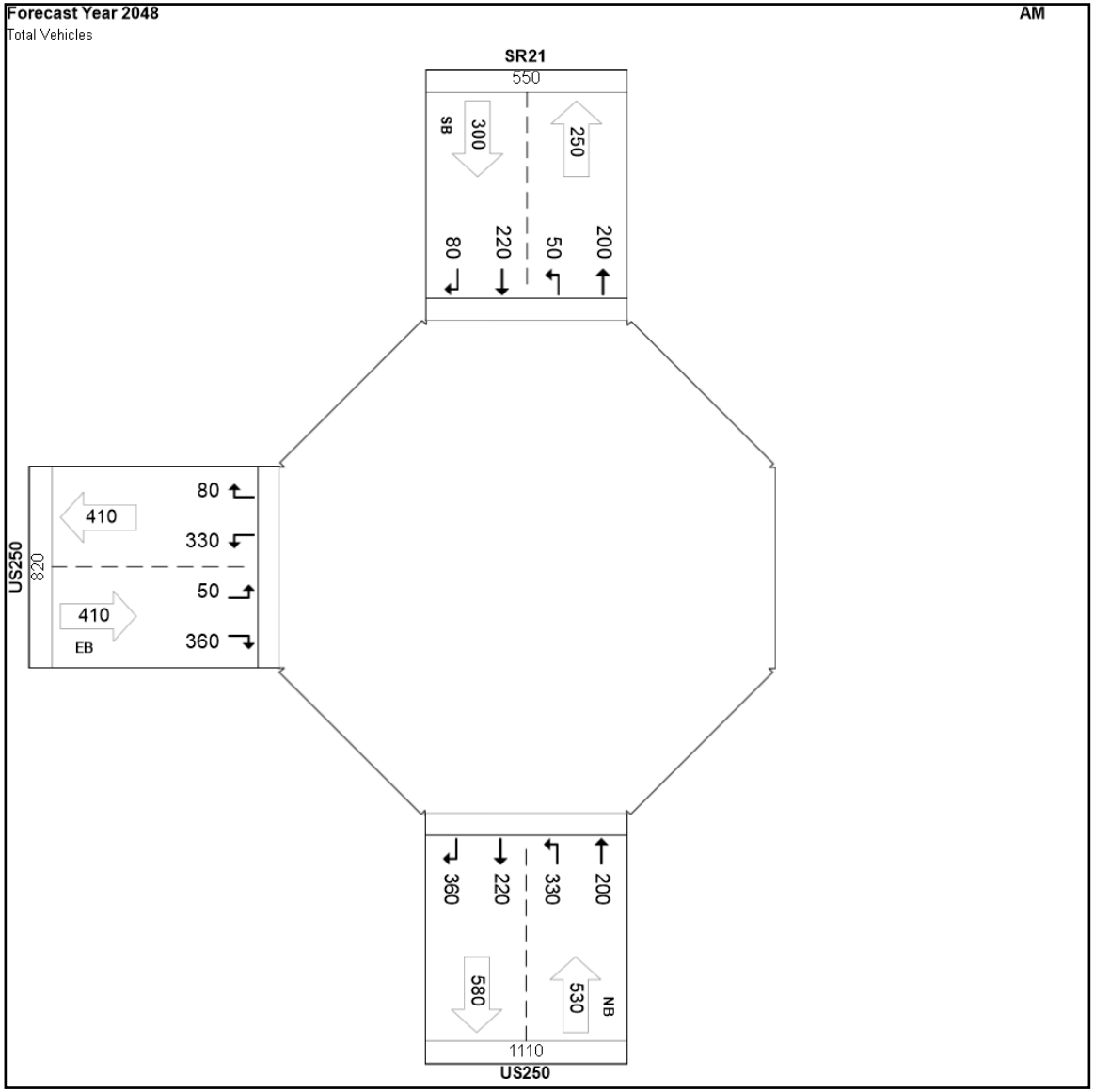
TFMS - Intersection Forecast Report

Opening Year Trucks ADT



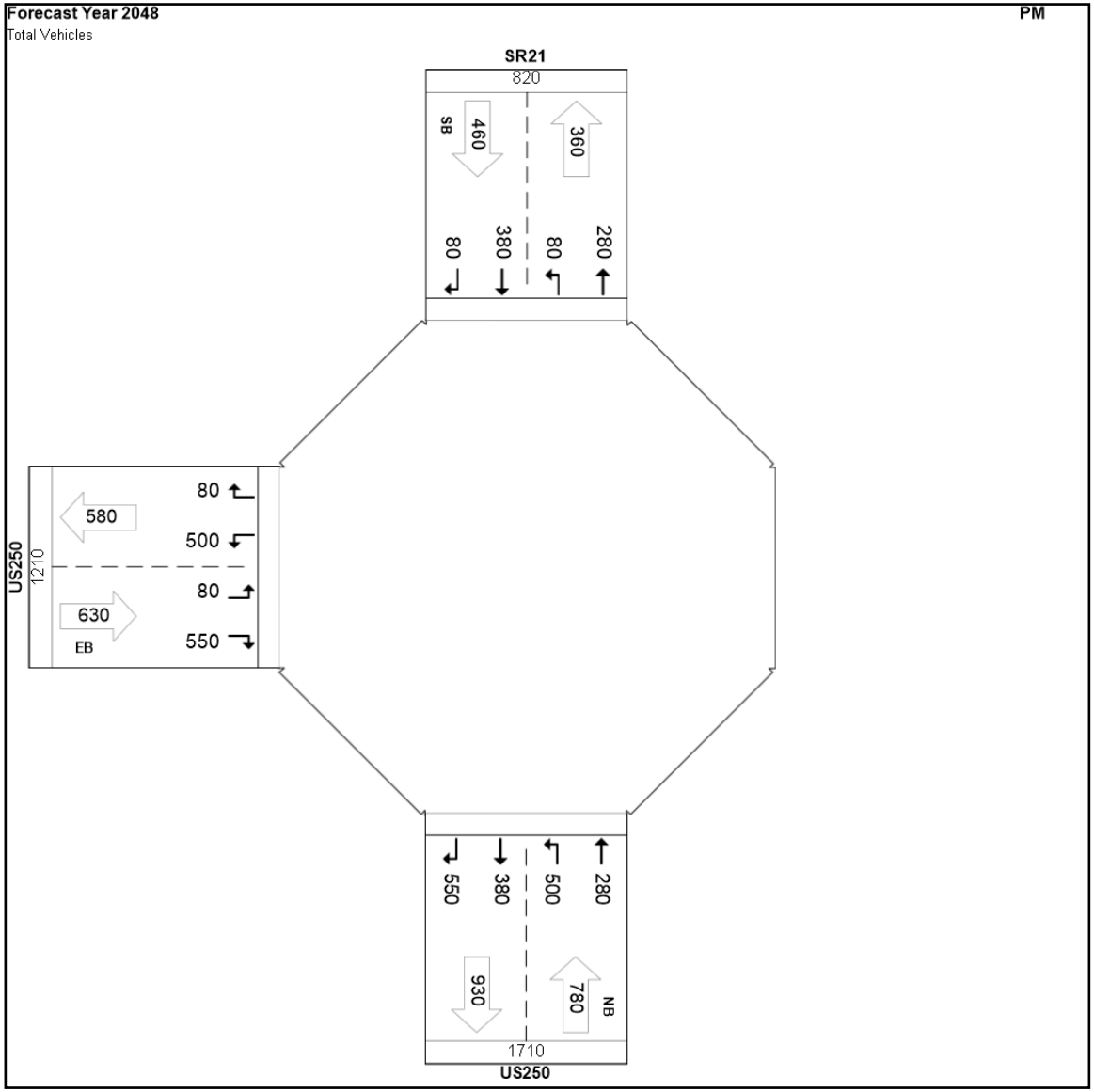
TFMS - Intersection Forecast Report

Design Year AM



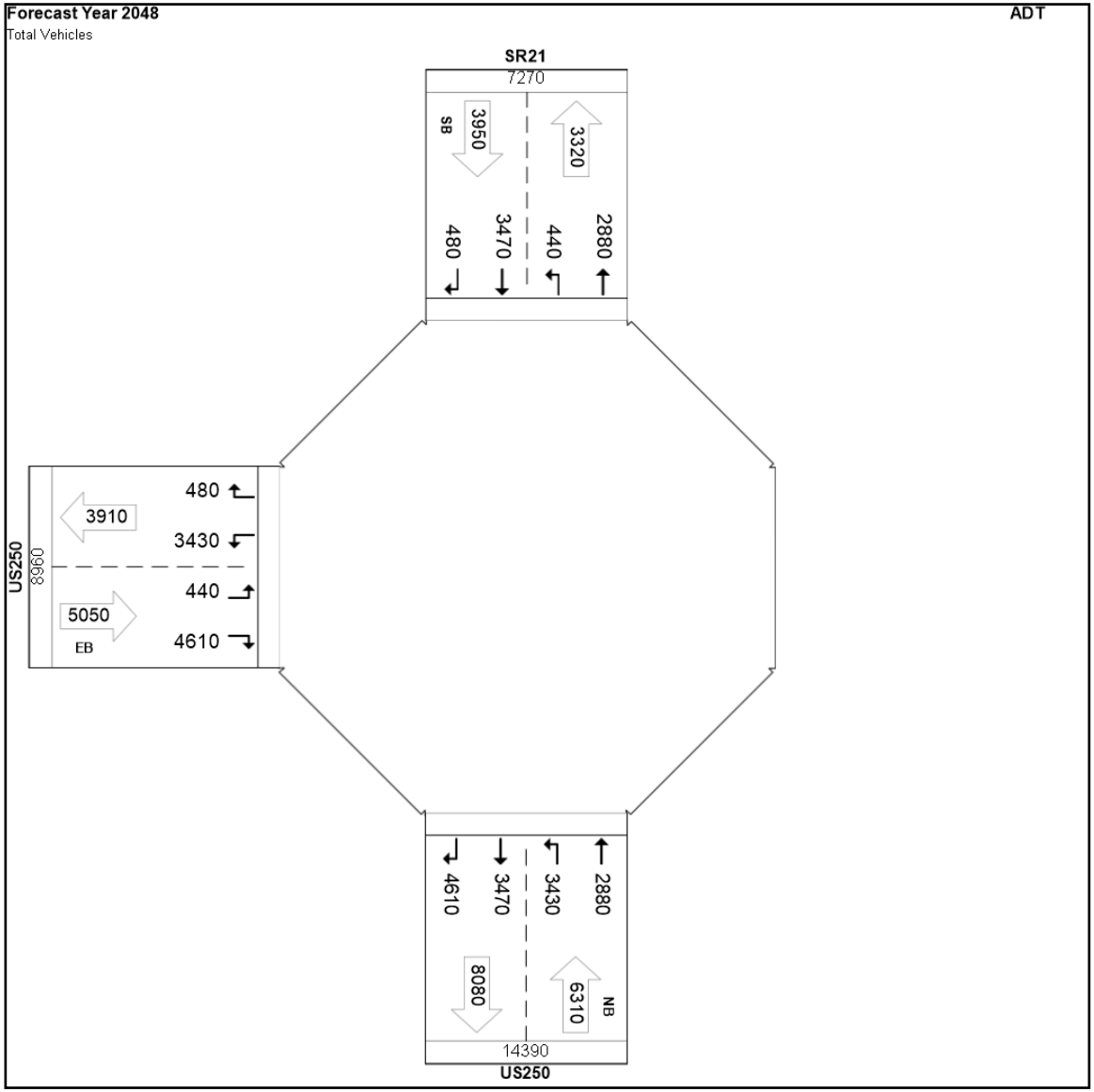
TFMS - Intersection Forecast Report

Design Year PM



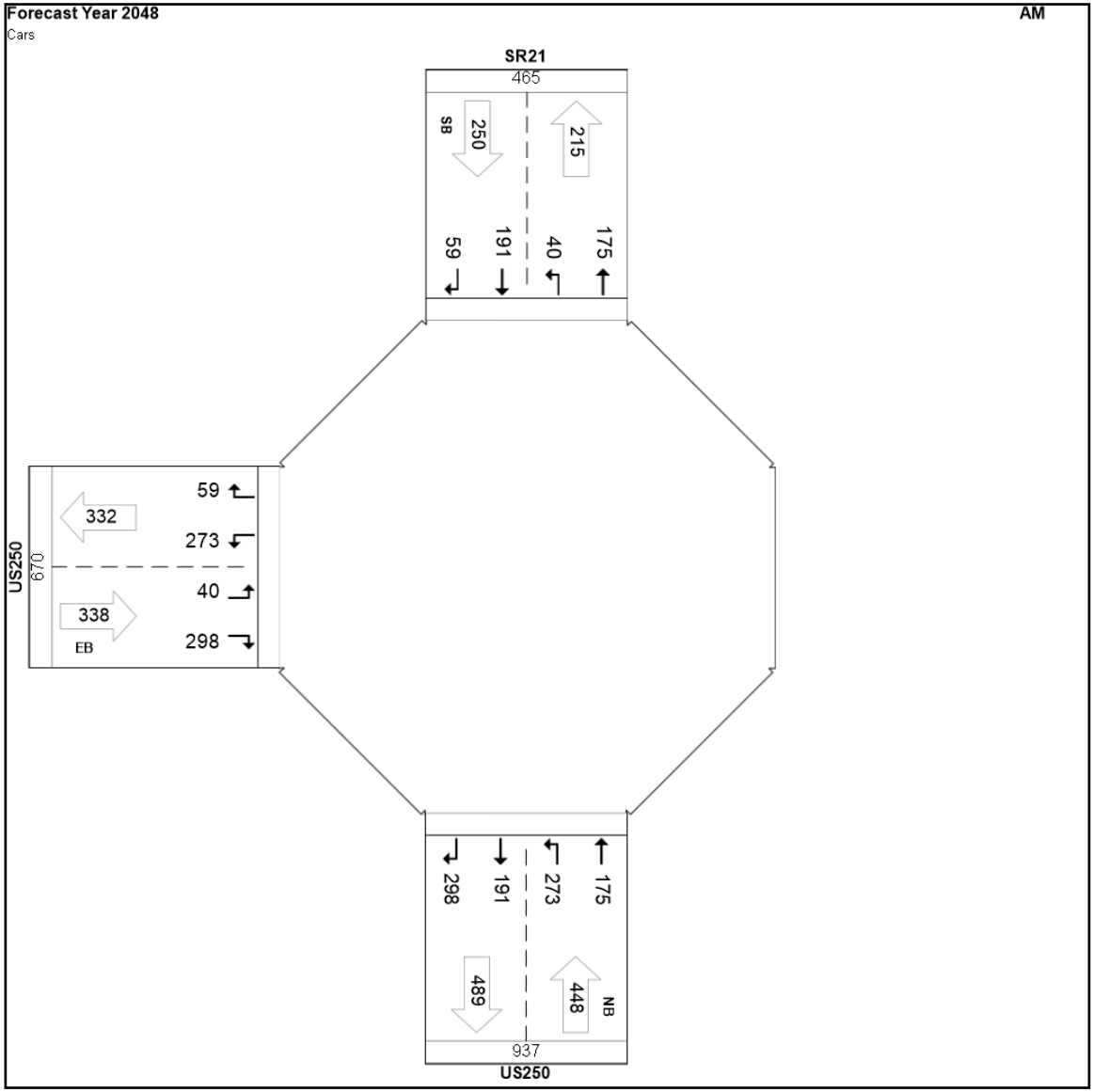
TFMS - Intersection Forecast Report

Design Year ADT

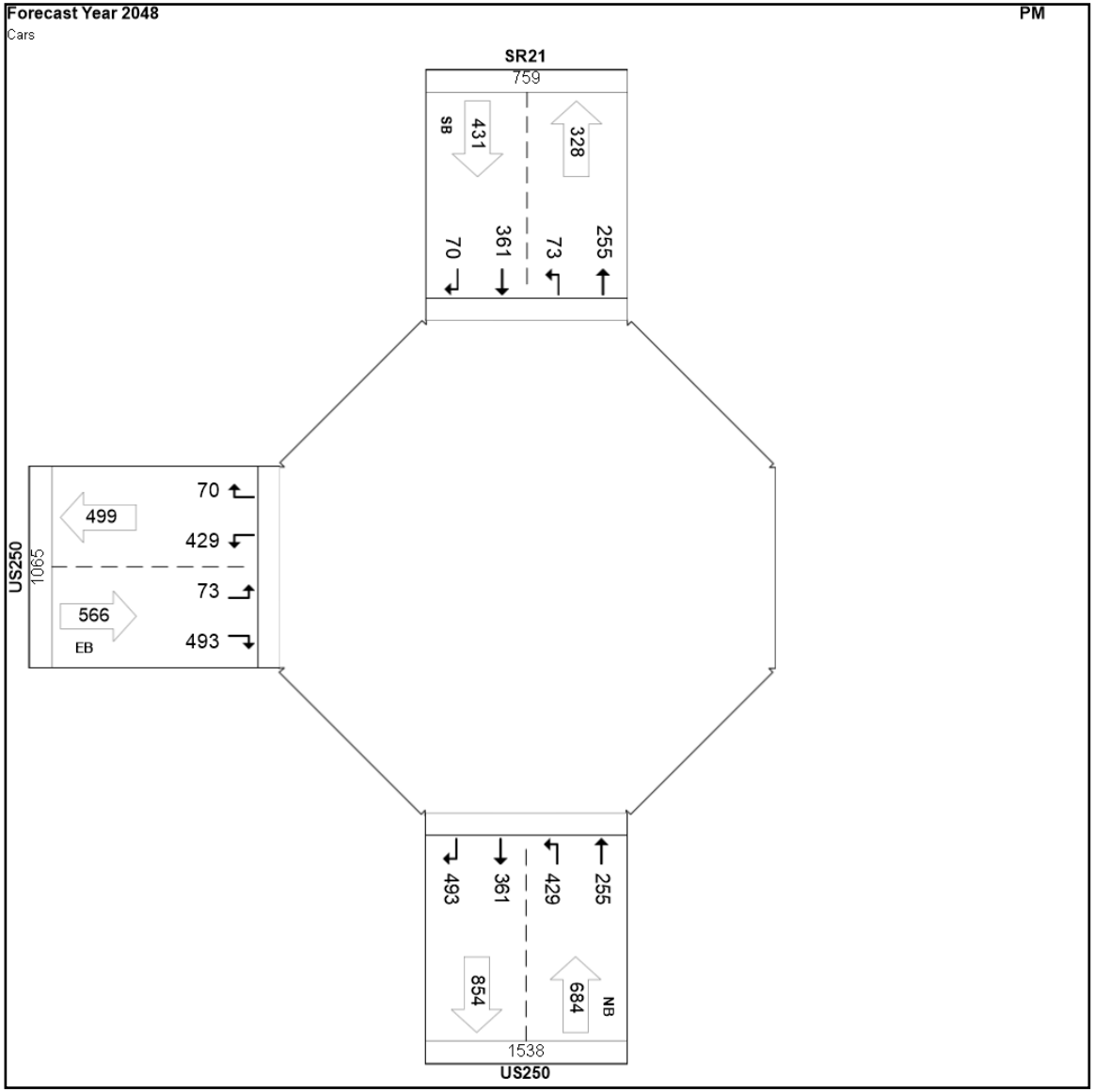


TFMS - Intersection Forecast Report

Design Year Cars AM

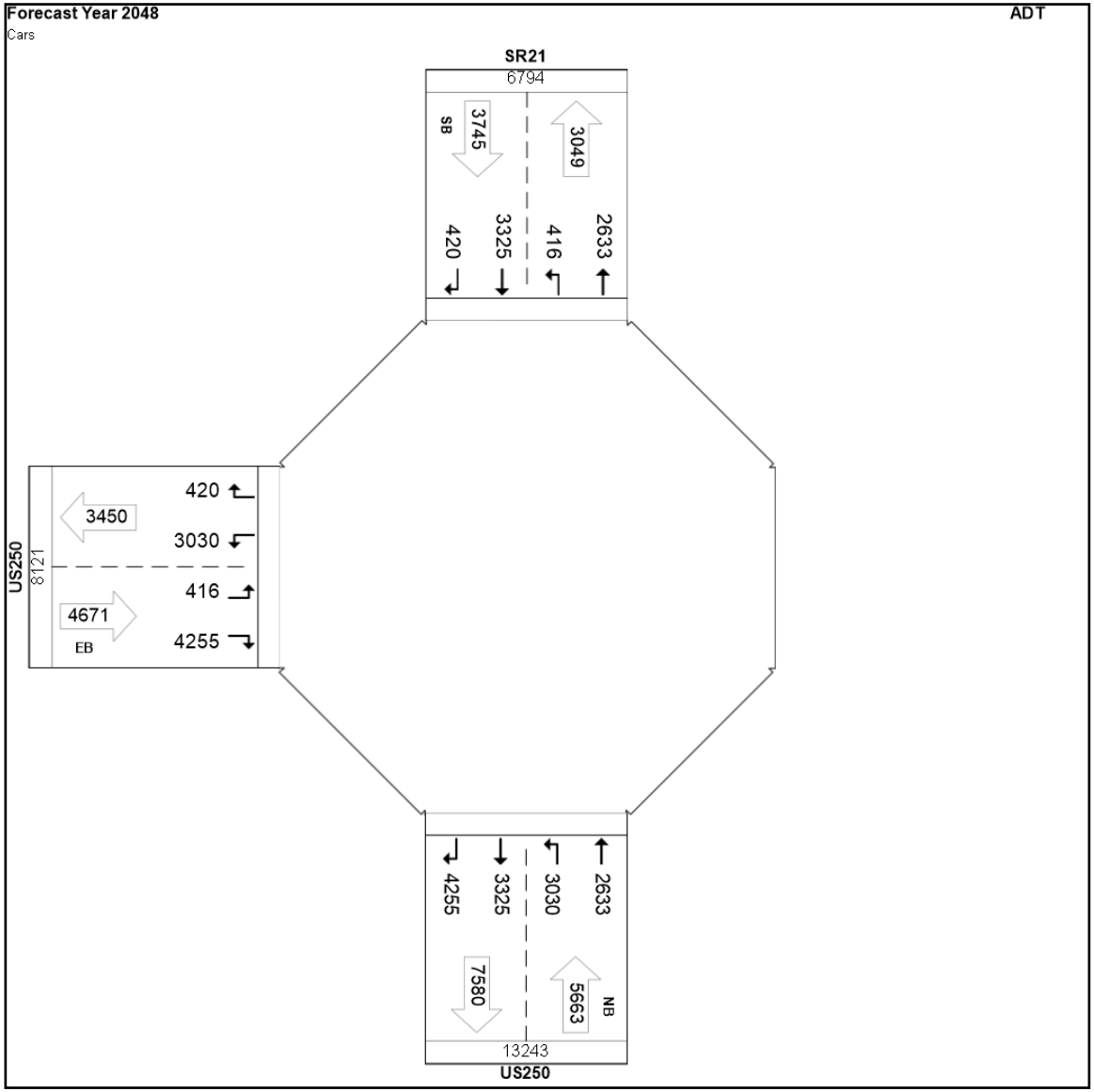


Design Year Cars PM

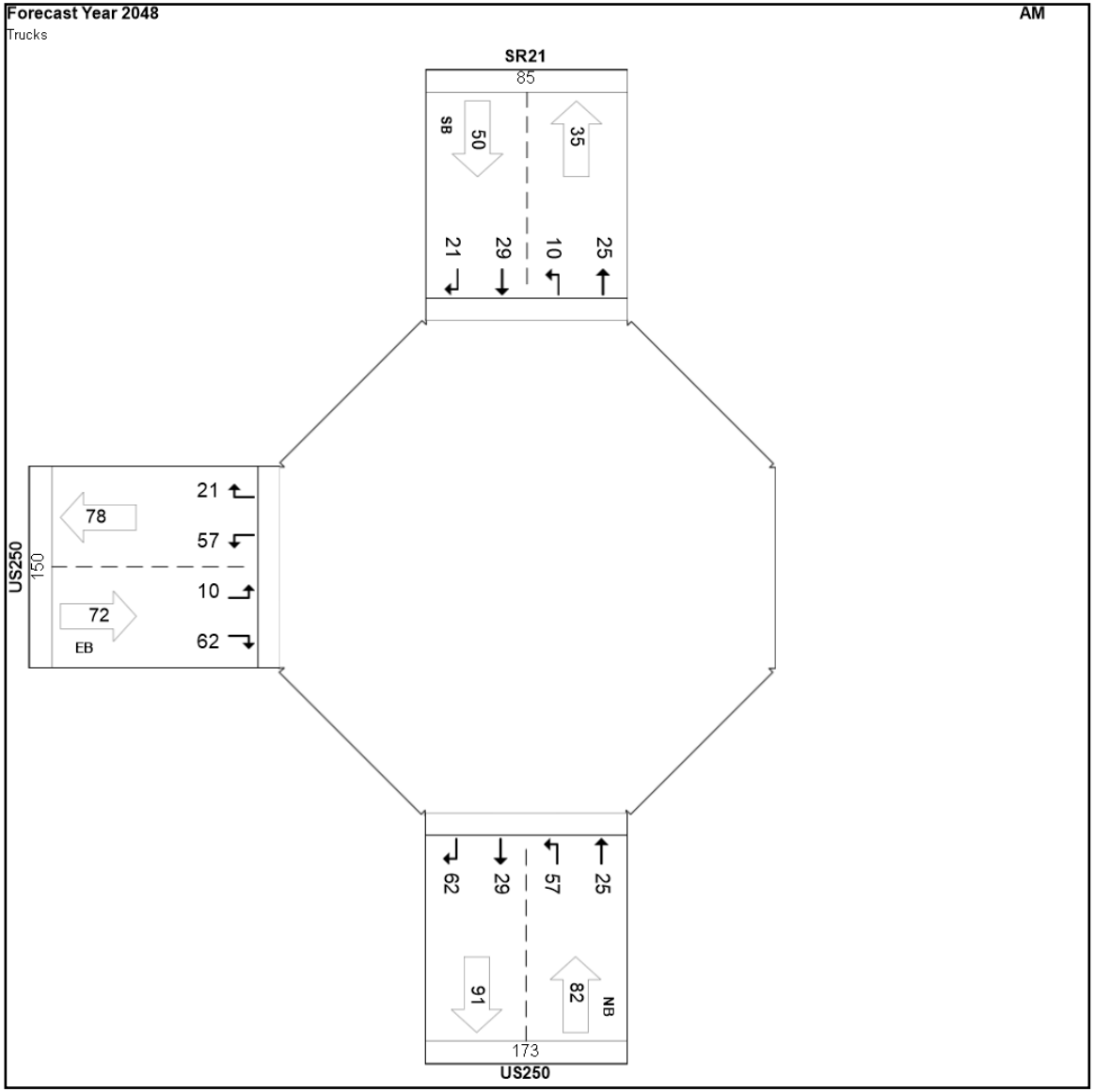


TFMS - Intersection Forecast Report

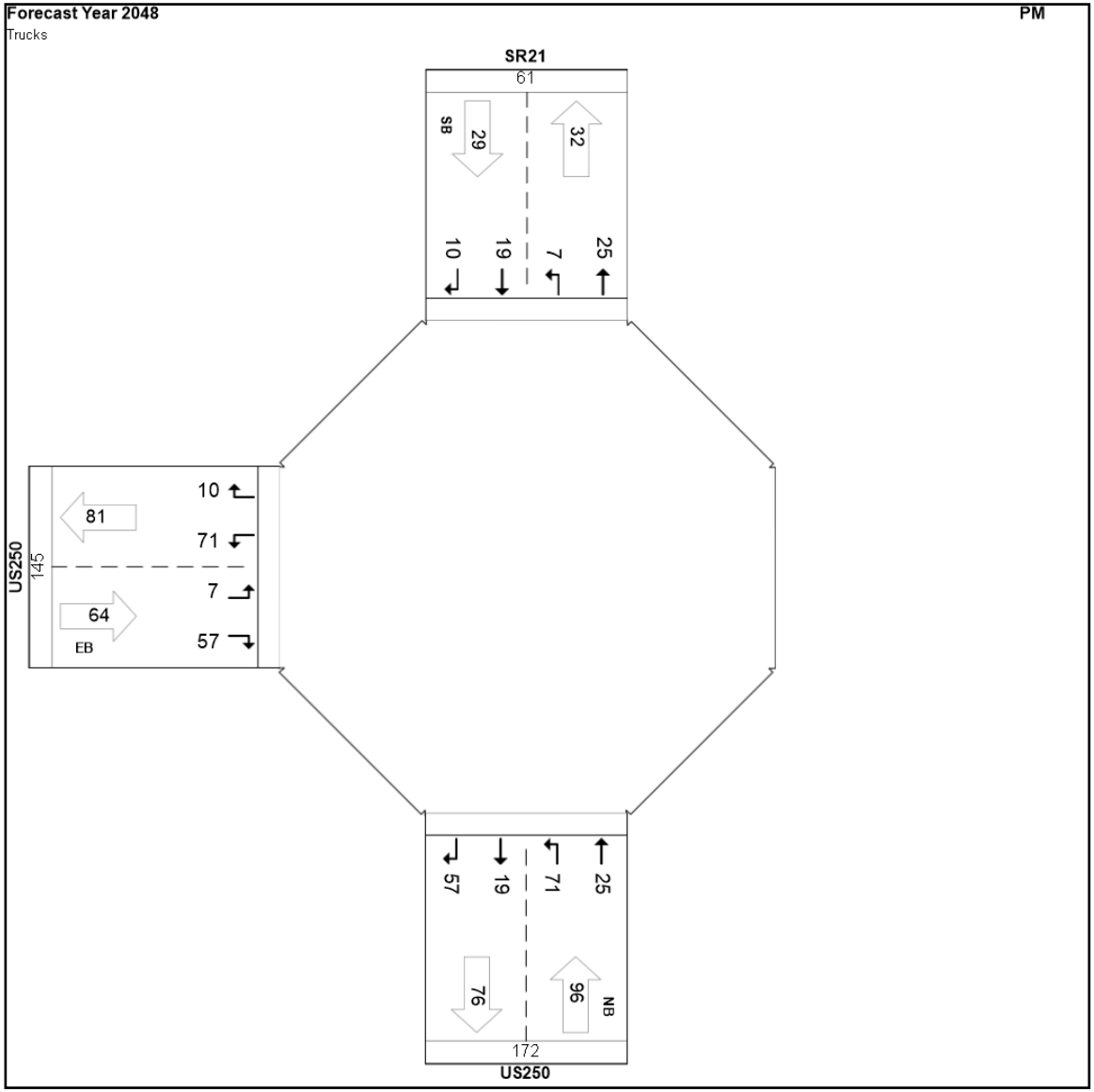
Design Year Cars ADT



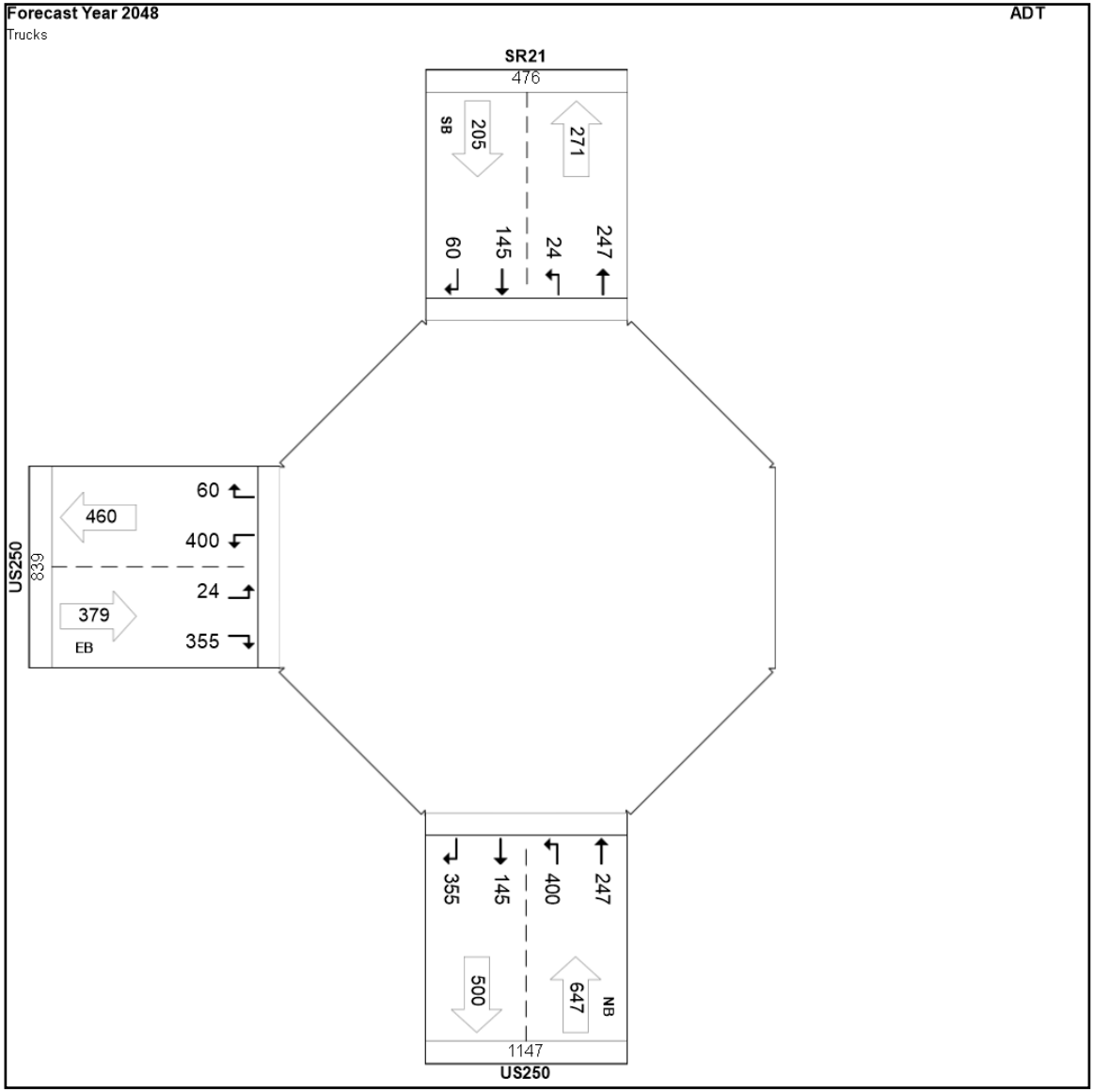
Design Year Trucks AM



Design Year Trucks PM

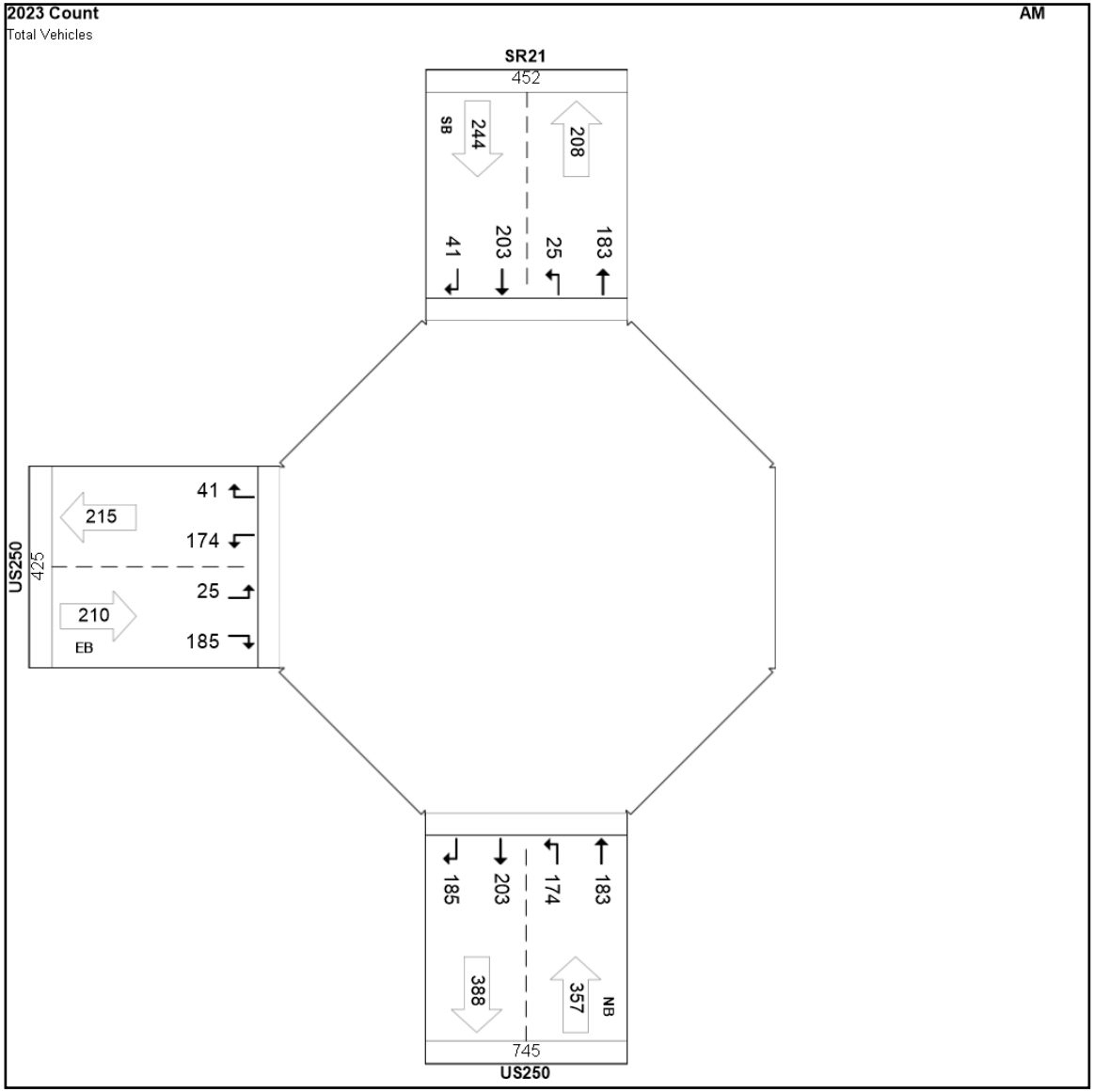


Design Year Trucks ADT



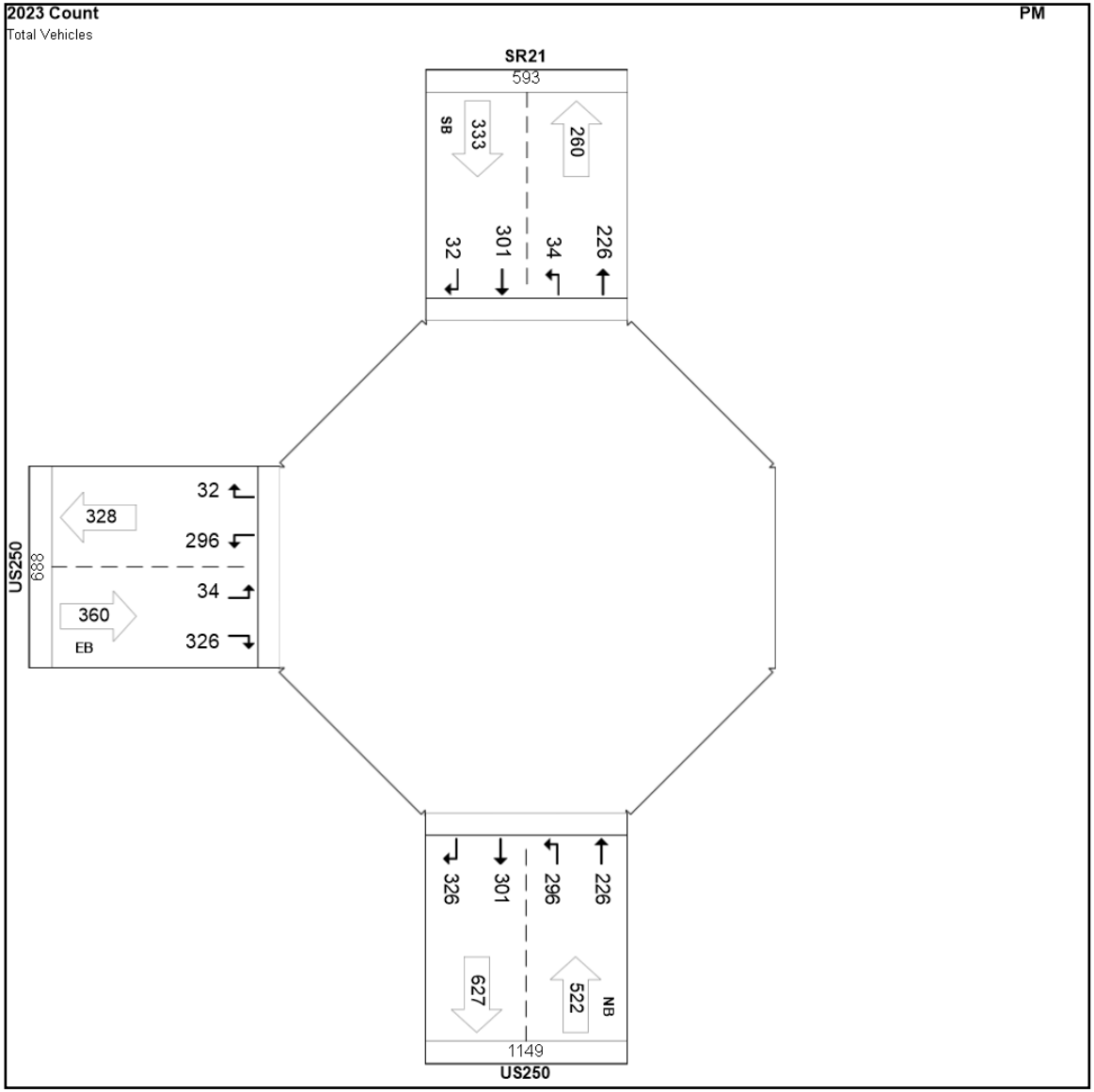
TFMS - Intersection Forecast Report

Pivot Point AM



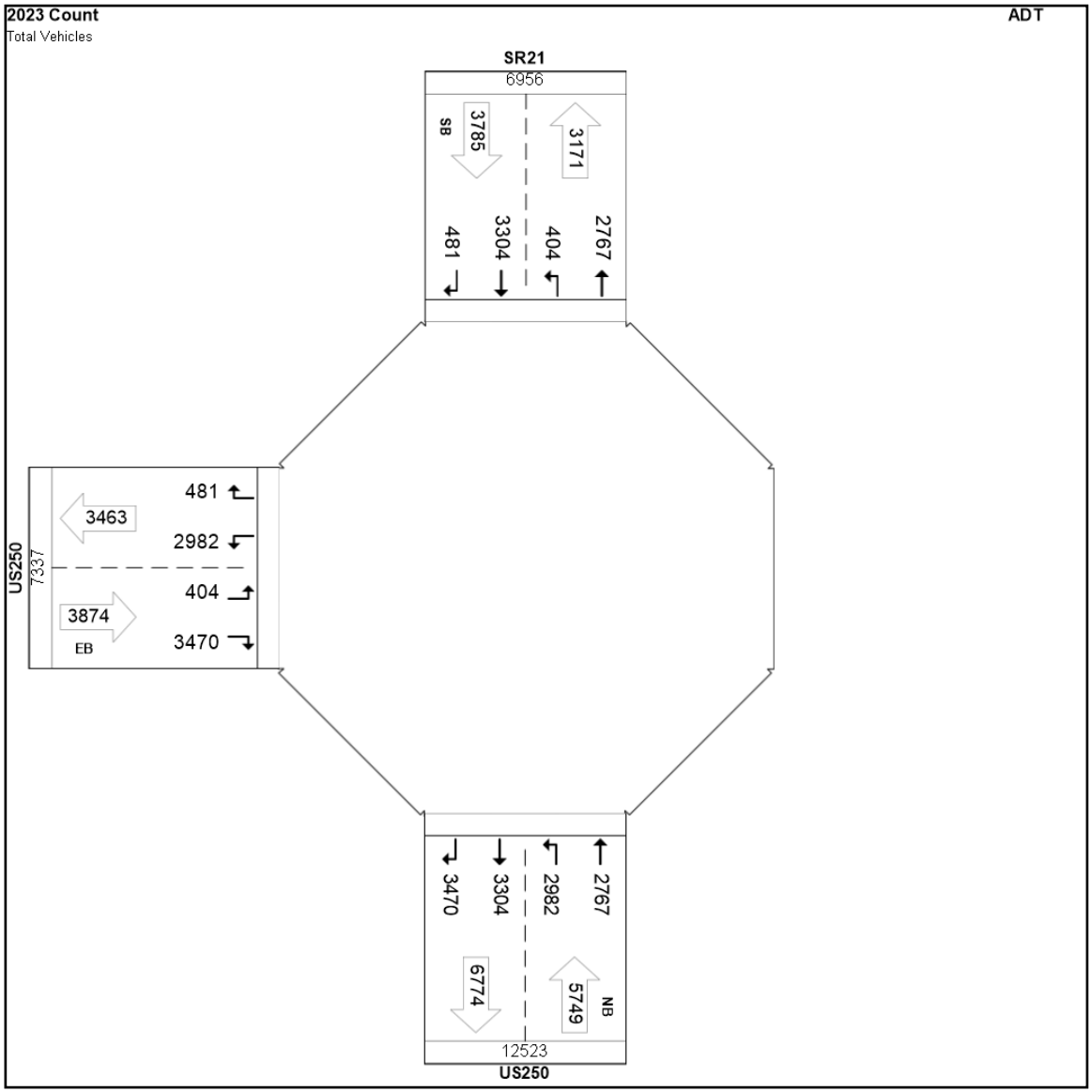
TFMS - Intersection Forecast Report

Pivot Point PM



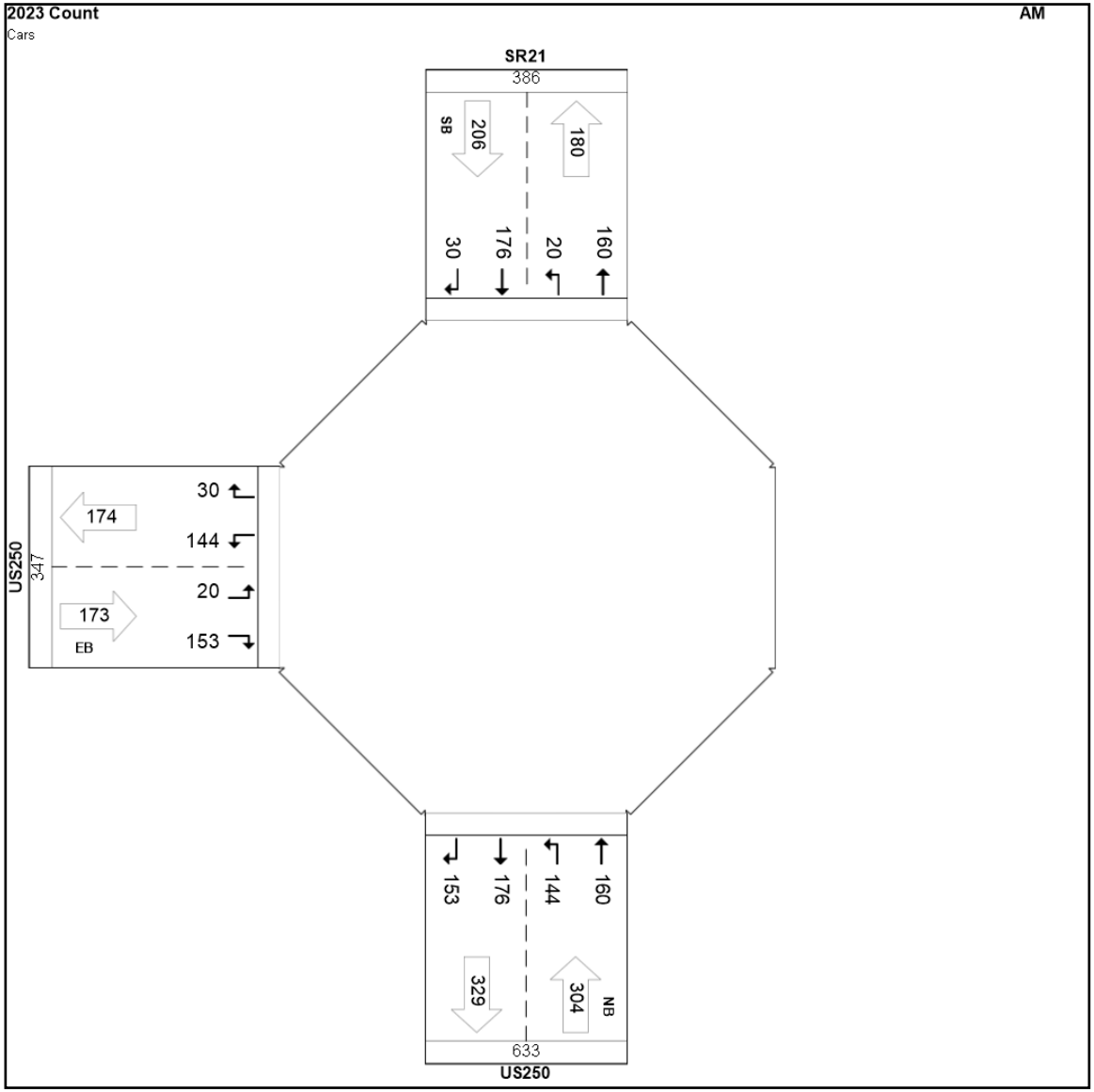
TFMS - Intersection Forecast Report

Pivot Point ADT



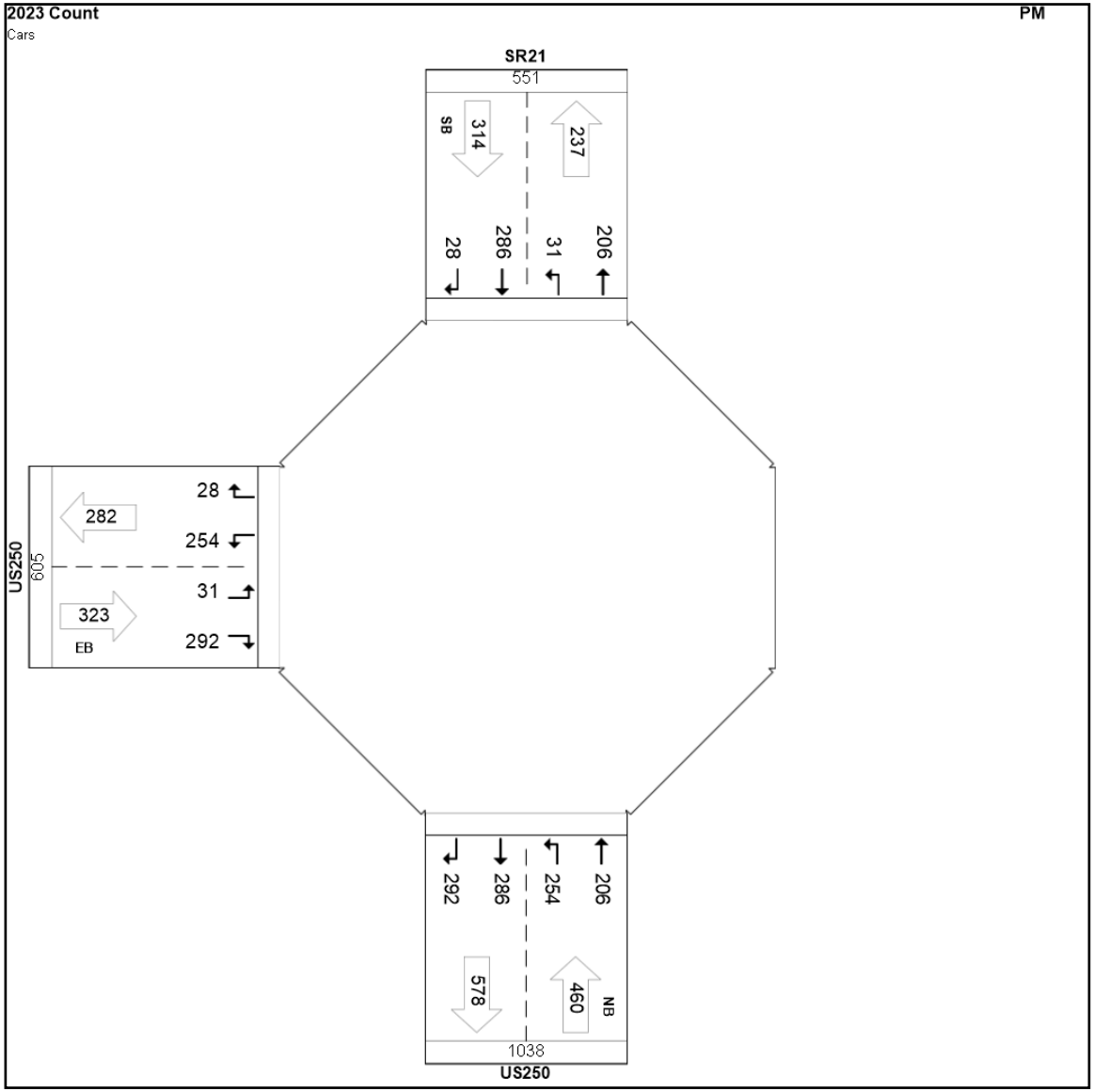
TFMS - Intersection Forecast Report

Pivot Point Cars AM



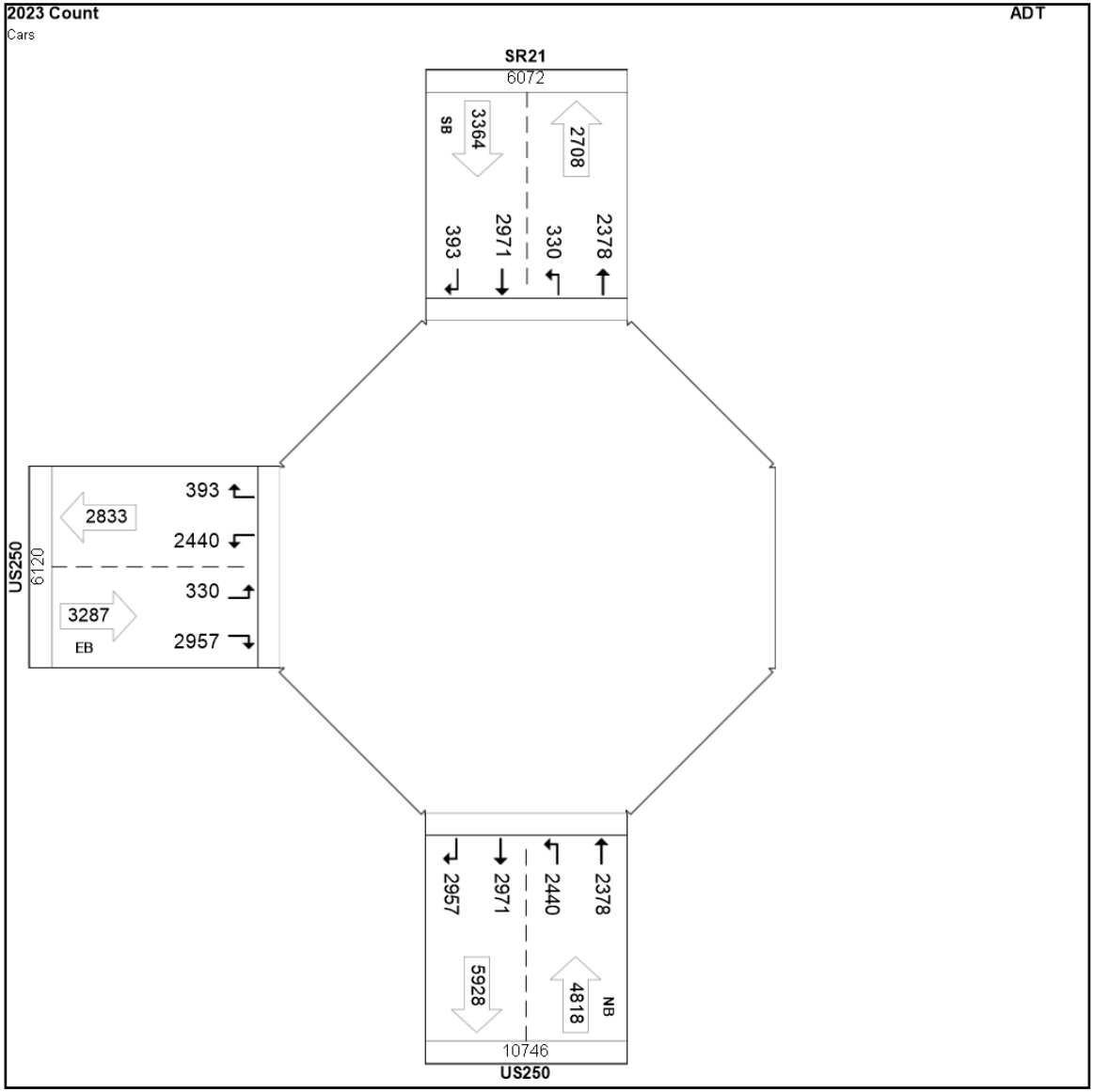
TFMS - Intersection Forecast Report

Pivot Point Cars PM



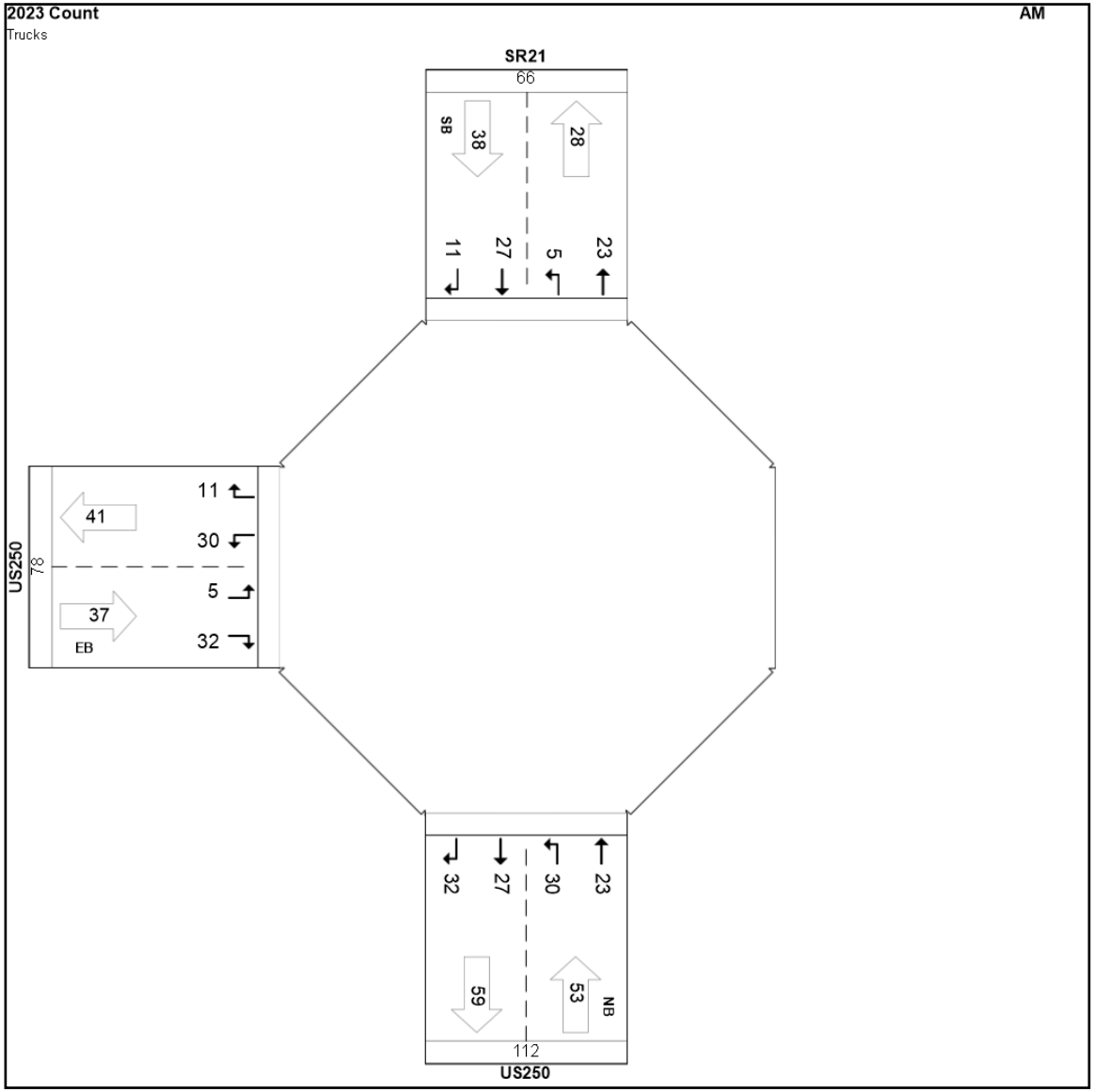
TFMS - Intersection Forecast Report

Pivot Point Cars ADT

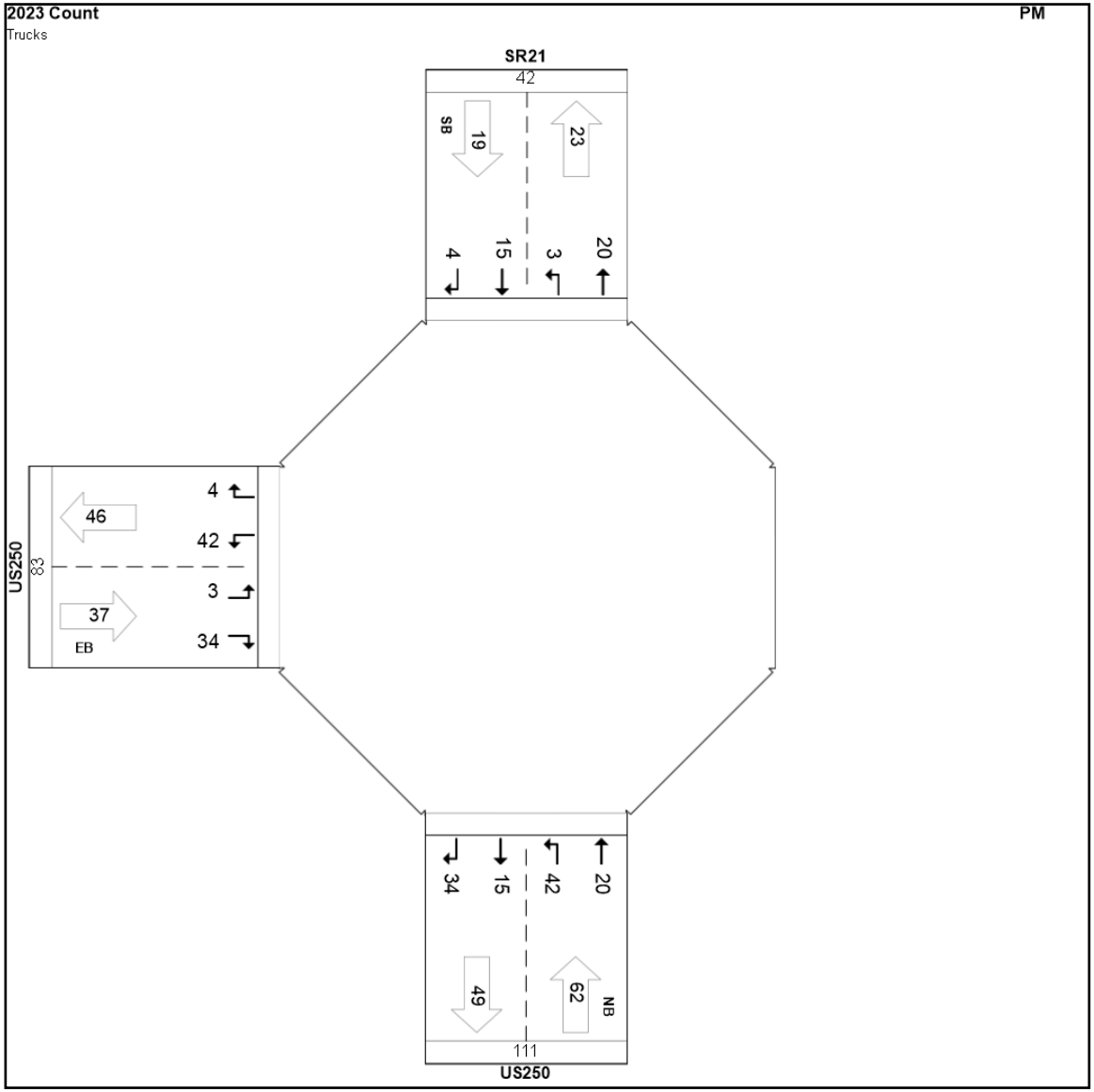


TFMS - Intersection Forecast Report

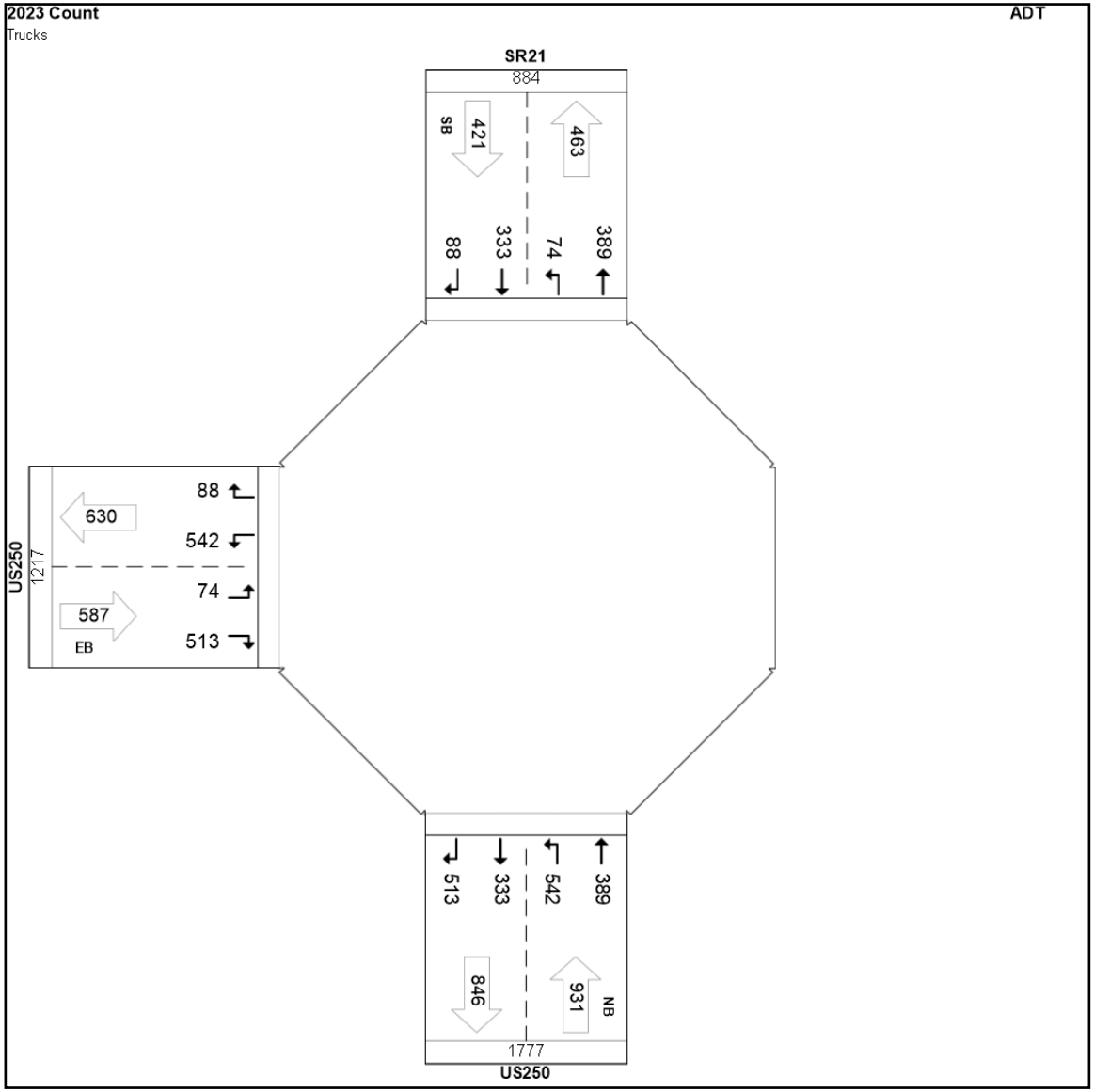
Pivot Point Trucks AM



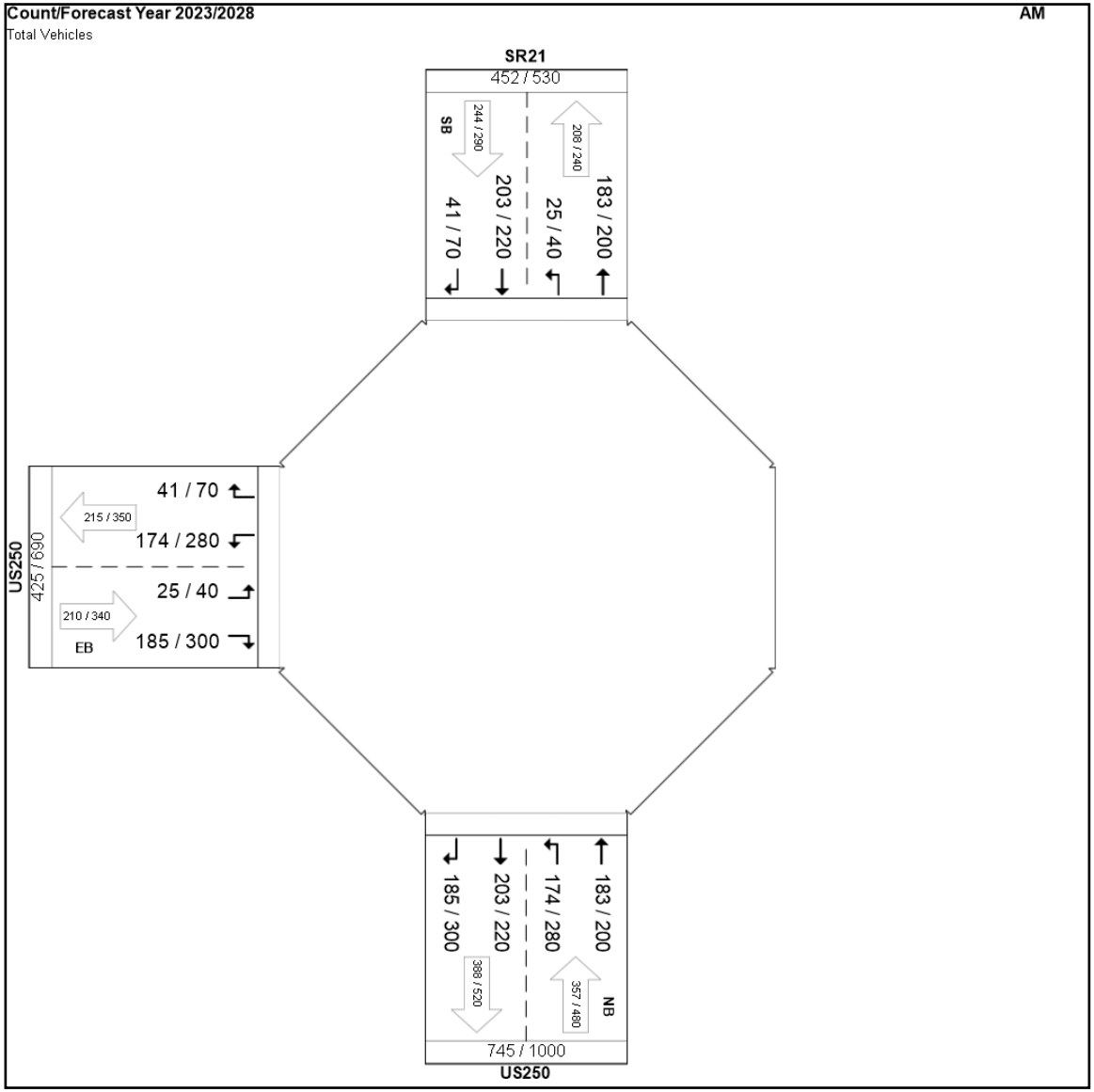
Pivot Point Trucks PM



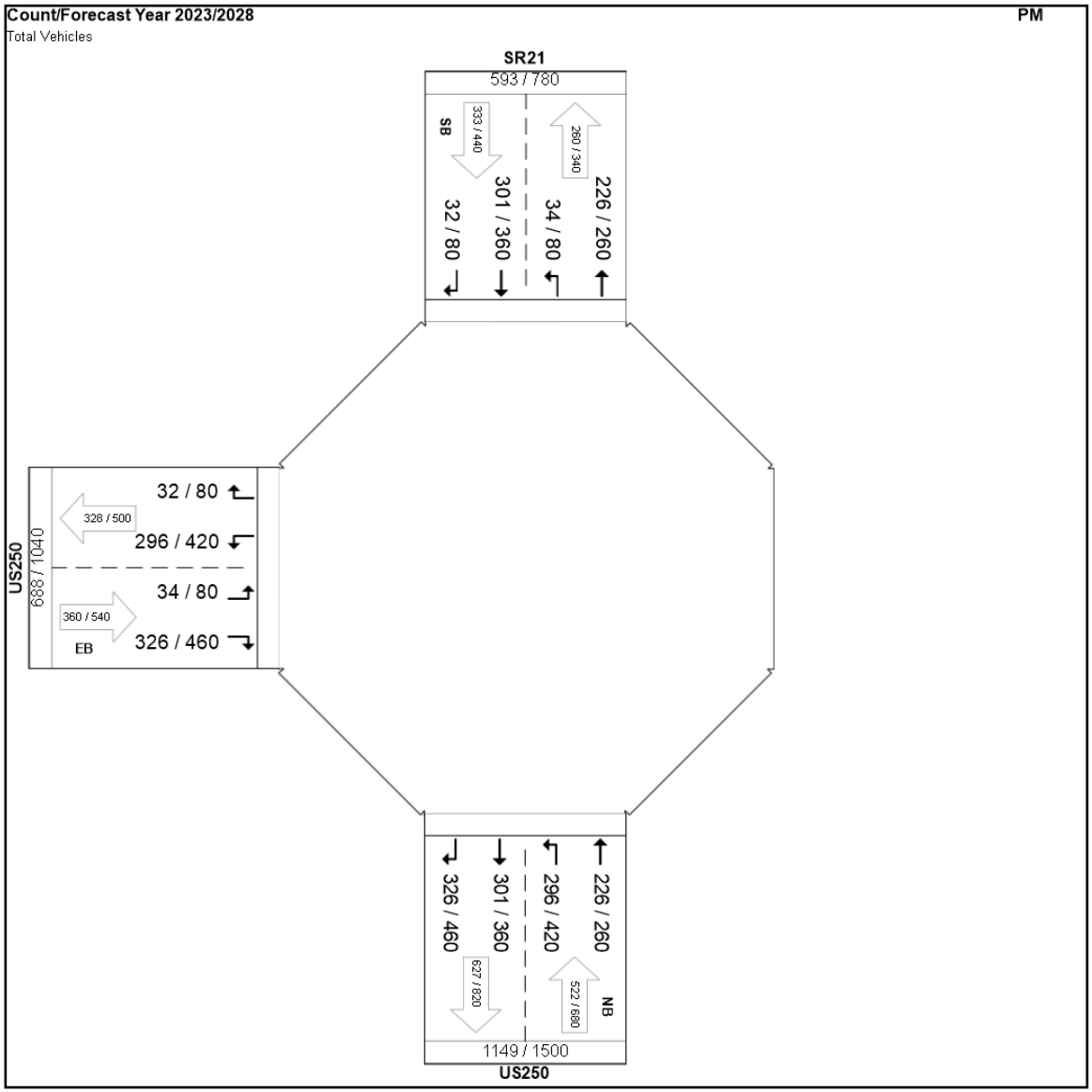
Pivot Point Trucks ADT



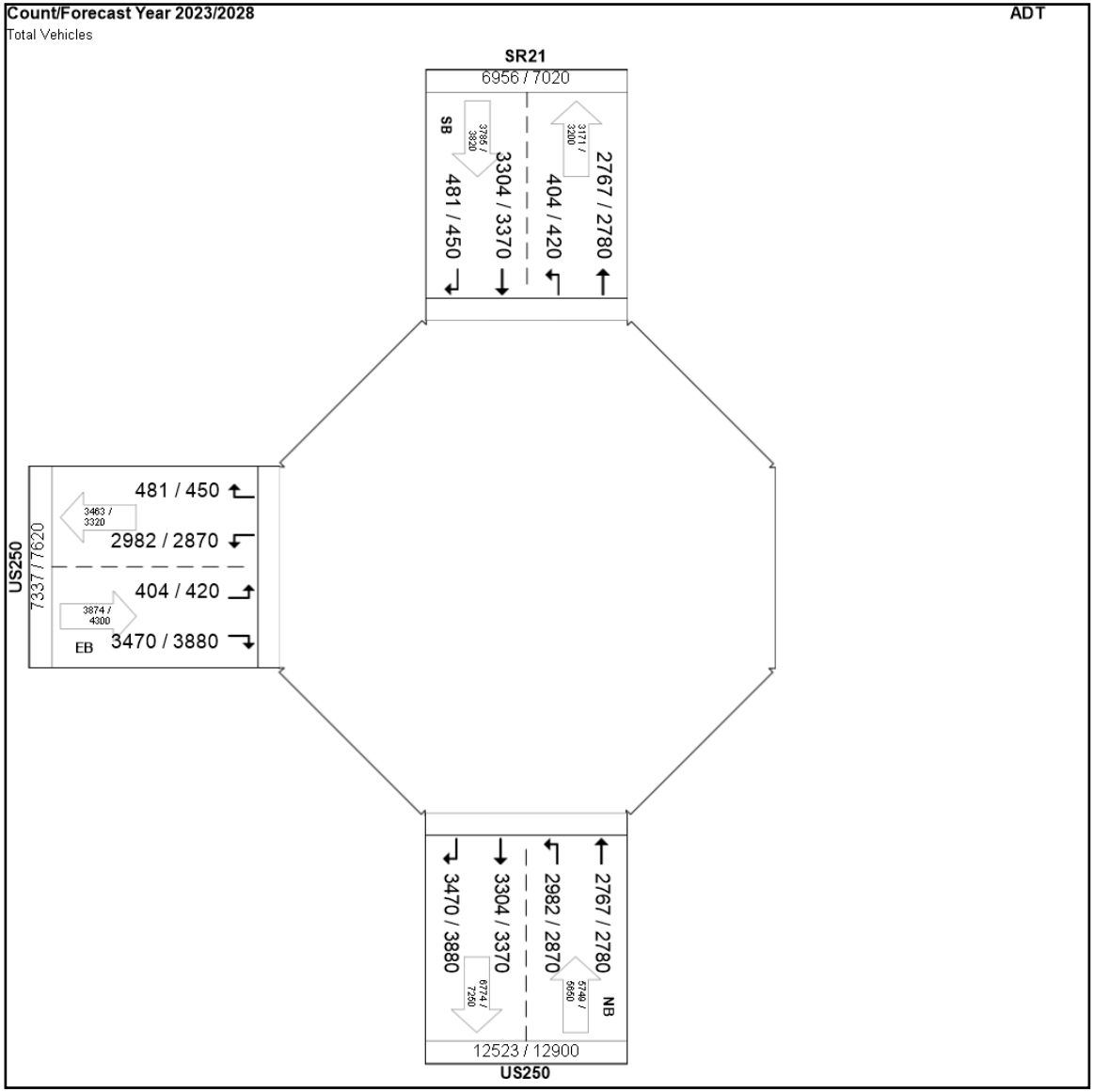
Count VS Opening Year AM



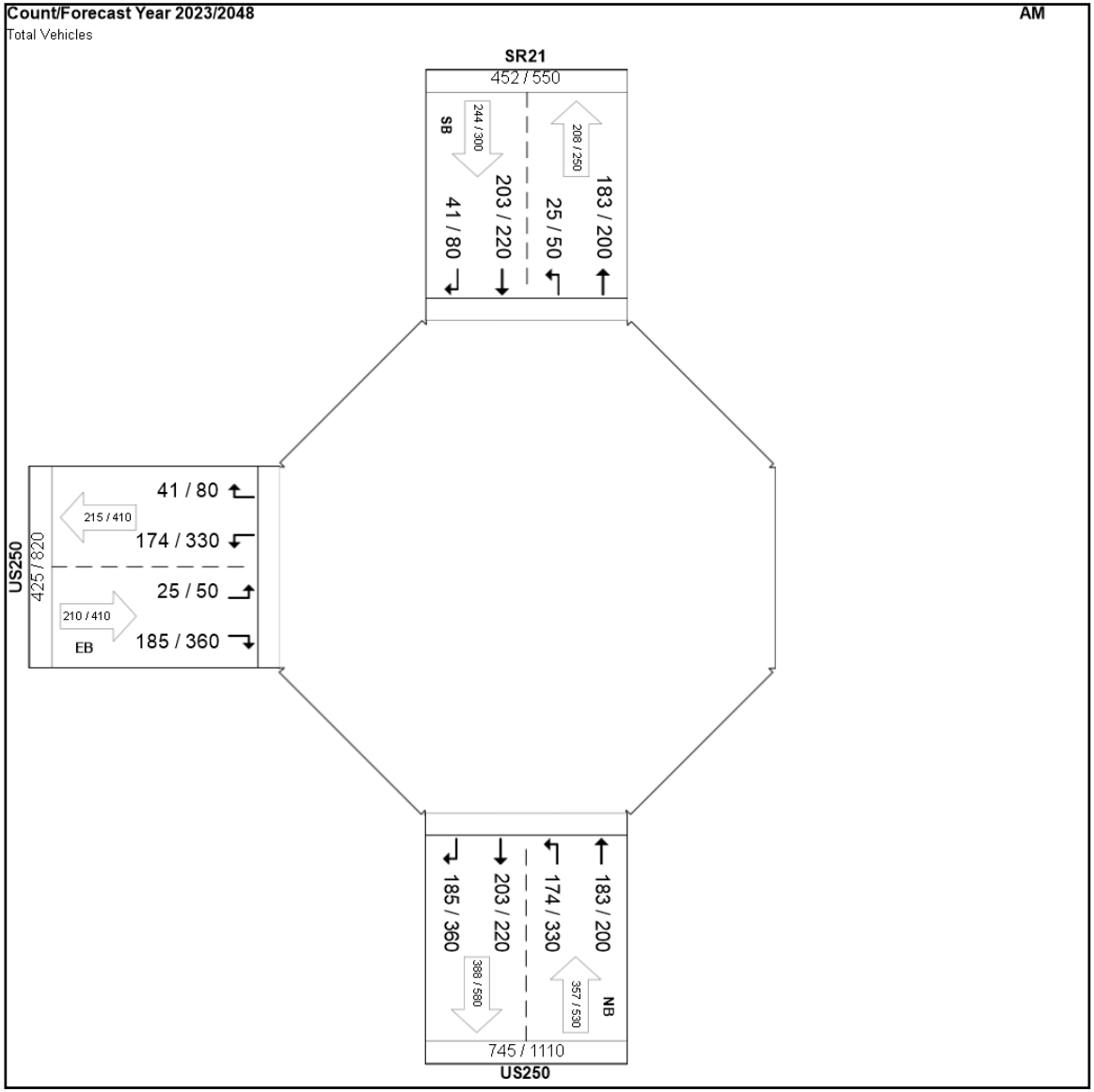
Count VS Opening Year PM



Count VS Opening Year ADT

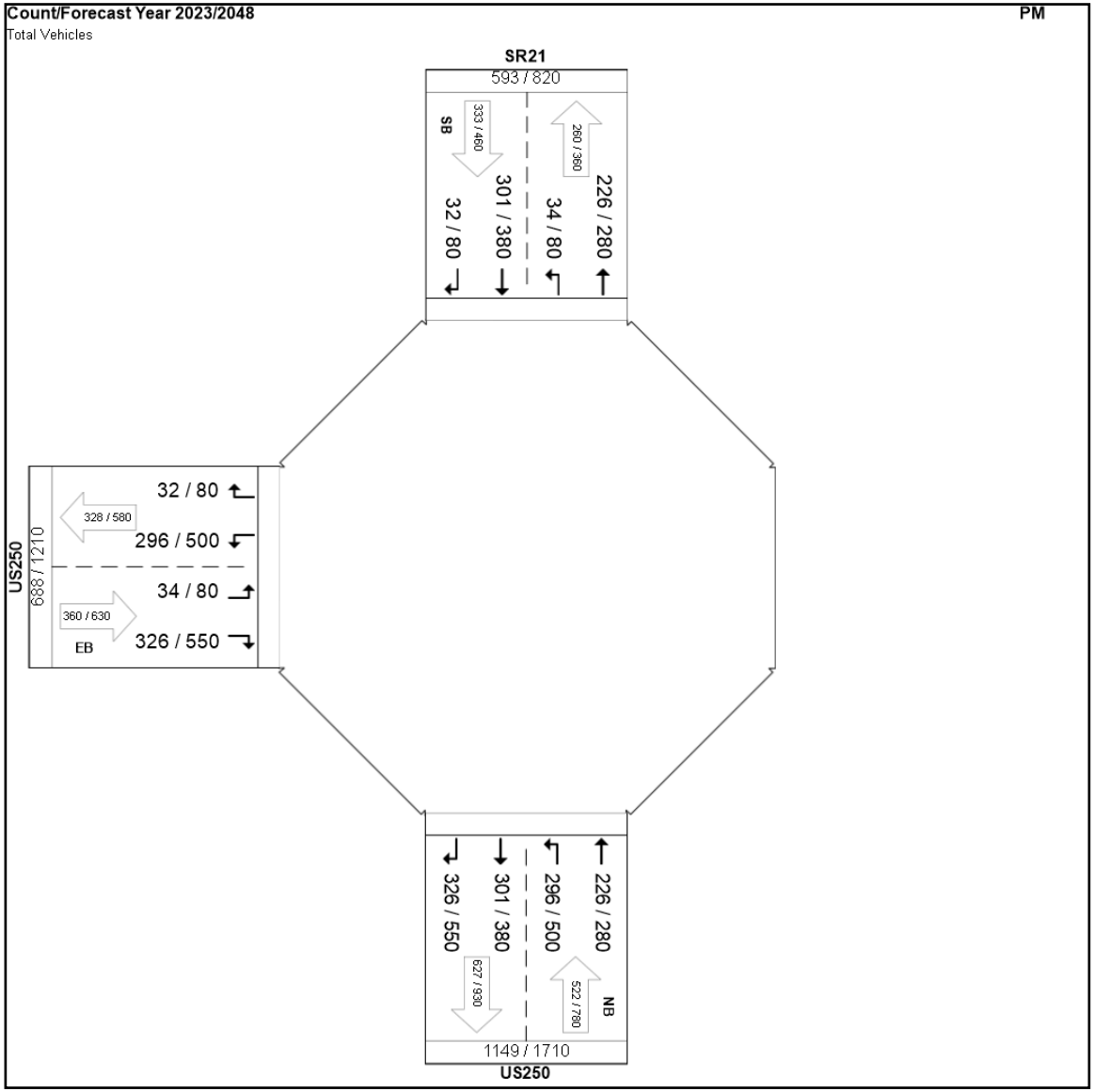


Count VS Design Year AM



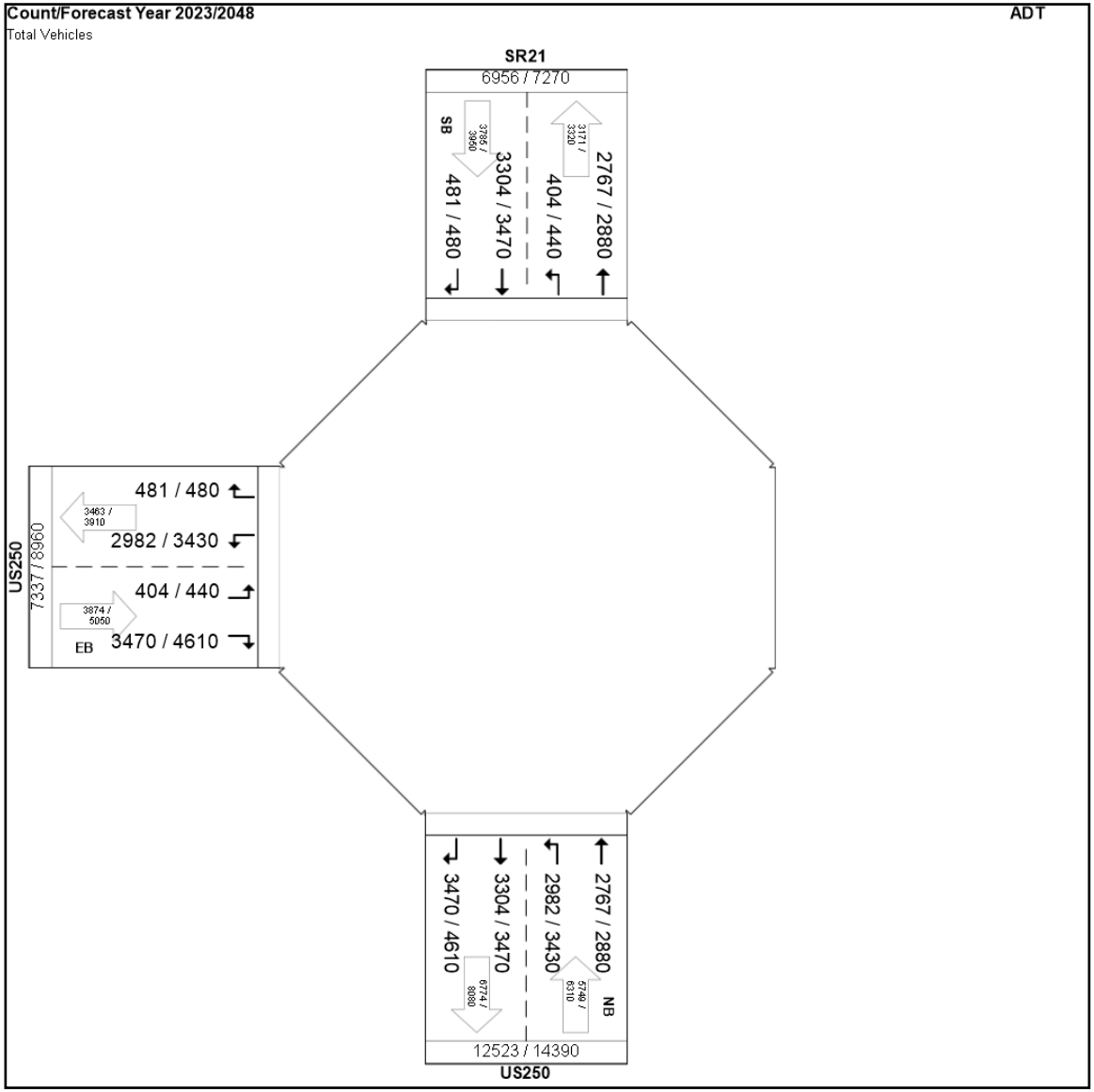
TFMS - Intersection Forecast Report

Count VS Design Year PM



TFMS - Intersection Forecast Report

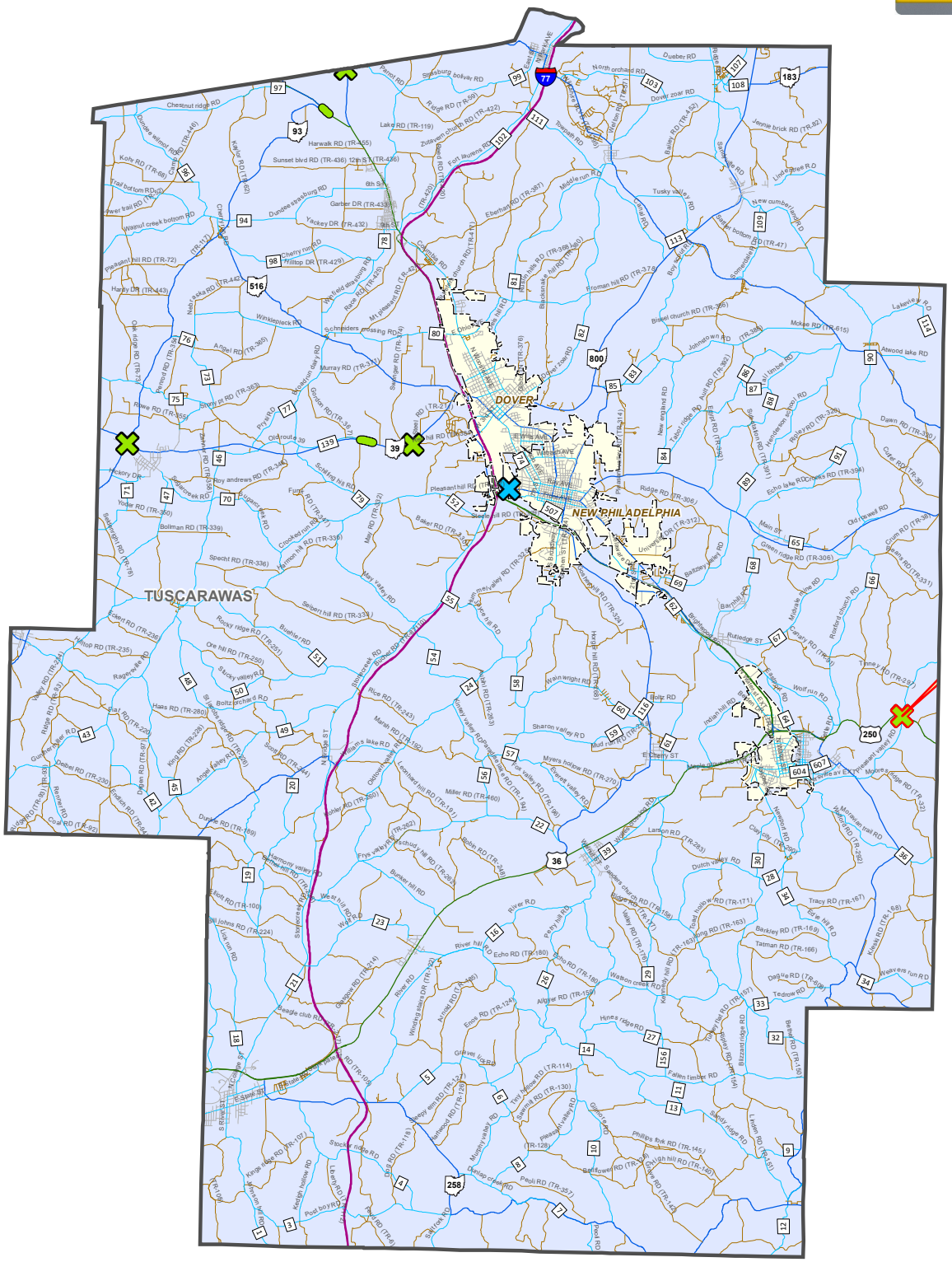
Count VS Design Year ADT



APPENDIX E

ODOT HSIP Priority & TOAST Maps

2021 Highway Safety Improvement Program (HSIP) Priority Locations - Tuscarawas County



City Boundary

Roads by Type

- Other Routes
- Interstate Route
- United States Route
- State Route
- County Road
- Township Road

Safety Priority Category

- Rural Intersections
- Suburban Intersections
- Urban Intersections

Safety Priority Category

- Rural Freeway
- Rural Non-Freeway
- Rural Ramp
- Suburban Non-Freeway
- Urban Freeway
- Urban Non-Freeway
- Urban Ramp

Date: 12/12/2022

0 1.25 2.5 5 7.5

Miles

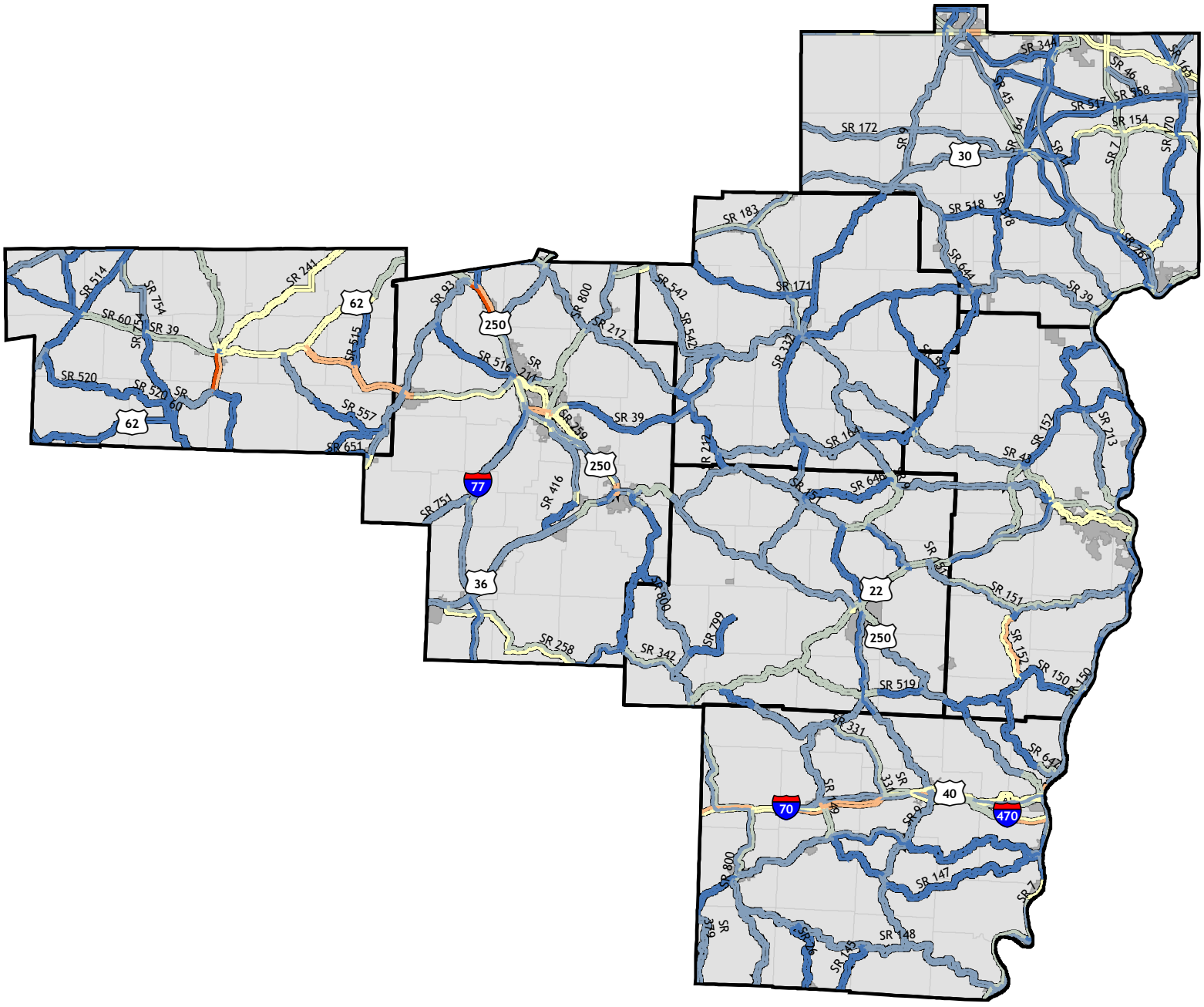
N

odot

Division of Planning

Program Management

DISTRICT 11



0 5 10 20 30 Miles

OHIO DEPARTMENT OF TRANSPORTATION
DIVISION OF OPERATIONS
Transportation Systems Management & Operations (TSMO)

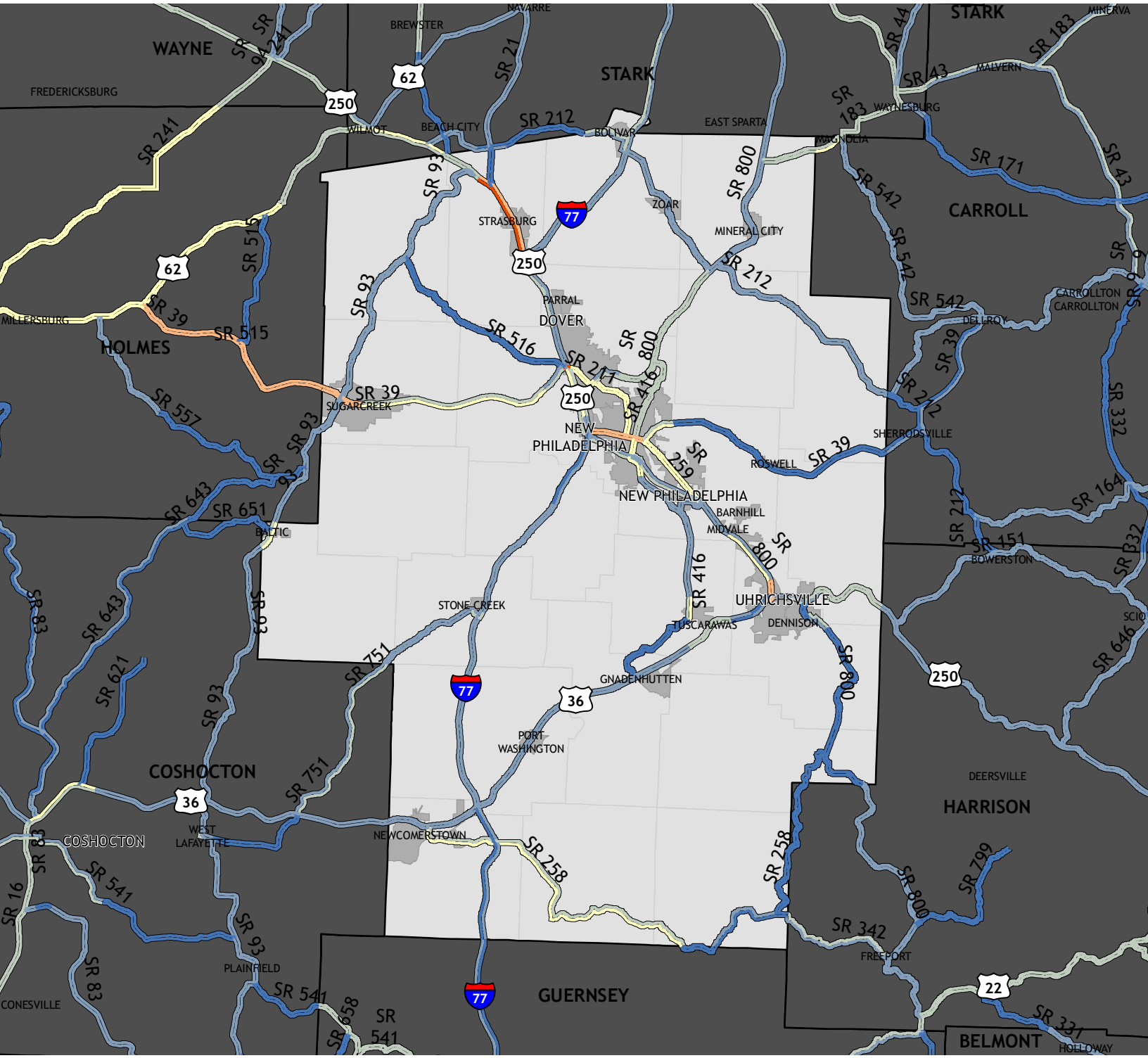
Legend

TOAST 2022
Overall Score

- 0.040000 - 0.365000
- 0.365001 - 0.532500
- 0.532501 - 0.637500
- 0.637501 - 0.722500
- 0.722501 - 0.802500
- 0.802501 - 0.880000
- 0.880001 - 1.000000

Data Updated 4/11/2023

TUSCARAWAS COUNTY



Legend

Score

0.040000 - 0.365000	0.637501 - 0.722500
0.365001 - 0.532500	0.722501 - 0.802500
0.532501 - 0.637500	0.802501 - 0.880000
	0.880001 - 1.000000

0 3 6 12 18 Miles

Data Updated 4/11/2023

OHIO DEPARTMENT OF TRANSPORTATION
DIVISION OF OPERATIONS

Transportation Systems Management & Operations (TSMO)

District 11

10 Lowest Scoring Segments Per Category

Legend

Lowest Segments Per Category

Roadway Category

- Rural Freeway
- Rural Nonfreeway
- Urban Freeway
- Urban Nonfreeway

TOAST 2022 Dataset
Updated April 2023

0 3.757.5 15 22.5 30 Miles

Areas outside map extent do not contain any Top 10 segments for this District.

Urban Freeway		
Rank	Score	TOAST ID
1	0.533	STUSUS00250**C_21.231_22.085_F
2	0.595	SBELIR00470**C_03.329_06.915_F
3	0.618	STUSUS00250**C_21.231_22.085_R
4	0.625	SBELSR00007**C_19.992_20.968_R
5	0.648	SBELSR00007**C_11.584_13.658_R
6	0.65	SBELIR00470**C_03.329_06.915_R
7	0.68	SCOLUS00030**C_34.130_34.730_R
8	0.693	SBELIR00070**C_16.442_18.205_F
9	0.71	SBELIR00070**C_18.205_20.039_F
9	0.71	STUSUS00250**C_18.902_21.231_F
9	0.71	SJEFUS00022**C_13.930_14.930_R

Urban Non-Freeway		
Rank	Score	TOAST ID
1	0.445	STUSUS00250**C_01.610_05.632_F
2	0.495	STUSSR00039**C_09.863_10.125_F
3	0.51	STUSSR00039**C_09.863_10.125_R
4	0.58	STUSUS00250**C_01.610_05.632_R
5	0.588	SCOLSR00014**C_02.690_03.810_F
5	0.588	SCOLSR00014**C_02.690_03.810_R
7	0.608	SBELUS00040**C_16.948_18.652_F
8	0.613	STUSSR00039**C_12.734_14.943_R
9	0.628	STUSSR00039**C_12.734_14.943_F
10	0.645	SBELSR00767**C_00.000_00.315_F

Rural Freeway		
Rank	Score	TOAST ID
1	0.6	SBELIR00070**C_06.142_09.649_F
2	0.605	SBELIR00070**C_09.649_14.308_R
3	0.608	SBELIR00070**C_09.649_14.308_F
4	0.623	SBELIR00070**C_00.000_03.918_R
5	0.658	SBELIR00070**C_06.142_09.649_R
6	0.678	SBELIR00070**C_03.918_06.142_F
7	0.693	SBELIR00070**C_00.000_03.918_F
8	0.695	SBELIR00070**C_14.308_16.442_F
9	0.698	SBELIR00070**C_03.918_06.142_R
10	0.725	SBELIR00070**C_14.308_16.442_R

Rural Non-Freeway		
Rank	Score	TOAST ID
1	0.523	SHOLUS00062**C_16.742_19.766_R
2	0.583	SBELSR00149**C_23.950_24.554_R
3	0.59	SHOLSR00039**C_24.187_32.489_R
3	0.59	SHOLSR00039**C_24.187_32.489_F
5	0.613	SHOLUS00062**C_16.742_19.766_F
6	0.623	STUSSR00039**C_00.000_01.639_F
6	0.623	STUSSR00039**C_00.000_01.639_R
8	0.628	SBELSR00149**C_23.950_24.554_F
9	0.63	SJEFSR00152**C_00.000_05.549_F
10	0.64	SHOLSR00241**C_00.281_13.275_F

OHIO DEPARTMENT OF TRANSPORTATION

Transportation Systems Management & Operations (TSMO)

District 11

25 Lowest Scoring Segments Per District

Legend

Lowest Scoring Segments in District

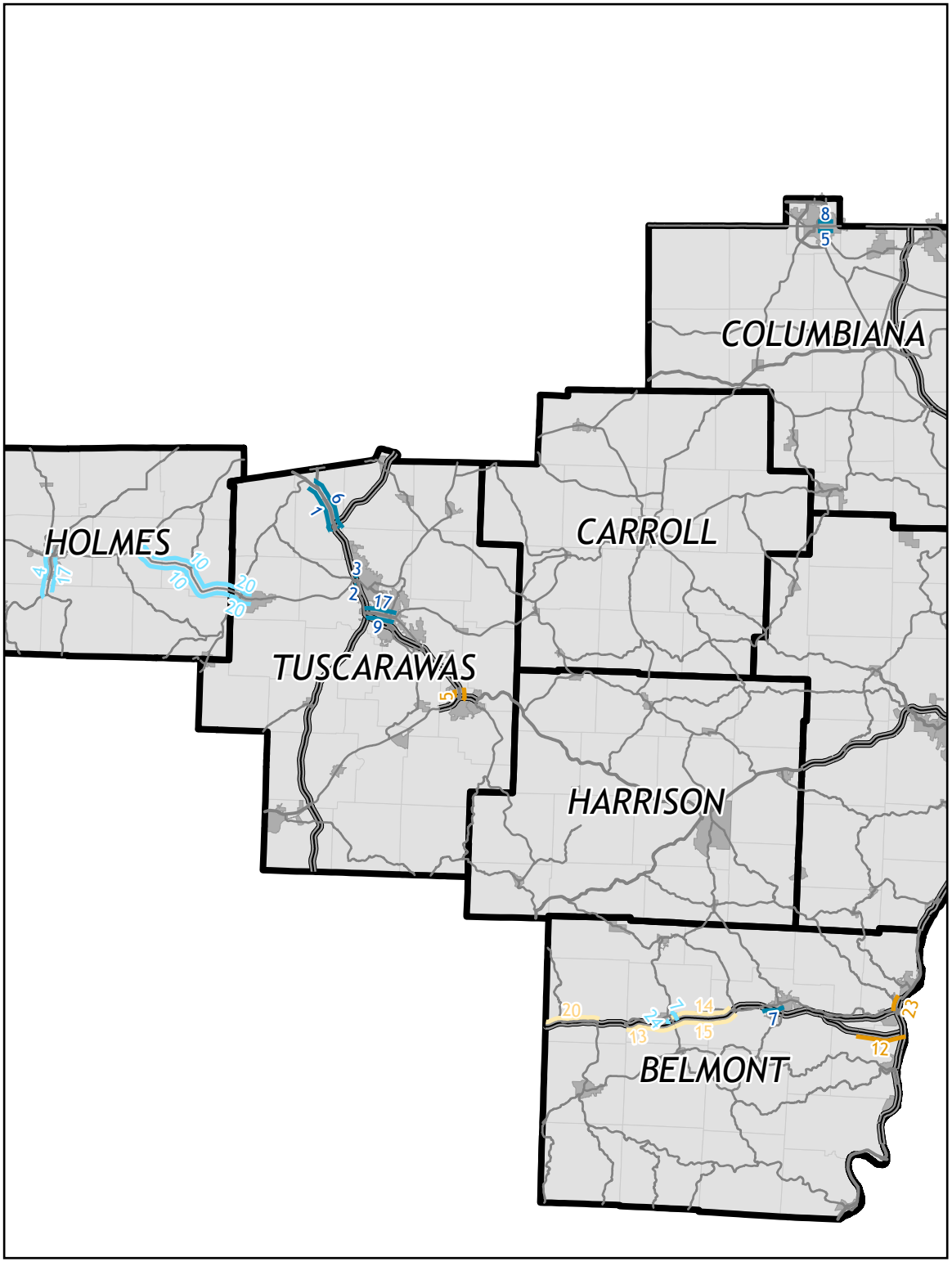
Roadway Category

- Rural Freeway
- Rural Nonfreeway
- Urban Freeway
- Urban Nonfreeway

TOAST 2022 Dataset Updated April 2023

0 3.5 7 14 21 28 Miles

Areas outside map extent do not contain any Top 25 segments for this District.



Rank	Score	TOAST ID
1	0.445	STUSUS00250**C_01.610_05.632_F
2	0.495	STUSSR00039**C_09.863_10.125_F
3	0.51	STUSSR00039**C_09.863_10.125_R
4	0.523	SHOLUS00062**C_16.742_19.766_R
5	0.533	STUSUS00250**C_21.231_22.085_F
6	0.58	STUSUS00250**C_01.610_05.632_R
7	0.583	SBELSR00149**C_23.950_24.554_R
8	0.588	SCOLSR00014**C_02.690_03.810_R
8	0.588	SCOLSR00014**C_02.690_03.810_F
10	0.59	SHOLSR00039**C_24.187_32.489_R
10	0.59	SHOLSR00039**C_24.187_32.489_F
12	0.595	SBELIR00470**C_03.329_06.915_F
13	0.6	SBELIR00070**C_06.142_09.649_F
14	0.605	SBELIR00070**C_09.649_14.308_R
15	0.608	SBELIR00070**C_09.649_14.308_F
15	0.608	SBELUS00040**C_16.948_18.652_F
17	0.613	SHOLUS00062**C_16.742_19.766_F
17	0.613	STUSSR00039**C_12.734_14.943_R
19	0.618	STUSUS00250**C_21.231_22.085_R
20	0.623	SBELIR00070**C_00.000_03.918_R
20	0.623	STUSSR00039**C_00.000_01.639_F
20	0.623	STUSSR00039**C_00.000_01.639_R
23	0.625	SBELSR00007**C_19.992_20.968_R
24	0.628	STUSSR00039**C_12.734_14.943_F
24	0.628	SBELSR00149**C_23.950_24.554_F

OHIO DEPARTMENT OF TRANSPORTATION

Transportation Systems Management & Operations (TSMO)

APPENDIX F

Highway Capacity Software Analysis

HCS Two-Way Stop-Control Report

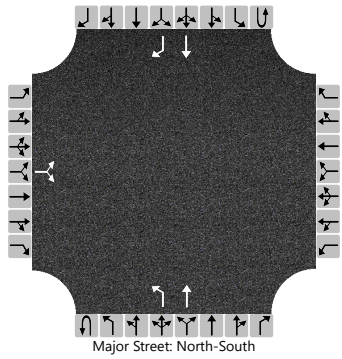
General Information

Analyst	DAH
Agency/Co.	ODOT District 11
Date Performed	1/3/2024
Analysis Year	2024
Time Analyzed	2024 AM Peak (7:15 AM)
Intersection Orientation	North-South
Project Description	TUS-250-2.223

Site Information

Intersection	US 250 & SR 21
Jurisdiction	ODOT
East/West Street	US 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		25		185						174	183				203	41
Percent Heavy Vehicles (%)		20		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.60		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.68		3.45						2.35						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			228							189						
Capacity, c (veh/h)			646							1265						
v/c Ratio			0.35							0.15						
95% Queue Length, Q_{95} (veh)			1.6							0.5						
Control Delay (s/veh)			13.6							8.3						
Level of Service (LOS)			B							A						
Approach Delay (s/veh)		13.6								4.1						
Approach LOS		B								A						

HCS Two-Way Stop-Control Report

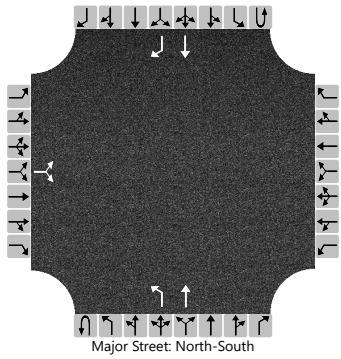
General Information

Analyst	DAH
Agency/Co.	ODOT District 11
Date Performed	1/3/2024
Analysis Year	2024
Time Analyzed	2024 PM Peak (4:15 PM)
Intersection Orientation	North-South
Project Description	TUS-250-2.223

Site Information

Intersection	US 250 & SR 21
Jurisdiction	ODOT
East/West Street	US 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		32		363						231	256				300	27
Percent Heavy Vehicles (%)		3		6						12						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.43		6.26						4.22						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.53		3.35						2.31						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			429							251						
Capacity, c (veh/h)			573							1179						
v/c Ratio			0.75							0.21						
95% Queue Length, Q_{95} (veh)			6.6							0.8						
Control Delay (s/veh)			27.7							8.9						
Level of Service (LOS)			D							A						
Approach Delay (s/veh)		27.7								4.2						
Approach LOS		D								A						

HCS Two-Way Stop-Control Report

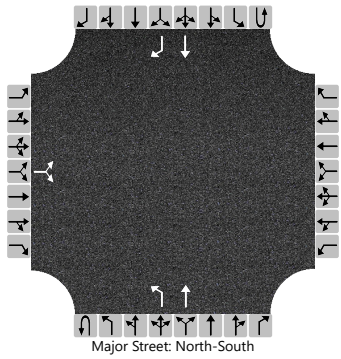
General Information

Analyst	DAH
Agency/Co.	ODOT District 11
Date Performed	1/3/2024
Analysis Year	2028
Time Analyzed	2028 AM Peak (7:15 AM)
Intersection Orientation	North-South
Project Description	TUS-250-2.223

Site Information

Intersection	US 250 & SR 21
Jurisdiction	ODOT
East/West Street	US 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		40		300						280	200				220	70
Percent Heavy Vehicles (%)		20		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.60		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.68		3.45						2.35						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			370							304						
Capacity, c (veh/h)			544							1245						
v/c Ratio			0.68							0.24						
95% Queue Length, Q_{95} (veh)			5.1							1.0						
Control Delay (s/veh)			24.5							8.8						
Level of Service (LOS)			C							A						
Approach Delay (s/veh)		24.5								5.1						
Approach LOS		C								A						

HCS Two-Way Stop-Control Report

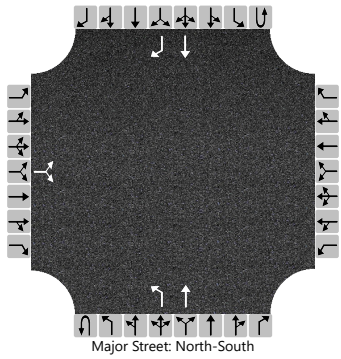
General Information

Analyst	DAH
Agency/Co.	ODOT District 11
Date Performed	1/3/2024
Analysis Year	2028
Time Analyzed	2028 PM Peak (4:15 AM)
Intersection Orientation	North-South
Project Description	TUS-250-2.223

Site Information

Intersection	US 250 & SR 21
Jurisdiction	ODOT
East/West Street	US 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		80		460						420	260				360	80
Percent Heavy Vehicles (%)		20		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.60		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.68		3.45						2.35						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			587							457						
Capacity, c (veh/h)			268							1090						
v/c Ratio			2.19							0.42						
95% Queue Length, Q_{95} (veh)			44.7							2.1						
Control Delay (s/veh)			576.3							10.7						
Level of Service (LOS)			F							B						
Approach Delay (s/veh)		576.3								6.6						
Approach LOS		F								A						

HCS Two-Way Stop-Control Report

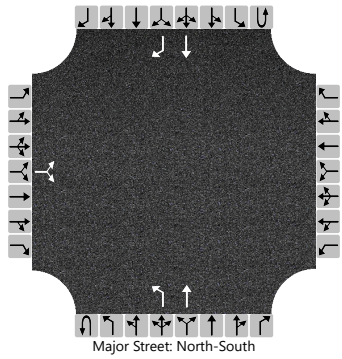
General Information

Analyst	DAH
Agency/Co.	ODOT District 11
Date Performed	1/3/2024
Analysis Year	2048
Time Analyzed	2048 AM Peak (7:15 AM)
Intersection Orientation	North-South
Project Description	TUS-250-2.223

Site Information

Intersection	US 250 & SR 21
Jurisdiction	ODOT
East/West Street	US 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		50		360						330	200				220	80
Percent Heavy Vehicles (%)		20		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.60		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.68		3.45						2.35						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			446							359						
Capacity, c (veh/h)			493							1245						
v/c Ratio			0.90							0.29						
95% Queue Length, Q_{95} (veh)			10.3							1.2						
Control Delay (s/veh)			49.1							9.1						
Level of Service (LOS)			E							A						
Approach Delay (s/veh)		49.1								5.6						
Approach LOS		E								A						

HCS Two-Way Stop-Control Report

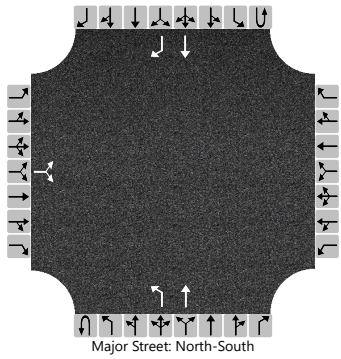
General Information

Analyst	DAH
Agency/Co.	ODOT District 11
Date Performed	1/3/2024
Analysis Year	2048
Time Analyzed	2048 PM Peak (4:15 PM)
Intersection Orientation	North-South
Project Description	TUS-250-2.223

Site Information

Intersection	US 250 & SR 21
Jurisdiction	ODOT
East/West Street	US 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		80		550						500	280				380	80
Percent Heavy Vehicles (%)		20		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

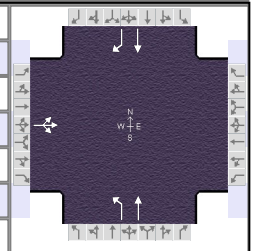
Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.60		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.68		3.45						2.35						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			685							543						
Capacity, c (veh/h)			212							1070						
v/c Ratio			3.24							0.51						
95% Queue Length, Q_{95} (veh)			63.2							3.0						
Control Delay (s/veh)			1053.0							11.8						
Level of Service (LOS)			F							B						
Approach Delay (s/veh)		1053.0								7.6						
Approach LOS		F								A						

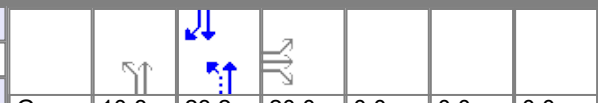
HCS Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	ODOT D11			Duration, h	0.250
Analyst	DAH	Analysis Date	Jan 5, 2024	Area Type	Other
Jurisdiction	ODOT	Time Period	AM Peak	PHF	0.92
Urban Street	US 250	Analysis Year	2028	Analysis Period	1> 7:15
Intersection	US 250 & SR 21	File Name	TUS-250-2.223 HCS Signal 2028 AM Peak.xus		
Project Description	TUS-250-2.223 Signal Analysis 2028 AM Peak 7:15AM				

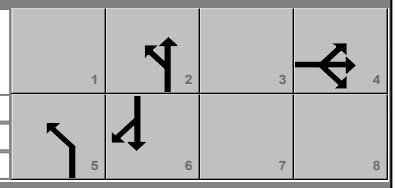


Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	40	0	300				280	200			220	70

Signal Information			
Cycle, s	75.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	10.8	23.2	20.0	0.0	0.0	0.0						
Yellow	5.0	5.0	5.0	0.0	0.0	0.0						
Red	2.0	2.0	2.0	0.0	0.0	0.0						



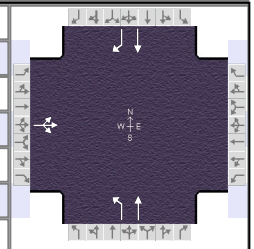
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		12.0			1.0	4.0		7.3
Phase Duration, s		27.0			17.8	48.0		30.2
Change Period, ($Y+R_c$), s		7.0			7.0	7.0		7.0
Max Allow Headway (*MAH*), s		3.2			3.0	0.0		0.0
Queue Clearance Time (g_s), s		18.1			10.7			
Green Extension Time (g_e), s		0.5			0.1	0.0		0.0
Phase Call Probability		1.00			1.00			
Max Out Probability		0.08			1.00			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h		370					304	217			239	76
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1631					1668	1752			1752	1485
Queue Service Time (g_s), s		16.1					8.7	4.8			8.2	2.8
Cycle Queue Clearance Time (g_c), s		16.1					8.7	4.8			8.2	2.8
Green Ratio (*g/C*)		0.27					0.48	0.55			0.31	0.31
Capacity (*c*), veh/h		435					550	958			542	459
Volume-to-Capacity Ratio (*X*)		0.850					0.553	0.227			0.442	0.166
Back of Queue (*Q*), ft/ln (95 th percentile)		268.2					129.8	74.9			161.7	46.1
Back of Queue (*Q*), veh/ln (95 th percentile)		10.7					4.8	2.8			6.0	1.7
Queue Storage Ratio (*RQ*) (95 th percentile)		0.00					0.26	0.00			0.00	0.23
Uniform Delay (d_1), s/veh		26.1					13.4	8.8			20.7	18.9
Incremental Delay (d_2), s/veh		8.5					0.4	0.6			2.6	0.8
Initial Queue Delay (d_3), s/veh		0.0					0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh		34.6					13.7	9.3			23.3	19.6
Level of Service (LOS)		C					B	A			C	B
Approach Delay, s/veh / LOS	34.6	C		0.0			11.9	B		22.4	C	
Intersection Delay, s/veh / LOS	21.6						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	ODOT D11			Duration, h	0.250
Analyst	DAH	Analysis Date	Jan 5, 2024	Area Type	Other
Jurisdiction	ODOT	Time Period	PM Peak	PHF	0.92
Urban Street	US 250	Analysis Year	2028	Analysis Period	1> 16:15
Intersection	US 250 & SR 21	File Name	TUS-250-2.223 HCS Signal 2028 PM Peak.xus		
Project Description	TUS-250-2.223 Signal Analysis 2028 PM Peak 4:15PM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	80	0	460				420	260			360	80

Signal Information			
Cycle, s	120.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

							1	2	3	4
Green	24.5	35.5	39.0	0.0	0.0	0.0	5	6	7	8
Yellow	5.0	5.0	5.0	0.0	0.0	0.0				
Red	2.0	2.0	2.0	0.0	0.0	0.0				

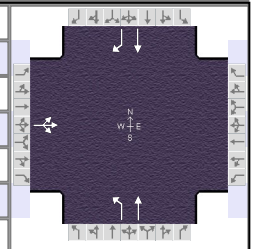
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		12.0			1.0	4.0		7.3
Phase Duration, s		46.0			31.5	74.0		42.5
Change Period, ($Y+R_c$), s		7.0			7.0	7.0		7.0
Max Allow Headway (*MAH*), s		3.2			3.0	0.0		0.0
Queue Clearance Time (g_s), s		41.0			23.8			
Green Extension Time (g_e), s		0.0			0.6	0.0		0.0
Phase Call Probability		1.00			1.00			
Max Out Probability		1.00			0.02			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h		587					457	283			391	87
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1637					1668	1752			1752	1485
Queue Service Time (g_s), s		39.0					21.8	10.2			24.3	5.3
Cycle Queue Clearance Time (g_c), s		39.0					21.8	10.2			24.3	5.3
Green Ratio (*g/C*)		0.32					0.52	0.56			0.30	0.30
Capacity (*c*), veh/h		532					487	978			518	439
Volume-to-Capacity Ratio (*X*)		1.103					0.937	0.289			0.755	0.198
Back of Queue (*Q*), ft/ln (95 th percentile)		888.5					416.7	188.8			454.5	94.4
Back of Queue (*Q*), veh/ln (95 th percentile)		35.5					15.4	7.0			16.8	3.5
Queue Storage Ratio (*RQ*) (95 th percentile)		0.00					0.84	0.00			0.00	0.47
Uniform Delay (d_1), s/veh		40.5					24.1	14.0			38.3	31.6
Incremental Delay (d_2), s/veh		70.4					18.3	0.7			9.8	1.0
Initial Queue Delay (d_3), s/veh		0.0					0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh		110.9					42.4	14.7			48.1	32.6
Level of Service (LOS)		F					D	B			D	C
Approach Delay, s/veh / LOS	110.9	F		0.0			31.8	C		45.3	D	
Intersection Delay, s/veh / LOS	61.1						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS Signalized Intersection Results Summary

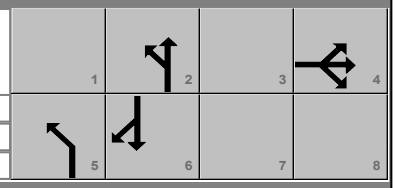
General Information				Intersection Information	
Agency	ODOT D11			Duration, h	0.250
Analyst	DAH	Analysis Date	Jan 5, 2024	Area Type	Other
Jurisdiction	ODOT	Time Period	AM Peak	PHF	0.92
Urban Street	US 250	Analysis Year	2048	Analysis Period	1> 7:15
Intersection	US 250 & SR 21	File Name	TUS-250-2.223 HCS Signal 2048 AM Peak.xus		
Project Description	TUS-250-2.223 Signal Analysis 2048 AM Peak 7:15AM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	50	0	360				330	200			220	80

Signal Information			
Cycle, s	75.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	10.8	21.0	22.2	0.0	0.0	0.0
Yellow	5.0	5.0	5.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0



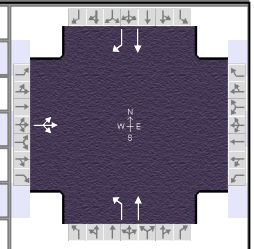
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		12.0			1.0	4.0		7.3
Phase Duration, s		29.2			17.8	45.8		28.0
Change Period, ($Y+R_c$), s		7.0			7.0	7.0		7.0
Max Allow Headway (*MAH*), s		3.2			3.0	0.0		0.0
Queue Clearance Time (g_s), s		21.8			12.8			
Green Extension Time (g_e), s		0.4			0.0	0.0		0.0
Phase Call Probability		1.00			1.00			
Max Out Probability		1.00			1.00			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h		446					359	217			239	87
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1632					1668	1752			1752	1485
Queue Service Time (g_s), s		19.8					10.8	5.1			8.5	3.4
Cycle Queue Clearance Time (g_c), s		19.8					10.8	5.1			8.5	3.4
Green Ratio (*g/C*)		0.30					0.45	0.52			0.28	0.28
Capacity (*c*), veh/h		483					514	906			491	416
Volume-to-Capacity Ratio (*X*)		0.923					0.698	0.240			0.488	0.209
Back of Queue (*Q*), ft/ln (95 th percentile)		356					193.3	83.1			173.2	56.8
Back of Queue (*Q*), veh/ln (95 th percentile)		14.2					7.2	3.1			6.4	2.1
Queue Storage Ratio (*RQ*) (95 th percentile)		0.00					0.39	0.00			0.00	0.28
Uniform Delay (d_1), s/veh		25.6					15.9	10.0			22.5	20.6
Incremental Delay (d_2), s/veh		19.1					3.5	0.6			3.4	1.1
Initial Queue Delay (d_3), s/veh		0.0					0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh		44.7					19.4	10.6			26.0	21.8
Level of Service (LOS)		D					B	B			C	C
Approach Delay, s/veh / LOS	44.7	D		0.0			16.1	B		24.8	C	
Intersection Delay, s/veh / LOS	27.7						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

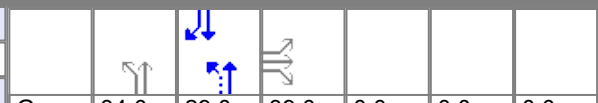
HCS Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	ODOT D11			Duration, h	0.250
Analyst	DAH	Analysis Date	Jan 5, 2024	Area Type	Other
Jurisdiction	ODOT	Time Period	PM Peak	PHF	0.92
Urban Street	US 250	Analysis Year	2048	Analysis Period	1> 16:15
Intersection	US 250 & SR 21	File Name	TUS-250-2.223 HCS Signal 2048 PM Peak.xus		
Project Description	TUS-250-2.223 Signal Analysis 2048 PM Peak 4:15PM				

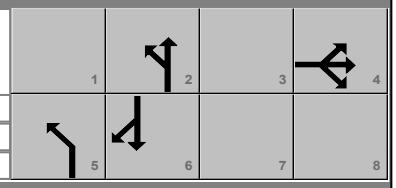


Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	80	0	550				500	280			380	80

Signal Information			
Cycle, s	120.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	34.0	29.0	39.0	0.0	0.0	0.0						
Yellow	5.0	5.0	5.0	0.0	0.0	0.0						
Red	1.0	1.0	1.0	0.0	0.0	0.0						



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		12.0			1.0	4.0		7.3
Phase Duration, s		45.0			40.0	75.0		35.0
Change Period, ($Y+R_c$), s		6.0			6.0	6.0		6.0
Max Allow Headway (*MAH*), s		3.2			3.0	0.0		0.0
Queue Clearance Time (g_s), s		41.0			36.0			
Green Extension Time (g_e), s		0.0			0.0	0.0		0.0
Phase Call Probability		1.00			1.00			
Max Out Probability		1.00			1.00			

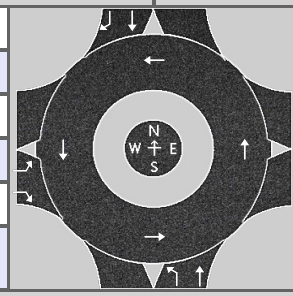
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h		685					543	304			413	87
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1633					1668	1752			1752	1485
Queue Service Time (g_s), s		39.0					34.0	10.7			28.1	5.7
Cycle Queue Clearance Time (g_c), s		39.0					34.0	10.7			28.1	5.7
Green Ratio (*g/C*)		0.32					0.54	0.57			0.24	0.24
Capacity (*c*), veh/h		531					540	1007			423	359
Volume-to-Capacity Ratio (*X*)		1.290					1.007	0.302			0.976	0.242
Back of Queue (*Q*), ft/ln (95 th percentile)		1329.7					774.1	196.2			611.6	104.2
Back of Queue (*Q*), veh/ln (95 th percentile)		53.2					28.7	7.3			22.7	3.9
Queue Storage Ratio (*RQ*) (95 th percentile)		0.00					0.97	0.00			0.00	0.52
Uniform Delay (d_1), s/veh		40.5					34.0	13.1			45.1	36.6
Incremental Delay (d_2), s/veh		144.3					40.4	0.8			38.1	1.6
Initial Queue Delay (d_3), s/veh		0.0					0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh		184.8					74.5	13.9			83.2	38.2
Level of Service (LOS)		F					F	B			F	D
Approach Delay, s/veh / LOS	184.8	F		0.0			52.7	D		75.4	E	
Intersection Delay, s/veh / LOS	102.8						F					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS Roundabouts Report

General Information

Analyst	DAH
Agency or Co.	ODOT District 11
Date Performed	1/3/2024
Analysis Year	2028
Time Analyzed	2028 AM Peak (7:15 AM)
Project Description	TUS 250 2.223



Site Information

Intersection	US 250 & SR 21
E/W Street Name	US 250
N/S Street Name	SR 21
Analysis Time Period, hrs	0.25
Peak Hour Factor	0.92
Jurisdiction	ODOT

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	1	0	1	0	0	0	0	0	1	1	0	0	0	1	1
Lane Assignment	L		R						L		T		T		R	
Volume (V), veh/h	0	40		300					0	280	200		0		220	70
Percent Heavy Vehicles, %	0	20		17					0	17	3		0		3	3
Flow Rate (v_{PCE}), pc/h	0	52		382					0	356	224		0		246	78
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1								1				1			
Pedestrians Crossing, p/h	0								0				0			
Proportion of CAVs	0															

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway, s	4.5436	4.5436					4.5436	4.5436		4.5436	4.5436	
Follow-Up Headway, s	2.5352	2.5352					2.5352	2.5352		2.5352	2.5352	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h	52	382					356	224		246	78	
Entry Volume, veh/h	44	326					320	202		239	76	
Circulating Flow (v_c), pc/h	246			632			52			356		
Exiting Flow (v_{ex}), pc/h	0			434			276			628		
Capacity (c_{pce}), pc/h	1135	1135					1354	1354		1027	1027	
Capacity (c), veh/h	967	967					1218	1218		997	997	
v/c Ratio (x)	0.05	0.34					0.26	0.17		0.24	0.08	

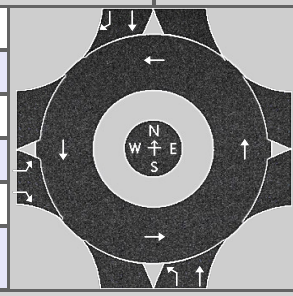
Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh	4.1	7.3					5.3	4.4		5.9	4.3	
Lane LOS	A	A					A	A		A	A	
95% Queue, veh	0.1	1.5					1.1	0.6		0.9	0.2	
Approach Delay, s/veh | LOS	6.9	A					5.0	A		5.5	A	
Intersection Delay, s/veh | LOS	5.7						A					

HCS Roundabouts Report

General Information

Analyst	DAH
Agency or Co.	ODOT District 11
Date Performed	1/3/2024
Analysis Year	2028
Time Analyzed	2028 PM Peak (4:15 PM)
Project Description	TUS 250 2.223



Site Information

Intersection	US 250 & SR 21
E/W Street Name	US 250
N/S Street Name	SR 21
Analysis Time Period, hrs	0.25
Peak Hour Factor	0.92
Jurisdiction	ODOT

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	1	0	1	0	0	0	0	0	1	1	0	0	0	1	1
Lane Assignment	L		R						L		T		T		R	
Volume (V), veh/h	0	80		460					0	420	260		0		360	80
Percent Heavy Vehicles, %	0	20		17					0	17	3		0		3	3
Flow Rate (v_{PCE}), pc/h	0	104		585					0	534	291		0		403	90
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1								1				1			
Pedestrians Crossing, p/h	0								0				0			
Proportion of CAVs	0															

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway, s	4.5436	4.5436					4.5436	4.5436		4.5436	4.5436	
Follow-Up Headway, s	2.5352	2.5352					2.5352	2.5352		2.5352	2.5352	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h	104	585					534	291		403	90	
Entry Volume, veh/h	89	498					478	261		391	87	
Circulating Flow (v_c), pc/h	403			929			104			534		
Exiting Flow (v_{ex}), pc/h	0			624			395			988		
Capacity (c_{pce}), pc/h	984	984					1292	1292		873	873	
Capacity (c), veh/h	838	838					1157	1157		848	848	
v/c Ratio (x)	0.11	0.59					0.41	0.23		0.46	0.10	

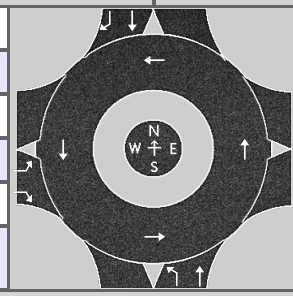
Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh	5.3	13.4					7.4	5.1		10.1	5.2	
Lane LOS	A	B					A	A		B	A	
95% Queue, veh	0.4	4.0					2.1	0.9		2.5	0.3	
Approach Delay, s/veh | LOS	12.2	B					6.6	A		9.2	A	
Intersection Delay, s/veh | LOS	9.1						A					

HCS Roundabouts Report

General Information

Analyst	DAH
Agency or Co.	ODOT District 11
Date Performed	1/3/2024
Analysis Year	2048
Time Analyzed	2048 AM Peak (7:15 AM)
Project Description	TUS 250 2.223



Site Information

Intersection	US 250 & SR 21
E/W Street Name	US 250
N/S Street Name	SR 21
Analysis Time Period, hrs	0.25
Peak Hour Factor	0.92
Jurisdiction	ODOT

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	1	0	1	0	0	0	0	0	1	1	0	0	0	1	1
Lane Assignment	L		R						L		T		T		R	
Volume (V), veh/h	0	50		360					0	330	200		0		220	80
Percent Heavy Vehicles, %	0	20		17					0	17	3		0		3	3
Flow Rate (v_{PCE}), pc/h	0	65		458					0	420	224		0		246	90
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1								1				1			
Pedestrians Crossing, p/h	0								0				0			
Proportion of CAVs	0															

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway, s	4.5436	4.5436					4.5436	4.5436		4.5436	4.5436	
Follow-Up Headway, s	2.5352	2.5352					2.5352	2.5352		2.5352	2.5352	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h	65	458					420	224		246	90	
Entry Volume, veh/h	55	390					376	201		239	87	
Circulating Flow (v_c), pc/h	246			709			65			420		
Exiting Flow (v_{ex}), pc/h	0			510			289			704		
Capacity (c_{pce}), pc/h	1135	1135					1338	1338		969	969	
Capacity (c), veh/h	967	967					1198	1198		941	941	
v/c Ratio (x)	0.06	0.40					0.31	0.17		0.25	0.09	

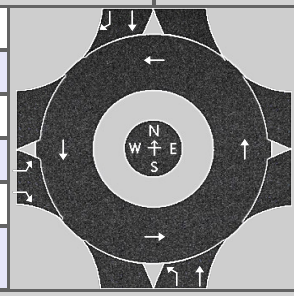
Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh	4.2	8.2					5.9	4.4		6.4	4.7	
Lane LOS	A	A					A	A		A	A	
95% Queue, veh	0.2	2.0					1.4	0.6		1.0	0.3	
Approach Delay, s/veh | LOS	7.7	A					5.4	A		5.9	A	
Intersection Delay, s/veh | LOS	6.3						A					

HCS Roundabouts Report

General Information

Analyst	DAH
Agency or Co.	ODOT District 11
Date Performed	1/3/2024
Analysis Year	2048
Time Analyzed	2048 PM Peak (4:15 PM)
Project Description	TUS 250 2.223



Site Information

Intersection	US 250 & SR 21
E/W Street Name	US 250
N/S Street Name	SR 21
Analysis Time Period, hrs	0.25
Peak Hour Factor	0.92
Jurisdiction	ODOT

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	1	0	1	0	0	0	0	0	1	1	0	0	0	1	1
Lane Assignment	L		R						L		T		T		R	
Volume (V), veh/h	0	80		550					0	500	280		0		380	80
Percent Heavy Vehicles, %	0	20		17					0	17	3		0		3	3
Flow Rate (v_{PCE}), pc/h	0	104		699					0	636	313		0		425	90
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1								1				1			
Pedestrians Crossing, p/h	0								0				0			
Proportion of CAVs	0															

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway, s	4.5436	4.5436					4.5436	4.5436		4.5436	4.5436	
Follow-Up Headway, s	2.5352	2.5352					2.5352	2.5352		2.5352	2.5352	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h	104	699					636	313		425	90	
Entry Volume, veh/h	89	596					568	280		413	87	
Circulating Flow (v_c), pc/h	425			1053			104			636		
Exiting Flow (v_{ex}), pc/h	0			726			417			1124		
Capacity (c_{pce}), pc/h	965	965					1292	1292		796	796	
Capacity (c), veh/h	822	822					1154	1154		773	773	
v/c Ratio (x)	0.11	0.72					0.49	0.24		0.53	0.11	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh	5.4	18.6					8.6	5.3		12.5	5.8	
Lane LOS	A	C					A	A		B	A	
95% Queue, veh	0.4	6.4					2.8	1.0		3.2	0.4	
Approach Delay, s/veh | LOS	16.9	C					7.5	A		11.4	B	
Intersection Delay, s/veh | LOS	11.6						B					

APPENDIX G

Traffic Signal Warrant Analysis

STUDY AND ANALYSIS INFORMATION

Municipality:	Franklin Township	**Traffic Volumes Obtained By:**	ODOT District 11
County:	Tuscarawas	**Analysis Date:**	12/26/2023
ODOT Engineering District:	11	**Agency/ Company Name Performing Warrant Analysis:**	ODOT District 11
Google map link:	Map		

Analysis Information

Data Collection Date: 10/26/2023

Day of the Week: Thursday

Is the intersection in a built-up area of an isolated community of <10,000 population? Yes

Existing Traffic Signal at intersection: No

Total Number of Approaches at Intersection: 3

Major Street Information

Major Street Name and Route Number: US 250

Major Street Approach Direction: E-Bound / W-Bound

Number of Thru Lanes on Each Major Street Approach: 1 **LANE(S)**

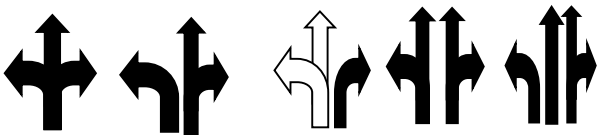
Speed Limit or 85th Percentile Speed on the Major Street*: 55 **MPH**

*Unknown assumes below 45 mph

Minor Street Information

Minor Street Name and Route Number: SR 21

Minor Street Approach Configuration: N-Bound / 1 S-Bound



1 2 3 4 5

Number of Thru Lanes on Each Minor Street Approach: 1 **LANE(S)**

Apply Right Turn Lane Reduction*: No

*Right Turn Lane Reduction Shall be used for Warrants 1, 2, & 3 for New ODOT Signals. Please refer to TEM 402-3.2 for clarification and criteria under which Right Turn Reduction is not required.

TRAFFIC SIGNAL WARRANT ANALYSIS FINDINGS

	Applicable?	Warrant Satisfied?	Notes and Comments:	
Warrant 1, Eight-Hour Vehicular Volume	Yes	**No**		
Warrant 2, Four-Hour Vehicular Volume	Yes	**Yes**	Figure 4C-2 (70% Factor)	
Warrant 3, Peak Hour	Yes	**Yes**	Signals installed under Warrant 3 should be traffic actuated.	**Peak Hour** 3:30 PM 4:30 PM
For Warrants 1-3, new ODOT signals must be based off of 100% volume thresholds (TEM 402-3.2)				
Warrant 4, Pedestrian Volume	No		If this warrant is met, and a traffic control signal is justified by an engineering study, the traffic control signal shall be equipped with pedestrian signal heads complying with the provisions set forth in Chapter 4E of the OMUTCD.	**Peak Hour** 4:30 PM 5:30 PM
Warrant 5, School Crossing	No		N/A	
Warrant 6, Coordinated Signal System	No		(Shall not be used as the sole warrant in the analysis)	
Warrant 7, Crash Experience	Yes	**No**	If this is the sole warrant, signal must be semi-actuated with control devices which provide proper coordination if installed at an intersection within a coordinated system and normally should be fully traffic actuated if installed at an isolated intersection.	
Warrant 8, Roadway Network	No		(Shall not be used as the sole warrant in the analysis)	
Warrant 9, Intersection Near a Grade Crossing	No		Figure 4C-9	
Multi-Way Stop Warrant	No		May be used as an interim measure if traffic signal warrants are satisfied.	

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

If no warrants are satisfied, additional options may be considered:
1. An engineering study, performed by a firm prequalified by ODOT for signal design, if approved by the ODOT district, may be used to justify a new signal installation or retention of an existing signal that otherwise does not meet the published warrants. An example of such an instance is a traffic signal in proximity to a railroad crossing that serves to reduce queuing across the tracks.
2. According to TEM 402-2, If the actual turning movement counts fail to satisfy a signal warrant, it may be acceptable to use traffic volumes projected to the second year after project completion. The **Modeling and Forecasting Section** should provide the projected traffic volumes.
3. A pedestrian hybrid beacon may be considered for installation to facilitate pedestrian crossings at a location that does not meet traffic signal warrants (see Chapter 4C of TEM) or at a location that meets traffic signal warrants under Sections 4C.05 and/or 4C.06 but a decision is made to not install a traffic control signal. **Please fill inputs on PHB Score Sheet and submit to ODOT.**

Considerations such as geometrics and lack of sight distance generally have not been accepted in lieu of satisfying signal warrants. These considerations may allow an otherwise unwarranted traffic signal to be retained at **100 percent** local cost. Please review TEM 402-4 for details.

Conclusion: Do Not Install New Traffic Signal

Notes:

Start Time	Southbound Approach						Westbound Approach						Northbound Approach						Eastbound Approach					
	Southbound						Westbound						Nouthbound						Eastbound					
	Right	Thru	Left	U-Turn	Peds	App Total	Right	Thru	Left	U-Turn	Peds	App Total	Right	Thru	Left	U-Turn	Peds	App Total	Right	Thru	Left	U-Turn	Peds	App Total
12:00 AM						0						0						0						0
12:15 AM						0						0						0						0
12:30 AM						0						0						0						0
12:45 AM						0						0						0						0
Hourly Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1:00 AM						0						0						0						0
1:15 AM						0						0						0						0
1:30 AM						0						0						0						0
1:45 AM						0						0						0						0
Hourly Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2:00 AM						0						0						0						0
2:15 AM						0						0						0						0
2:30 AM						0						0						0						0
2:45 AM						0						0						0						0
Hourly Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:00 AM						0						0						0						0
3:15 AM						0						0						0						0
3:30 AM						0						0						0						0
3:45 AM						0						0						0						0
Hourly Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 AM						0						0						0						0
4:15 AM						0						0						0						0
4:30 AM						0						0						0						0
4:45 AM						0						0						0						0
Hourly Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 AM						0						0						0						0
5:15 AM						0						0						0						0
5:30 AM						0						0						0						0
5:45 AM						0						0						0						0
Hourly Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6:00 AM						0						0						0						0
6:15 AM						0						0						0						0
6:30 AM						0						0						0						0
6:45 AM						0						0						0						0
Hourly Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:00 AM	4	53	0	0		57	0	0	0	0		0	0	37	40	0		77	25	1	11	0		37
7:15 AM	8	45	0	0		53	0	0	0	0		0	0	50	61	0		111	53	0	9	0		62
7:30 AM	10	54	0	0		64	0	0	0	0		0	0	42	48	0		90	51	0	6	0		57
7:45 AM	14	49	0	0		63	0	0	0	0		0	0	46	34	0		80	49	1	4	0		54
Hourly Total	36	201	0	0	0	237	0	0	0	0	0	0	0	175	183	0	0	358	178	2	30	0	0	210
8:00 AM	9	55	0	0		64	0	0	0	0		0	0	45	31	0		76	32	1	6	0		39
8:15 AM	6	37	0	0		43	0	0	0	0		0	1	32	46	0		79	43	0	4	0		47
8:30 AM	3	36	1	0		40	0	0	0	0		0	1	30	47	0		78	56	0	8	0		64
8:45 AM	4	36	0	0		40	0	0	0	0		0	0	30	39	0		69	35	0	5	0		40
Hourly Total	22	164	1	0	0	187	0	0	0	0	0	0	2	137	163	0	0	302	166	1	23	0	0	190
9:00 AM	5	35	0	0		40	0	0	0	0		0	0	29	35	0		64	43	0	2	0		45
9:15 AM	9	32	0	0		41	0	1	0	0		1	0	41	44	0		85	48	0	2	0		50
9:30 AM	6	32	0	0		38	0	0	0	0		0	0	30	50	0		80	50	0	5	0		55
9:45 AM	4	43	0	0		47	1	0	0	0		1	1	23	37	0		61	45	0	5	0		50
Hourly Total	24	142	0	0	0	166	1	1	0	0	0	2	1	123	166	0	0	290	186	0	14	0	0	200
10:00 AM	8	37	0	0		45	0	1	0	0		1	0	32	47	0		79	34	0	7	0		41
10:15 AM	11	41	0	0		52	0	0	0	0		0	0	34	37	0		71	43	0	6	0		49
10:30 AM	7	36	0	0		43	0	0	0	0		0	0	35	34	0		69	48	0	11	0		59
10:45 AM	13	45	0	0		58	0	0	0	0		0	0	48	49	0		97	51	0	5	0		56
Hourly Total	39	159	0	0	0	198	0	1	0	0	0	1	0	149	167	0	0	316	176	0	29	0	0	205
11:00 AM	15	60	0	0		75	0	3	0	0		3	0	30	44	0		74	46	0	1	0		47
11:15 AM	8	55	0	0		63	0	0	0	1		1	0	46	42	0		88	38	1	6	0		45
11:30 AM	17	48	0	0		65	1	1	0	0		2	0	45	42	0		87	39	0	3	0		42
11:45 AM	13	40	0	0		53	1	0	1	0		2	0	48	30	0		78	48	0	3	0		51
Hourly Total	53	203	0	0	0	256	2	4	1	1	0	8	0	169	158	0	0	327	171	1	13	0	0	185
12:00 PM	3	49	0	0		52	0	2	0	0		2	0	46	46	0		92	40	0	3	0		43
12:15 PM	11	39	0	0		50	0	2	0	0		2	0	38	40	0		78	56	0	5	0		61
12:30 PM	11	49	0	0		60	1	3	0	2		6	1	43	42	0		86	46	0	6	0		52
12:45 PM	10	57	0	0		67	0	2	0	0		2	0	38	52	0		90	53	0	4	0		57
Hourly Total	35	194	0	0	0	229	1	9	0	2	0	12	1	165	180	0	0	346	195	0	18	0	0	213
1:00 PM	4	53	1	0		58	0	1	1	0		2	0	49	39	1		89	49	0	11	0		60
1:15 PM	5	40	0	0		45	0	1	0	1		2	0	50	49	0		99	65	1	11	1		78
1:30 PM	6	61	0	0		67	0	1	0	0		1	0	46	60	0		106	61	0	5	0		66
1:45 PM	7	62	0	0		69	0	1	0	0		1	0	44	55	0		99	60	1	6	0		67
Hourly Total	22	216	1	0	0	239	0	4	1	1	0	6	0	189	203	1	0	393	235	2	33	1	0	271
2:00 PM	15	82	0	0		97	0	0	0	1		1	1	54	54	0		109	64	0	12	0		76
2:15 PM	7	72	0	0		79	0	0	0	0		0	1	53	48	0		102	61	1	11	0		73
2:30 PM	8	110	0	0		118	1	0	0	0		1	0	59	75	0		134	71	0	2	0		73
2:45 PM	11	61	0	0		72	0	0	0	0		0	0	50	50	0		100	83	1	12	0		96
Hourly Total	41	325	0	0	0	366	1	0	0	1	0	2	2	216	227	0	0	445	279	2	37	0	0	318
3:00 PM	10	70	1	0		81	0	0	0	0		0	1	57	57	0		115	76	0	9	0		85
3:15 PM	6	74	0	0		80	0	0	0	0		0	0	54	67	0		121	69	0	12	0		81
3:30 PM	5	84	0	0		89	0	0	0	0		0	0	57	78	0		135	91	0	7	0		98
3:45 PM	6	65	0	0		71	0	0	0	0		0	0	51	82	0		133	88	1	10	0		99
Hourly Total	27	293	1	0	0	321	0	0	0	0	0	0	1	219	284	0	0	504	324	1	38	0	0	363
4:00 PM	10	64	0	0		74	0	1	0	0		1	0	60	65	1		126	74	0	6	0		80
4:15 PM	11	88	0	0		99	0	1	0	0		1	0	58	71	0		129	73	0	11	0		84
4:30 PM	3	93	0	0		96	1	1	0	0		2	0	65	62	0		127	85	0	7	0		92
4:45 PM	7	52	0	0		59	0	1	0	0		1	0	62	49	0		111	101	0	5	0		106
Hourly Total	31	297	0	0	0	328	1	4	0	0	0	5	0	245	247	1	0	493	333	0	29	0	0	362
5:00 PM	6	67	0	1		74	0	4	0	0		4	0	71	49	1		121	104	1	9	0		114
5:15 PM	11	50	0	0		61	0	1	0	0		1	0	58	55	0		113	86	1	8	0		95
5:30 PM	8	57	0	0		65	0	0	0	0		0	0	48	46	0		94	73	0	9	0		82
5:45 PM	4	41	0	0		45	1	1	0	0		2	0	52	37	0		89	45	0	6	0		51
Hourly Total	29	215	0	1	0	245	1	6	0	0	0	7	0	229	187	1	0	417	308	2	32	0	0	342
6:00 PM	5	48	1	0		54	0	0	0	1		1	0	40	41	0		81	46	0	5	0		51
6:15 PM	6	38	0	0		44	0	0	0	0		0	0	35	42	0		77	39	0	5	0		44
6:30 PM	5	41	0	0		46	1	1	0	0		2	0	38	48	0		86	34	0	4	0		38
6:45 PM	1	38	0	0		39	0	2	0	0		2	0	32	34	0		66	38	0	6	0		44
Hourly Total	17	165	1	0	0	183	1	3	0	1	0	5	0	145	165	0	0	310	157	0	20	0	0	177
7:00 PM						0						0						0						0
7:15 PM						0						0						0						0
7:30 PM						0						0						0						0
7:45 PM						0						0						0						0
Hourly Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:00 PM						0						0						0						0
8:15 PM						0						0						0						0
8:30 PM						0						0						0						0
8:45 PM						0						0						0						0
Hourly Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9:00 PM						0						0						0						0
9:15 PM						0						0						0						0
9:30 PM						0						0						0						0
9:45 PM						0						0						0						0
Hourly Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 PM						0						0						0						0
10:15 PM						0						0						0						0
10:30 PM						0						0						0						0
10:45 PM						0						0						0						0
Hourly Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 PM						0						0						0						0
11:15 PM						0						0						0						0
11:30 PM						0						0						0						0
11:45 PM						0						0						0						0
Hourly Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

OMUTCD WARRANT 1, EIGHT-HOUR VEHICULAR VOLUME

Number of Lanes for Moving Traffic on Each Approach	
Major Street:	1 Lane
Minor Street:	1 Lane

Built up Isolated Community with Less Than 10,000 Population or Above 40 MPH on Major Street? Yes

**Only applicable after an adequate trial of other alternatives (See section 4C.02.06 of the 2012 OMUTCD)*

Lanes Major/ Minor	Adjusted Volumes		Condition A				Condition B				Combination A/B*							
											Cond. A		Cond. B		Cond. A		Cond. B	
	Major	Minor	100%		70%		100%		70%		80%		80%		56%		56%	
			Maj.	Min.	Maj.	Min.	Maj.	Min.	Maj.	Min.	Maj.	Min.	Maj.	Min.	Maj.	Min.	Maj.	Min.
1 / 1	X		500	150	350	105	750	75	525	53	400	120	600	60	280	84	420	42
2+ / 1			600	150	420	105	900	75	630	53	480	120	720	60	336	84	504	42
2+ / 2+			600	200	420	140	900	100	630	70	480	160	720	80	336	112	504	56
1 / 2+			500	200	350	140	750	100	525	70	400	160	600	80	280	112	420	56
12:00 AM	0	0																
12:15 AM	0	0																
12:30 AM	0	0																
12:45 AM	0	0																
1:00 AM	0	0																
1:15 AM	0	0																
1:30 AM	0	0																
1:45 AM	0	0																
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5:30 AM	0	0																
5:45 AM	0	0																
6:00 AM	0	0																
6:15 AM	37	77																
6:30 AM	99	188																
6:45 AM	156	278																
7:00 AM	210	358																
7:15 AM	212	357																
7:30 AM	197	325																
7:45 AM	204	313																
8:00 AM	190	302																
8:15 AM	196	290																
8:30 AM	200	296																
8:45 AM	191	298																
9:00 AM	202	290																
9:15 AM	199	305																
9:30 AM	197	291																
9:45 AM	201	280																

10:00 AM	206	316																
10:15 AM	214	311																
10:30 AM	211	328																
10:45 AM	196	346																
11:00 AM	193	327																
11:15 AM	188	345																
11:30 AM	205	335																
11:45 AM	219	334																
12:00 PM	225	346																
12:15 PM	242	343																
12:30 PM	259	364																
12:45 PM	268	384																
1:00 PM	277	393																
1:15 PM	292	413													1	1		
1:30 PM	285	416																
1:45 PM	292	444																
2:00 PM	320	445																
2:15 PM	328	451													1	1		
2:30 PM	336	470																
2:45 PM	360	471			1	1												
3:00 PM	363	504																
3:15 PM	359	515													1	1		
3:30 PM	363	523																
3:45 PM	359	515			1	1												
4:00 PM	367	493																
4:15 PM	404	488									1	1			1	1		
4:30 PM	415	472																
4:45 PM	403	439			1	1												
5:00 PM	349	417																
5:15 PM	283	377													1	1		
5:30 PM	231	341																
5:45 PM	189	333																
6:00 PM	182	310																
6:15 PM	130	229																
6:30 PM	86	152																
6:45 PM	46	66																
7:00 PM	0	0																
7:15 PM	0	0																
7:30 PM	0	0																
7:45 PM	0	0																
8:00 PM	0	0																
8:15 PM	0	0																
8:30 PM	0	0																
8:45 PM	0	0																
9:00 PM	0	0																
9:15 PM	0	0																
9:30 PM	0	0																
9:45 PM	0	0																
HOURS MET			**0**	**0**	**3**	**3**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**5**	**5**	**0**	**0**
WARRANT SATISFIED?			**NO**		**NO**		**NO**		**NO**		**NO**				**NO**			

Warrant Met: **No**

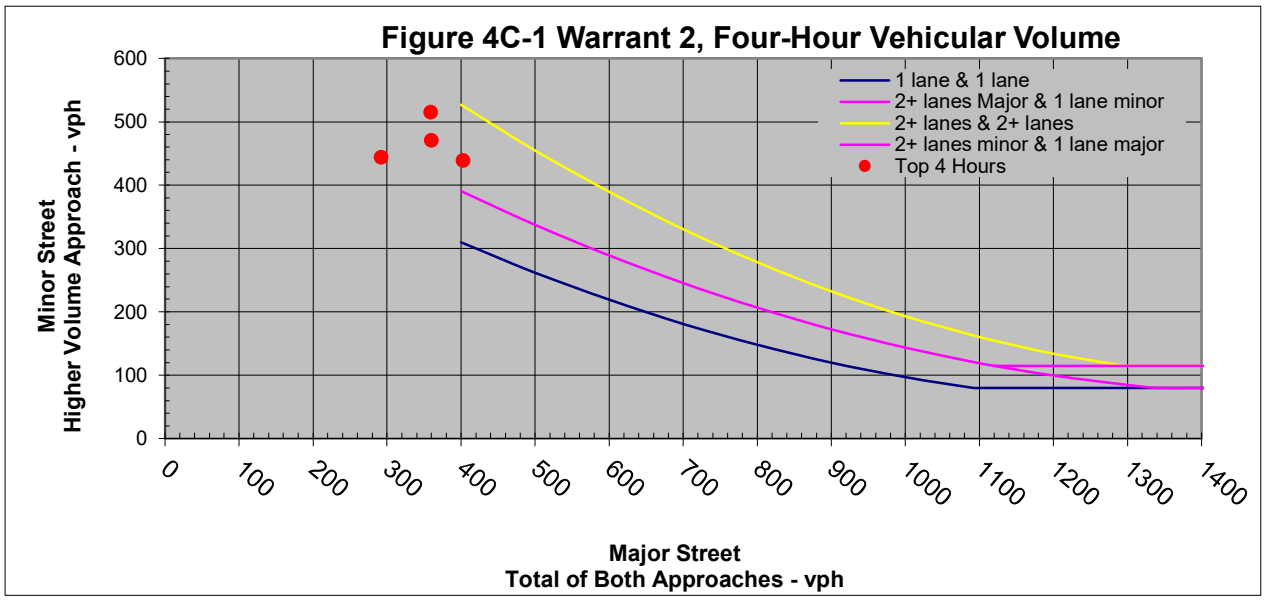
Notes:

OMUTCD WARRANT 2, FOUR-HOUR VEHICULAR VOLUME

Number of Lanes for Moving Traffic on Each Approach		Total Number of Unique Hours Met on Figure 4C-1	5
Major street:	1 Lane	Total Number of Unique Hours Met on Figure 4C-2 (70% Factor)	12
Minor Street:	1 Lane		

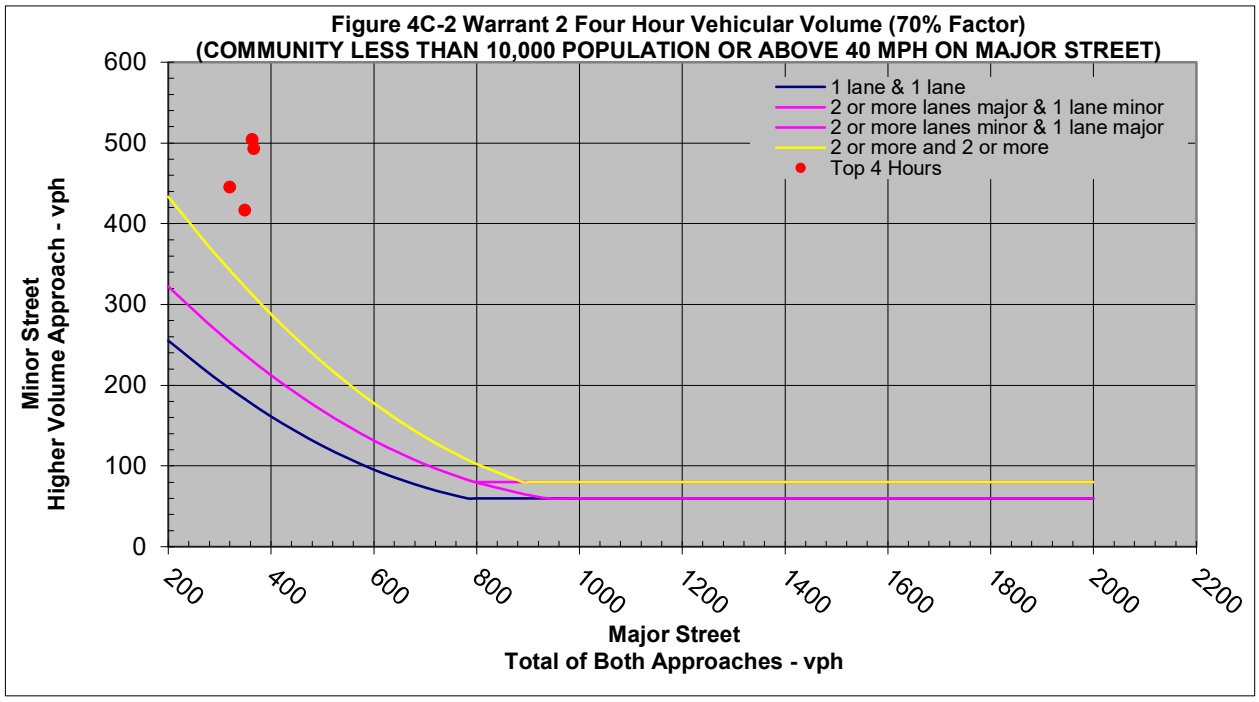
Built up Isolated Community with Less Than 10,000 Population or Above 40 MPH on Major Street?	Yes

Hour Interval Beginning At	Raw Traffic Counts				Total Major Approach Volumes	Highest Actual Minor Street Approach Volumes	Hour Met?	Hour Met? (70% Factor)
	Minor - SR 21		Major - US 250					
	N-Bound	S-Bound	W-Bound	E-Bound				
6:00 AM	0	0	0	0	0	0		
6:15 AM	77	57	0	37	37	77		
6:30 AM	188	110	0	99	99	188		
6:45 AM	278	174	0	156	156	278		
7:00 AM	358	237	0	210	210	358		Met
7:15 AM	357	244	0	212	212	357		
7:30 AM	325	234	0	197	197	325		
7:45 AM	313	210	0	204	204	313		
8:00 AM	302	187	0	190	190	302		Met
8:15 AM	290	163	0	196	196	290		
8:30 AM	296	161	1	199	200	296		
8:45 AM	298	159	1	190	191	298		
9:00 AM	290	166	2	200	202	290		Met
9:15 AM	305	171	3	196	199	305		
9:30 AM	291	182	2	195	197	291		
9:45 AM	280	187	2	199	201	280		
10:00 AM	316	198	1	205	206	316		Met
10:15 AM	311	228	3	211	214	311		
10:30 AM	328	239	4	207	211	328		
10:45 AM	346	261	6	190	196	346		
11:00 AM	327	256	8	185	193	327		Met
11:15 AM	345	233	7	181	188	345		
11:30 AM	335	220	8	197	205	335		
11:45 AM	334	215	12	207	219	334		
12:00 PM	346	229	12	213	225	346		Met
12:15 PM	343	235	12	230	242	343		
12:30 PM	364	230	12	247	259	364		
12:45 PM	384	237	7	261	268	384	Met	
1:00 PM	393	239	6	271	277	393		Met
1:15 PM	413	278	5	287	292	413		
1:30 PM	416	312	3	282	285	416		
1:45 PM	444	363	3	289	292	444	Met	
2:00 PM	445	366	2	318	320	445		Met
2:15 PM	451	350	1	327	328	451		
2:30 PM	470	351	1	335	336	470		
2:45 PM	471	322	0	360	360	471	Met	
3:00 PM	504	321	0	363	363	504		Met
3:15 PM	515	314	1	358	359	515		
3:30 PM	523	333	2	361	363	523		
3:45 PM	515	340	4	355	359	515	Met	
4:00 PM	493	328	5	362	367	493		Met
4:15 PM	488	328	8	396	404	488		
4:30 PM	472	290	8	407	415	472		
4:45 PM	439	259	6	397	403	439	Met	
5:00 PM	417	245	7	342	349	417		Met
5:15 PM	377	225	4	279	283	377		
5:30 PM	341	208	3	228	231	341		
5:45 PM	333	189	5	184	189	333		
6:00 PM	310	183	5	177	182	310		Met
6:15 PM	229	129	4	126	130	229		
6:30 PM	152	85	4	82	86	152		
6:45 PM	66	39	2	44	46	66		
7:00 PM	0	0	0	0	0	0		
7:15 PM	0	0	0	0	0	0		
7:30 PM	0	0	0	0	0	0		
7:45 PM	0	0	0	0	0	0		
8:00 PM	0	0	0	0	0	0		



Top Hours for Figure 4C-1	Start Time	End Time	Major Street	Minor Street
Top Hour	3:45 PM	4:45 PM	359	515
2nd Highest Hour	2:45 PM	3:45 PM	360	471
3rd Highest Hour	4:45 PM	5:45 PM	403	439
4th Highest Hour	1:45 PM	2:45 PM	292	444

Top Hours for Figure 4C-2	Start Time	End Time	Major Street	Minor Street
Top Hour	3:00 PM	4:00 PM	363	504
2nd Highest Hour	4:00 PM	5:00 PM	367	493
3rd Highest Hour	2:00 PM	3:00 PM	320	445
4th Highest Hour	5:00 PM	6:00 PM	349	417



Are the requirements for Warrant 2 met?: Yes

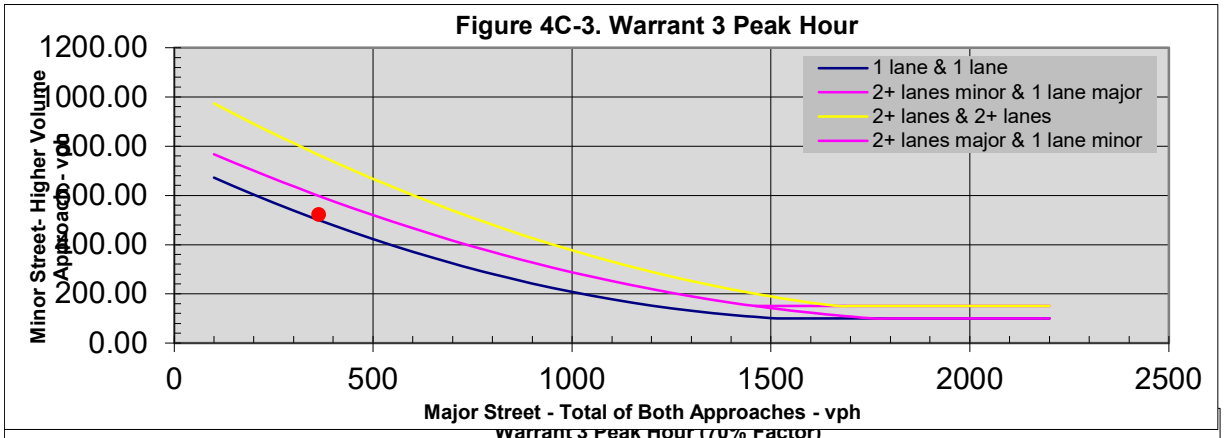
OMUTCD WARRANT 3, PEAK HOUR

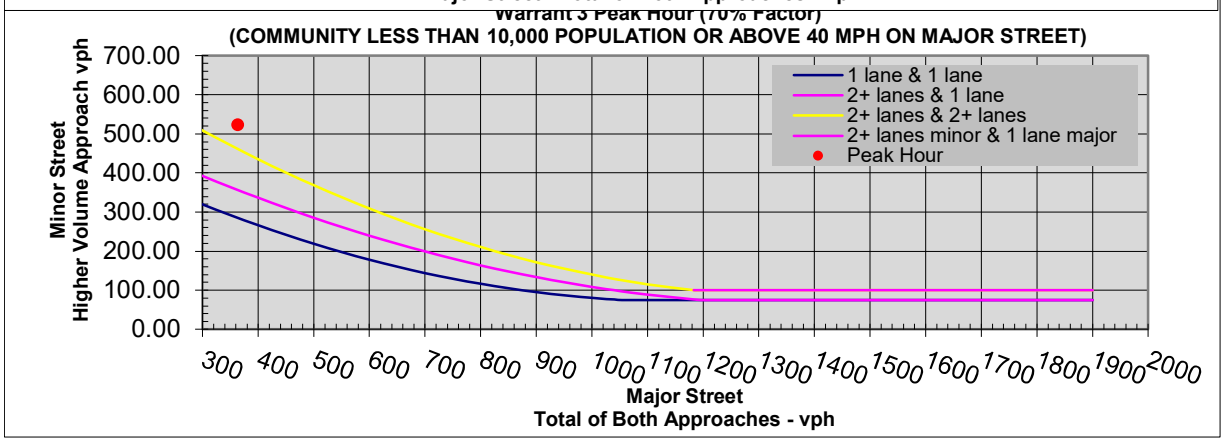
Number of Lanes for Moving Traffic on Each Approach		Peak Hour Start time	3:30 PM
Major Street:	1 Lane	Peak Hour End Time	4:30 PM
Minor Street:	1 Lane		

Built up Isolated Community with Less Than 10,000 Population or Above 40 MPH on Major Street?	Yes

Is this signal warrant being applied for an unusual case, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time?	No

Indicate whether all three of the following conditions for the same 1 hour (any four consecutive 15-minute periods) of an average day are present*	
Does the total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equal or exceed 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach?	Yes
Does the volume on the same minor-street approach (one direction only) equal or exceed 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes?	Yes
Does the total entering volume serviced during the hour equal or exceed 650 vehicles per hour for intersection with three approaches or 800 vehicles per hour for intersections with four or more approaches?	Yes
**If applicable, attach all supporting calculations and documentation.*	
Are the requirements for Warrant 3 met?:	**Yes**





Hour Vehicular Volume				
Hour Interval Beginning At	**Major Street Combined Vehicles Per Hour (VPH)**	**Highest Minor Street Approach Vehicles Per Hour (VPH)**	**Sum of Major Street and Highest Minor Street**	**Sum of Major Street and Combined Minor Street**
6:00 AM	0	0	0	0
6:15 AM	37	77	114	171
6:30 AM	99	188	287	397
6:45 AM	156	278	434	608
7:00 AM	210	358	568	805
7:15 AM	212	357	569	813
7:30 AM	197	325	522	756
7:45 AM	204	313	517	727
8:00 AM	190	302	492	679
8:15 AM	196	290	486	649
8:30 AM	200	296	496	657
8:45 AM	191	298	489	648
9:00 AM	202	290	492	658
9:15 AM	199	305	504	675
9:30 AM	197	291	488	670
9:45 AM	201	280	481	668
10:00 AM	206	316	522	720
10:15 AM	214	311	525	753
10:30 AM	211	328	539	778
10:45 AM	196	346	542	803
11:00 AM	193	327	520	776
11:15 AM	188	345	533	766
11:30 AM	205	335	540	760
11:45 AM	219	334	553	768
12:00 PM	225	346	571	800
12:15 PM	242	343	585	820
12:30 PM	259	364	623	853
12:45 PM	268	384	652	889
1:00 PM	277	393	670	909
1:15 PM	292	413	705	983
1:30 PM	285	416	701	1013
1:45 PM	292	444	736	1099
2:00 PM	320	445	765	1131
2:15 PM	328	451	779	1129
2:30 PM	336	470	806	1157
2:45 PM	360	471	831	1153
3:00 PM	363	504	867	1188
3:15 PM	359	515	874	1188
3:30 PM	363	523	886	1219
3:45 PM	359	515	874	1214
4:00 PM	367	493	860	1188
4:15 PM	404	488	892	1220
4:30 PM	415	472	887	1177
4:45 PM	403	439	842	1101
5:00 PM	349	417	766	1011
5:15 PM	283	377	660	885
5:30 PM	231	341	572	780
5:45 PM	189	333	522	711
6:00 PM	182	310	492	675
6:15 PM	130	229	359	488
6:30 PM	86	152	238	323
6:45 PM	46	66	112	151
7:00 PM	0	0	0	0
7:15 PM	0	0	0	0
7:30 PM	0	0	0	0
7:45 PM	0	0	0	0
8:00 PM	0	0	0	0

Actual Peak Hour Major Traffic Volume	Actual Peak Hour Minor Traffic Volume	Required Peak Hour Minor Traffic Volume for Fig. 4C-3	Required Peak Hour Minor Traffic Volume for Fig. 4C-4
363	523	500	285

OMUTCD WARRANT 7, CRASH EXPERIENCE

Built-up Isolated Community With Less Than 10,000 Population or Above 40 mph on Major Street?: Yes

Number of Lanes for Moving Traffic on Each Approach
Major Street: 1 Lane
Minor Street: 1 Lane

Has adequate trial of alternative with satisfactory observance and enforcement failed to reduce the crash frequency? No

Five or more reportable and/ or non-reportable crashes, of types susceptible to correction by a traffic control signal have occurred within a 12-month period during the most recent 3 years of available crash data.* Yes
**If applicable attach a summary of the crash data analysis used for this criterion*

For each of any 8 hours of an average day, the vehicles per hour given in both the 80% columns of Condition A in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, if in a built-up isolated community with less than 10,000 population or above 40 mph on major street, the 56% columns may be used. No

For each of any 8 hours of an average day, the vehicles per hour given in both the 80% columns of Condition B in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, if in a built-up isolated community with less than 10,000 population or above 40 mph on major street, the 56% columns may be used. No

The volume of pedestrian traffic is 80% or more of the requirements specified in Warrant 4, the Pedestrian Volume warrant.* No
**If applicable, attach all supporting calculations and documentation*

Are the requirements for Warrant 7 met?: No

OMUTCD WARRANT 8, ROADWAY NETWORK*

Does the intersection have a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1, 2, and 3, during the average weekday?

Does the intersection have a total existing or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a non-normal business day (Saturday or Sunday)?

Is the major street part of the street or highway system that serves as the principal roadway network for through traffic flow?

Does the major street include rural or suburban highways outside, entering, or traversing a city?

Does the major street appear as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study?

**Refer to Section 4.3 of ODOT Publication 46 (Traffic Engineering Manual) for additional Department documentation requirements to justify the installation of a signal under Warrant 8. Attach all supplementary documentation and calculations, especially those relating to traffic volume projections and subsequent Warrant analyses.*

Are the requirements for Warrant 8 met?: No

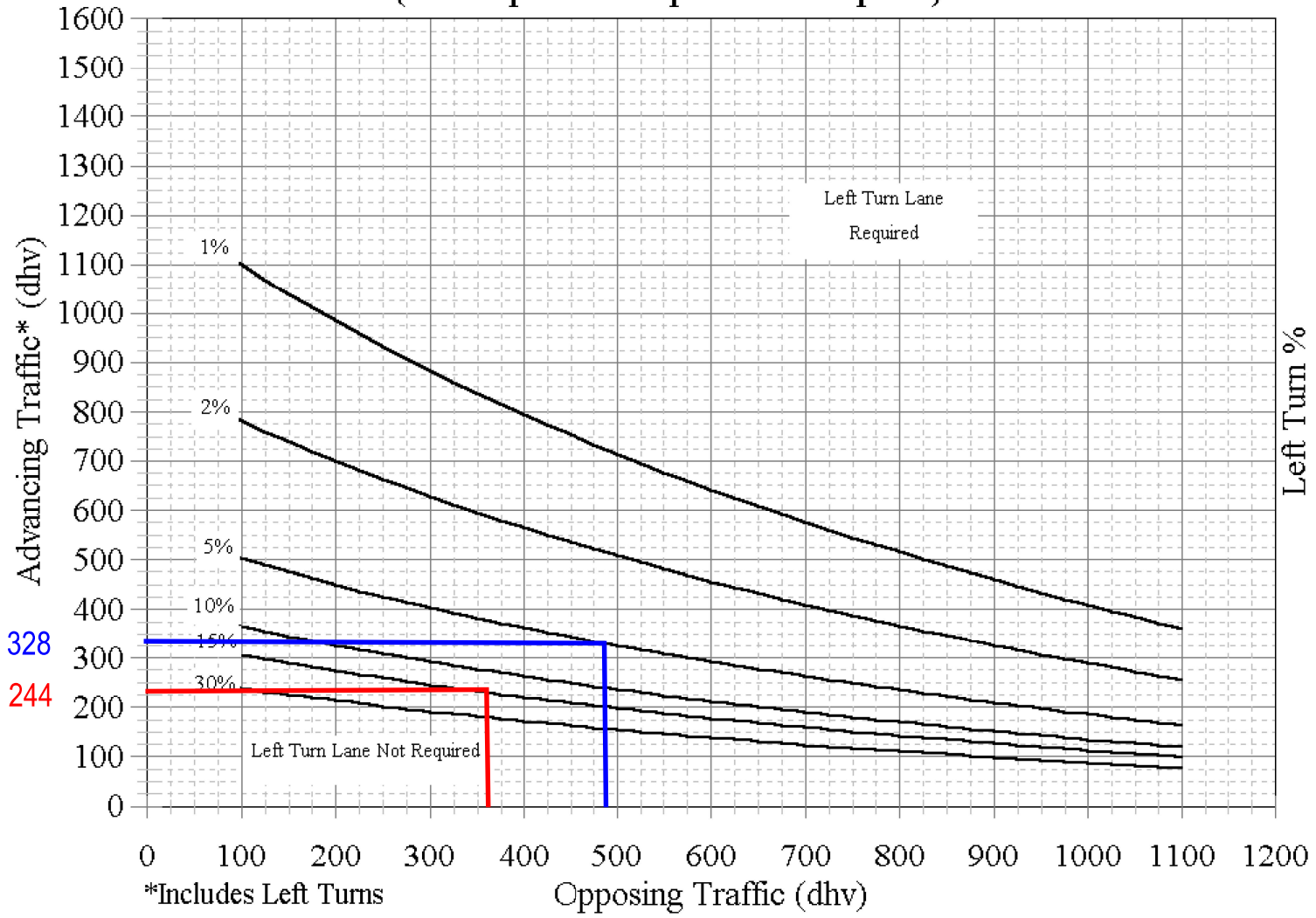
APPENDIX H

Turn Lane Warrant Analysis & Design

US 250 Westbound Intersection Approach

2-Lane Highway Left Turn Lane Warrant

(>40 mph or 70 kph Posted Speed)



AM Peak Traffic Volumes (Left Turn % = 48.7%)

PM Peak Traffic Volumes (Left Turn % = 47.3%)

October 2004

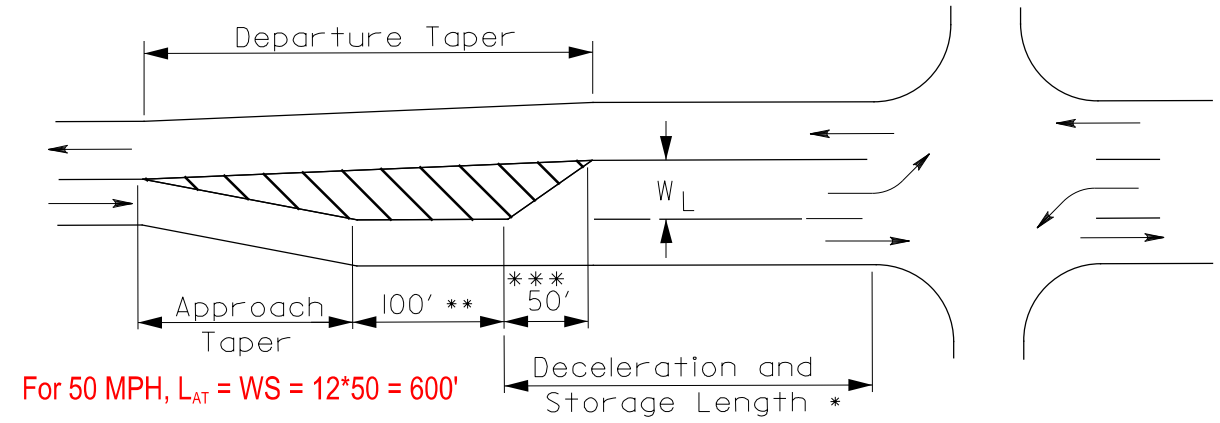
2-LANE LEFT TURN LANE WARRANT (HIGH SPEED)

401-5b

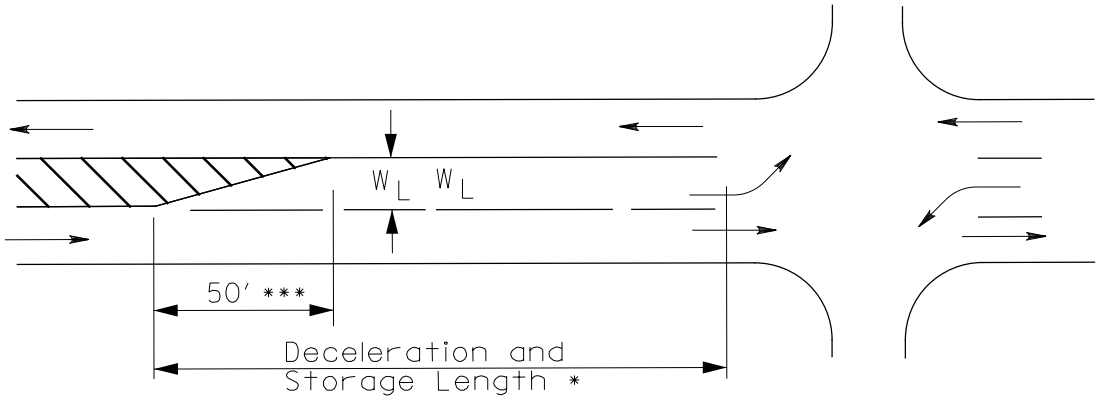
REFERENCE SECTION 401.6.1

US 250 Westbound Intersection Approach

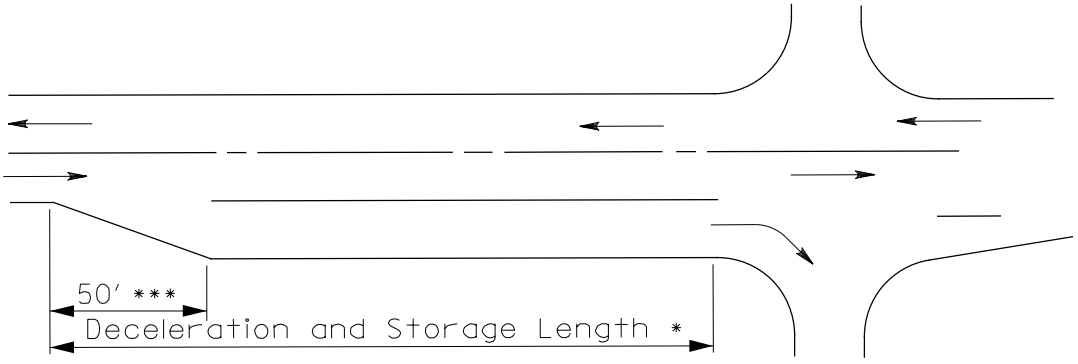
TURNING LANE DESIGN	401-7 REFERENCE SECTIONS 401.6.1, 401.6.3



LEFT TURN LANE - NO MEDIAN OR MEDIAN WIDTH < W_L



LEFT TURN LANE - MEDIAN WIDTH >= W_L



RIGHT TURN LANE

* See Figures 401-9 and 401-10 to compute length.

** May be reduced or eliminated in urban areas if intersection spacing or storage is constraining

*** Diverging taper

W_L = Turn Lane Width

US 250 Westbound Intersection Approach

BASIS FOR COMPUTING LENGTH OF TURN LANES

401-9

REFERENCE SECTIONS
401.6.1 & 401.6.3

Type of Traffic Control	Design Speed		
	30-35	40-65 50	
	Turn Demand Volume		
	All	Low*	High
Signalized	A	** B or C	** B or C
Unsignalized Stopped Crossroad	A	A	A
Unsignalized Through Road	A	B	** B or C

* Low is considered 10% or less of approach traffic volume (>45%)

** Whichever is greater

CONDITION A	STORAGE ONLY
Length = 50' (diverging taper) + Storage Length (Figure 401-10)	

CONDITION B	HIGH SPEED DECELERATION ONLY
Design Speed	Length (including 50' Diverging Taper)
40	125
45	175
50	225
55	285
60	345
65	405

495' > 225'
Use Condition C

CONDITION C	MODERATE SPEED DECELERATION AND STORAGE
Design Speed	Length (including 50' Diverging Taper)
40	115 + Storage Length (Figure 401-10)
45	125 "
50	145 " 350
55	165 "
60	185 "
65	205 "

495' Total

For explanation, see Turn Lane Design Example

US 250 Westbound Intersection Approach

STORAGE LENGTH AT INTERSECTIONS	401-10
	REFERENCE SECTIONS 401.6.1 & 401.6.3

* AVERAGE NO. OF VEHICLES/CYCLE	REQUIRED LENGTH (FT.)
1	50
2	100
3	150
4	175
5	200
6	250
7	275
8	325
9	350
10	375
11	400
12	450
13	475
14	500
15	525
16	550

* AVERAGE NO. OF VEHICLES/CYCLE	REQUIRED LENGTH (FT.)
17	600
18	625
19	650
20	675
21	725
22	750
23	775
24	800
25	825
30	975
35	1125
40	1250
45	1400
50	1550
55	1700
60	1850

$$\text{* AVERAGE VEHICLES PER CYCLE} = \frac{\text{DHV (TURNING LANE)}}{\text{CYCLES/HOUR}}$$

488 / 60 = 8.1 => Use 9

IF CYCLES ARE UNKNOWN ASSUME:

UNSIGNALIZED OR 2 PHASE = 60 CYCLES/HOUR

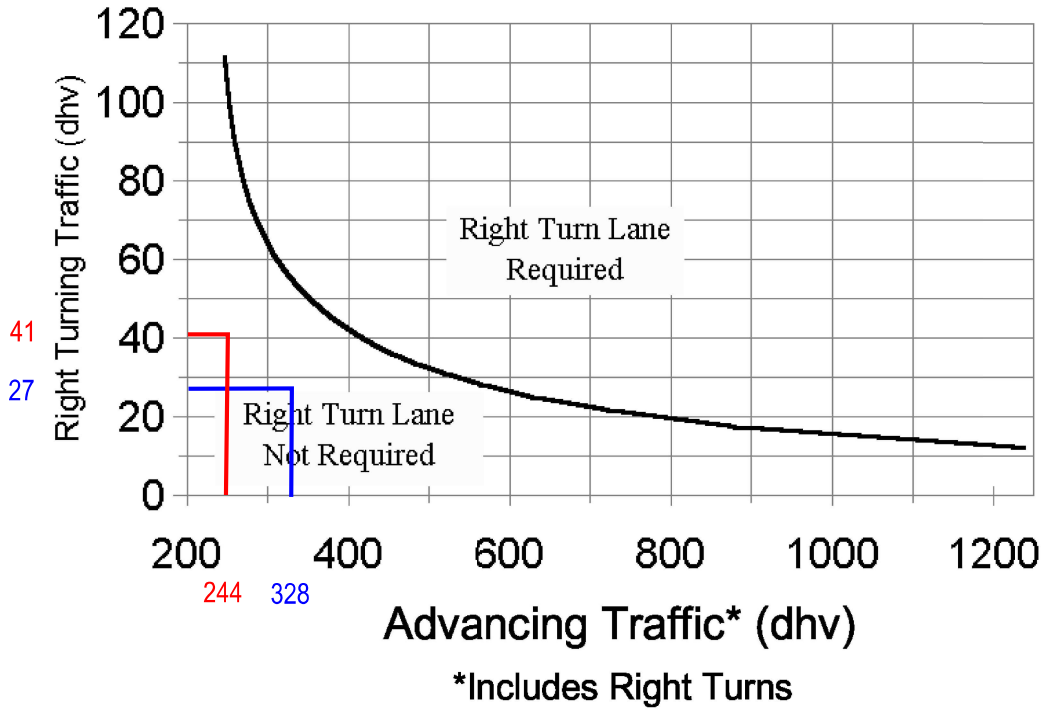
3 PHASE = 40 CYCLES/HOUR

4 PHASE = 30 CYCLES/HOUR

SR 21 Southbound Intersection Approach

2-Lane Highway Right Turn Lane Warrant

> 40 mph or 70 kph Posted Speed



AM Peak Traffic Volumes (Right Turn % = 16.8%)

PM Peak Traffic Volumes (Right Turn % = 8.2%)

2-LANE RIGHT TURN LANE WARRANT (HIGH SPEED)

401-6b

REFERENCE SECTION 401.6.3

October 2004

APPENDIX I

Countermeasure Plan Sheets & Estimates

Y:\GROUPS\planning\Traffic Safety Analysis\TUS\TUS 250 2.223 SR 21 Intersection\2023\TUS 250 2.223 Safety Study 2023\TUS 250 & SR 21 Design A.dgn 09-FEB-2024 12:22AM dhoffma1

	TUS-250-2.22	SIGNALIZED INTERSECTION PLAN ALTERNATIVE 'A'	CALCULATED RDA / CHECKED DAH	0 40 80 160 HORIZONTAL SCALE IN FEET

Department of Transportation

Preliminary Cost Estimate

Alternative: New Traffic Signal & Added Left-Turn Lane Storage Capacity

Item	Assumed Quantity			Unit Cost			Total
Roadway							
Excavation	530	cu yd	x	$ 20.00	/cu yd	=	$ 10,600.00
Embankment	50	cu yd	x	$ 25.00	/cu yd	=	$ 1,250.00
Erosion Control							
Seeding & Mulching	444	sq yd	x	$ 3.00	/sq yd	=	$ 1,332.00
Erosion Control	5000	each	x	$ 1.00	/each	=	$ 5,000.00
Pavement							
Pavement Removed	1460	sq yd	x	$ 25.00	/sq yd	=	$ 36,500.00
Proposed Asphalt Pavement	2520	sq yd	x	$ 80.00	/sq yd	=	$ 201,600.00
Traffic Control							
Traffic Signal	1	each	x	$ 250,000.00	/each	=	$ 250,000.00
Pavement Marking	3543	ft	x	$ 3.00	/ft	=	$ 10,629.00
Sign Assemblies	11	each	x	$ 500.00	/each	=	$ 5,500.00
Highway Lighting							
Highway Lighting System w/ 3 Luminaires	1	each	x	$ 75,000.00	/each	=	$ 75,000.00
Incidentals							
Maintaining Traffic	1	lump	x	$ 80,000.00	/lump	=	$ 80,000.00
Mobilization	1	lump	x	$ 40,000.00	/lump	=	$ 40,000.00
Const. Layout Stakes	1	lump	x	$ 10,000.00	/lump	=	$ 10,000.00
Field Office, Type B	4	month	x	$ 2,500.00	/month	=	$ 10,000.00
					Construction Subtotal	=	**$ 737,411.00**
					Add Right-of-Way Costs	=	$ -
					Add for Contingencies 20%	=	$ 147,482.20
					Estimated Construction Cost	=	**$ 884,893.20**
					Add for Engineering Design Costs 35%	=	$ 309,712.62
					Adjust for inflation 21.3%	=	$ 254,451.04
					Total Estimated Construction Cost	=	**$ 1,449,056.86**

Y:\GROUPS\planning\Traffic Safety Analysis\TUS\TUS 250 2.223 SR 21 Intersection\2023\TUS 250 2.223 Safety Study 2023\TUS 250 & SR 21 Design B.dgn 09-FEB-2024 12:24AM dhoffma1

TUS-250-2.22

ROUNDABOUT PLAN
ALTERNATIVE 'B'

CALCULATED RDA
CHECKED DAH

0 40
20 80
HORIZONTAL SCALE IN FEET

Department of Transportation

Preliminary Cost Estimate
Alternative: Single-Lane Roundabout

Item	Assumed Quantity			Unit Cost			Total
Roadway							
Excavation	418	cu yd	x	$ 20.00	/cu yd	=	$ 8,360.00
Embankment	100	cu yd	x	$ 25.00	/cu yd	=	$ 2,500.00
Erosion Control							
Seeding & Mulching	6406	sq yd	x	$ 3.00	/sq yd	=	$ 19,218.00
Erosion Control	10000	each	x	$ 1.00	/each	=	$ 10,000.00
Pavement							
Pavement Removed	7328	sq yd	x	$ 25.00	/sq yd	=	$ 183,200.00
Proposed Asphalt Pavement	7650	sq yd	x	$ 80.00	/sq yd	=	$ 612,000.00
Proposed Concrete Pavement	2292	sq yd	x	$ 130.00	/sq yd	=	$ 297,960.00
Curb	1708.5	ft	x	$ 30.00	/ft	=	$ 51,255.00
Traffic Control							
Pavement Marking	6048	ft	x	$ 3.00	/ft	=	$ 18,144.00
Sign Assemblies	24	each	x	$ 500.00	/each	=	$ 12,000.00
Highway Lighting							
Highway Lighting System w/ 3 Luminaires	1	each	x	$ 75,000.00	/each	=	$ 75,000.00
Incidentals							
Maintaining Traffic	1	lump	x	$ 200,000.00	/lump	=	$ 200,000.00
Mobilization	1	lump	x	$ 100,000.00	/lump	=	$ 100,000.00
Const. Layout Stakes	1	lump	x	$ 20,000.00	/lump	=	$ 20,000.00
Field Office, Type B	9	month	x	$ 2,500.00	/month	=	$ 22,500.00
					Construction Subtotal	=	**$ 1,632,137.00**
					Add Right-of-Way Costs	=	$ 20,000.00
					Add for Contingencies 20%	=	$ 330,427.40
					Total Estimated Construction Cost	=	**$ 1,982,564.40**
					Add for Engineering Design Costs 25%	=	$ 495,641.10
					Adjust for inflation 21.3%	=	$ 527,857.77
					Total Estimated Project Cost	=	**$ 3,006,063.27**

FY 2024-2028 Business Plan Inflation Calculator:

Not sure if you have the latest calculator? Click here.

Last Modified: 7/20/2023

Today's Date:
February 7, 2024

Please Enter Values in the Yellow Areas Only:

Estimation Start Date:
Less than or Equal to Today's Date
(mm/dd/yyyy)

2/7/2024
Start Date:

Enter Construction Mid-Point Date:
(cannot exceed 02/07/2049)
(mm/dd/yyyy)

8/1/2028
Construction Mid-Point Date:

Present-Day Estimated Cost:

$1,000.00
Estimated Dollar Amount:

Estimate Start Date to Construction Mid-Point Date: **54** **Months**

Inflation - Start to Mid-Point of Construction:

	(compounded growth rate)	**Inflated Dollar Amount:**
Business Plan	**21.3%**	**$1,213.23**

Estimator's Name:

County - Route - Section: TUS-250-2.223

PID: NA

Estimator's Notes: Traffic Study Alternatives

APPENDIX J

Highway Safety Manual Analysis (Using ECAT)

Project Information

General Information

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Existing Conditions	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		
Perform Benefit Cost Analysis?	Yes		

Do the proposed improvements fundamentally change the conditions of the base safety performance function (SPF), Or is crash data unavailable for the analysis condition, Or is only predicted (and not expected) analysis needed for the existing or proposed condition?	**Yes**

(Examples: unsignalized to signalized, undivided to divided, increase or decrease in the number of lanes, change the number of approaches to an intersection, significant realignment of the roadway)

If Yes, are you analyzing the existing or proposed conditions?	**Existing**

Project Elements Description Table

Project Element ID (Must be Unique)	Site Type	Intersection Control Type	Location Information					
			NLFID	Begin Logpoint/ Intersection Midpoint	End Logpoint *(Leave blank for Intersection)*	Length (mi) OR Intersection Radius Buffer (mi)	Cross Route NLFID(s)	Common Name
US250; 2.223	Urban & Suburban Arterial Intersection	Unsignalized	STUSUS00250**C	2.223		0.05	STUSSR0002	SR21

Traffic Volume Growth Rate Calculation For Benefit Cost Analysis

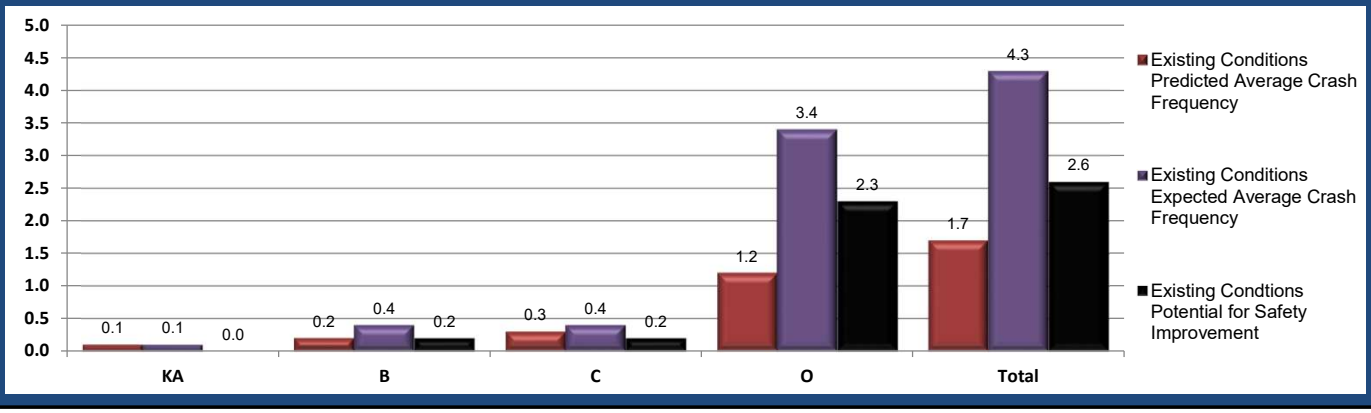
	Year	AADT	
Present ADT (PADT)	2028	11,657	veh / day
Future ADT (FADT)	2048	12,823	veh / day
Annual Linear Growth Rate		0.0050	

Project Safety Performance Report

General Information

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Existing Conditions	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		

Summary of Anticipated Safety Performance of the Project (average crashes/year)



Project Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
$N_{predicted}$ - Existing Conditions	0.0613	0.2307	0.2644	1.1505	1.7069
$N_{expected}$ - Existing Conditions	0.1031	0.3873	0.4400	3.4067	4.3371
$N_{potential\ for\ improvement}$ - Existing Conditions	**0.0418**	**0.1566**	**0.1756**	**2.2562**	**2.6302**

Project Information

General Information

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Install New Traffic Signal	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		
Perform Benefit Cost Analysis?	Yes		

Do the proposed improvements fundamentally change the conditions of the base safety performance function (SPF), Or is crash data unavailable for the analysis condition, Or is only predicted (and not expected) analysis needed for the existing or proposed condition?	**Yes**

(Examples: unsignalized to signalized, undivided to divided, increase or decrease in the number of lanes, change the number of approaches to an intersection, significant realignment of the roadway)

If Yes, are you analyzing the existing or proposed conditions?	**Proposed**

Project Elements Description Table

Project Element ID (Must be Unique)	Site Type	Intersection Control Type	Location Information					
			NLFID	Begin Logpoint/ Intersection Midpoint	End Logpoint *(Leave blank for Intersection)*	Length (mi) OR Intersection Radius Buffer (mi)	Cross Route NLFID(s)	Common Name
US250; 2.223	Urban & Suburban Arterial Intersection	Signalized	STUSUS00250**C	2.223		0.05	STUSSR0002	SR21

Traffic Volume Growth Rate Calculation For Benefit Cost Analysis

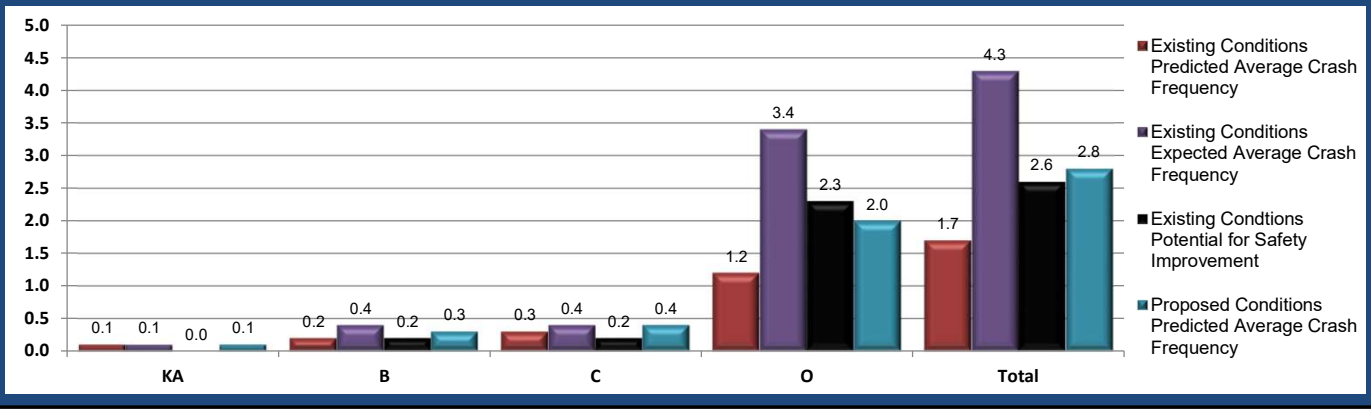
	Year	AADT	
Present ADT (PADT)	2028	11,657	veh / day
Future ADT (FADT)	2048	12,823	veh / day
Annual Linear Growth Rate		0.0050	

Project Safety Performance Report

General Information

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Install New Traffic Signal	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		

Summary of Anticipated Safety Performance of the Project (average crashes/year)



Project Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
$N_{predicted}$ - Existing Conditions	0.0613	0.2307	0.2644	1.1505	1.7069
$N_{expected}$ - Existing Conditions	0.1031	0.3873	0.4400	3.4067	4.3371
$N_{potential\ for\ improvement}$ - Existing Conditions	**0.0418**	**0.1566**	**0.1756**	**2.2562**	**2.6302**
$N_{expected}$ - Proposed Conditions	0.0608	0.3434	0.4404	1.9652	2.8098

Existing Conditions Project Element Predicted Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
US250; 2.223	SR21	0.0613	0.2307	0.2644	1.1505	1.7069

Existing Conditions Project Element Expected Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
US250; 2.223	SR21	0.1031	0.3873	0.44	3.4067	4.3371

Existing Conditions Project Element Potential for Safety Improvement Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
US250; 2.223	SR21	**0.0418**	**0.1566**	**0.1756**	**2.2562**	**2.6302**

Proposed Conditions Project Element Predicted Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
US250; 2.223	SR21	0.0608	0.3434	0.4404	1.9652	2.8098

Project Safety Performance Report

General Information

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Install New Traffic Signal	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		

Summary by Crash Type

Crash Type	Existing			Proposed
	Predicted Crash Frequency	Expected Crash Frequency	PSI	Predicted Crash Frequency
Unknown	0.0016	0.0015	-0.0001	0.0028
Head On	0.0440	0.1010	**0.0571**	0.0365
Rear End	0.7338	2.0181	**1.2843**	1.2540
Backing	0.0394	0.1260	**0.0866**	0.0679
Sideswipe - Meeting	0.0041	0.0105	**0.0064**	0.0022
Sideswipe - Passing	0.1570	0.4635	**0.3064**	0.3616
Angle	0.3210	0.8372	**0.5162**	0.3617
Parked Vehicle	0.0100	0.0115	**0.0015**	0.0137
Pedestrian	0.0071	0.0071	0.0000	0.0064
Animal	0.0000	0.0000	0.0000	0.0000
Train	0.0001	0.0001	0.0000	0.0053
Pedalcycles	0.0000	0.0000	0.0000	0.0031
Other Non-Vehicle	0.0001	0.0001	**0.0001**	0.0000
Fixed Object	0.1690	0.1980	**0.0291**	0.2536
Other Object	0.0053	0.0049	-0.0004	0.0137
Overturning	0.0058	0.0091	**0.0033**	0.0025
Other Non-Collision	0.0122	0.0128	**0.0006**	0.0326
Left Turn	0.1274	0.3332	**0.2058**	0.2766
Right Turn	0.0692	0.2025	**0.1333**	0.1156

Project Cost Estimate

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Install New Traffic Signal	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		

Engineering Design %	35%
Contingency %	20%

Countermeasures	Construction Costs	Right of Way Costs	Engineering Design Costs	Contingency Amount	Total Cost of Countermeasure	Annual Maintenance & Energy Costs	Salvage Value
Construct extension for Left Turn Lanes, New Traffic Signal, and New Highway Lighting	$737,411.00	$0.00	$309,712.62	$147,482.20	**$1,194,605.82**	$5,000.00	$0.00
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
Totals	**$737,411.00**	**$0.00**	**$309,712.62**	**$147,482.20**	**$1,194,605.82**	**$5,000.00**	**$0.00**

Inflation %	21%

Final Costruction Cost:	**$1,449,056.86**

*Final construction cost should match the Project Cost Estimate

Safety Benefit - Cost Analysis

General Information

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Install New Traffic Signal	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		

Select Site Types to be used in Benefit-Cost Analysis:

All Sites

Comments:

Countermeasure Service Lives, Costs, and Safety Benefits

Countermeasures	Service Life (Years)	Initial Cost of Countermeasure	Annual Maintenance & Energy Costs	Salvage Value	Net Present Cost of Countermeasure	Total Cost of Countermeasures	Summary of Annual Crash Modifications	Net Present Value of Safety Benefits
Construct extension for Left Turn Lanes, New Traffic Signal, and New Highway Lighting	25	$1,449,056.86	$5,000.00	$0.00	$1,569,056.86	$1,665,615.58	1.103	($260,845)
					$0.00	$0.00		
					$0.00	$0.00		
					$0.00	$0.00		
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
Totals		**$1,449,056.86**	**$5,000.00**	**$0.00**	**$1,569,056.86**	**$1,665,615.58**	**1.103**	**($260,845)**

Safety Benefit - Cost Analysis

ECAT Economic Crash Analysis Tool

General Information

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Install New Traffic Signal	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		

Benefit - Cost Calculator

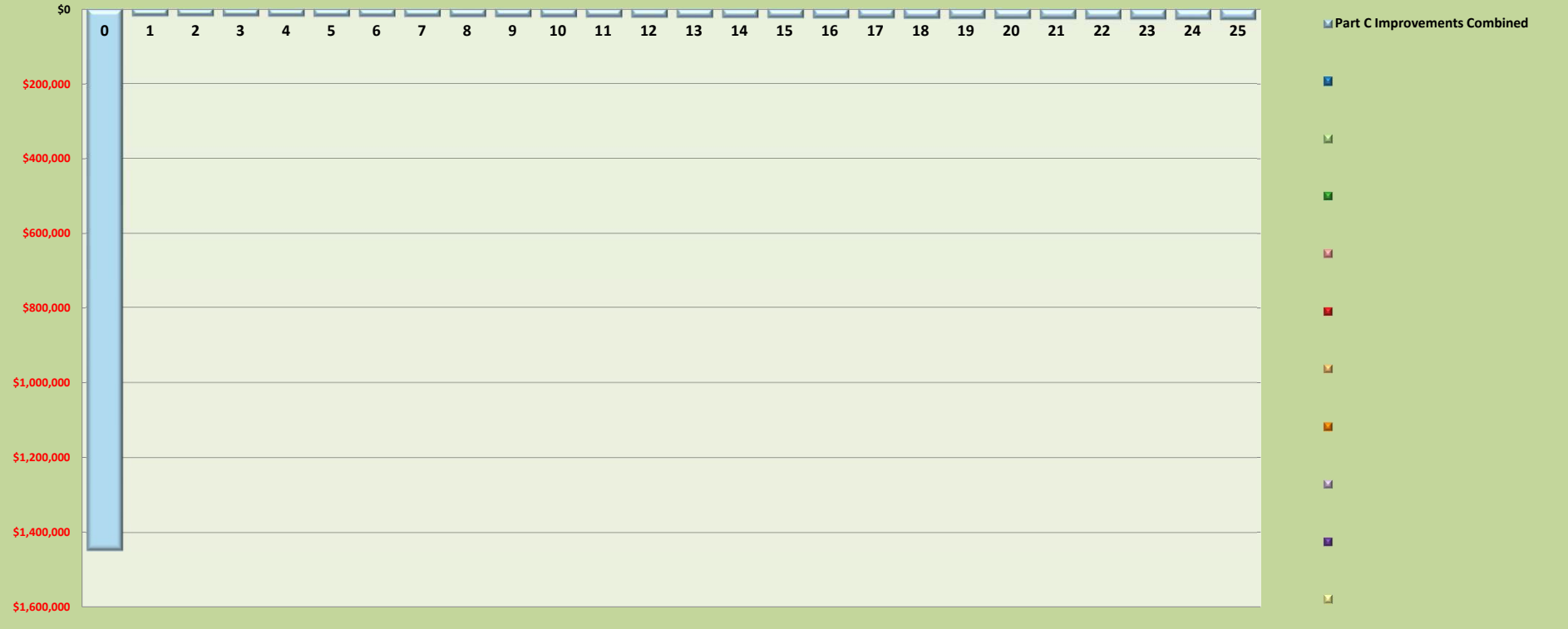
Net Present Value of Project	$1,569,056.86
Net Present Value of Safety Benefits	($260,844.65)
Net Benefit	($1,829,901.51)
Benefit / Cost Ratio	-0.17

Expected Annual Crash Adjustment

Number of Fatal & Incapacitating Injury Crashes	-0.001
Number of Injury Crashes	0.288
Number of Total Crashes	1.103

Comments:

Safety Benefits and Project Costs Combined Cash Flows By Countermeasure Per Year

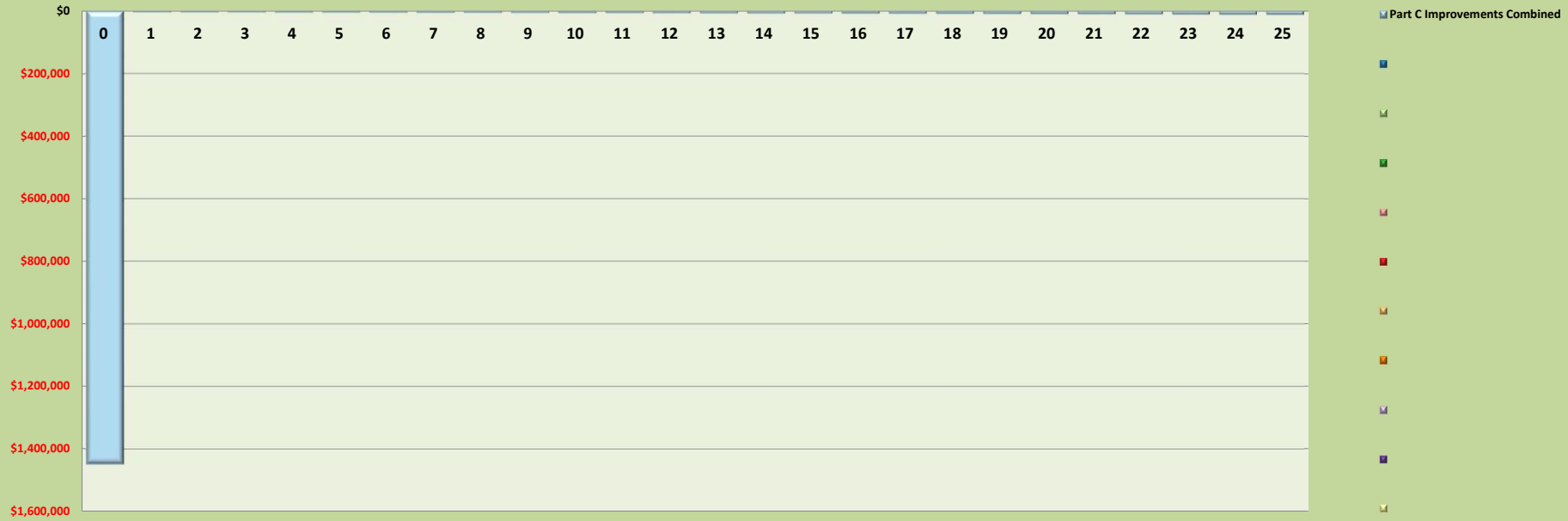


Safety Benefit - Cost Analysis

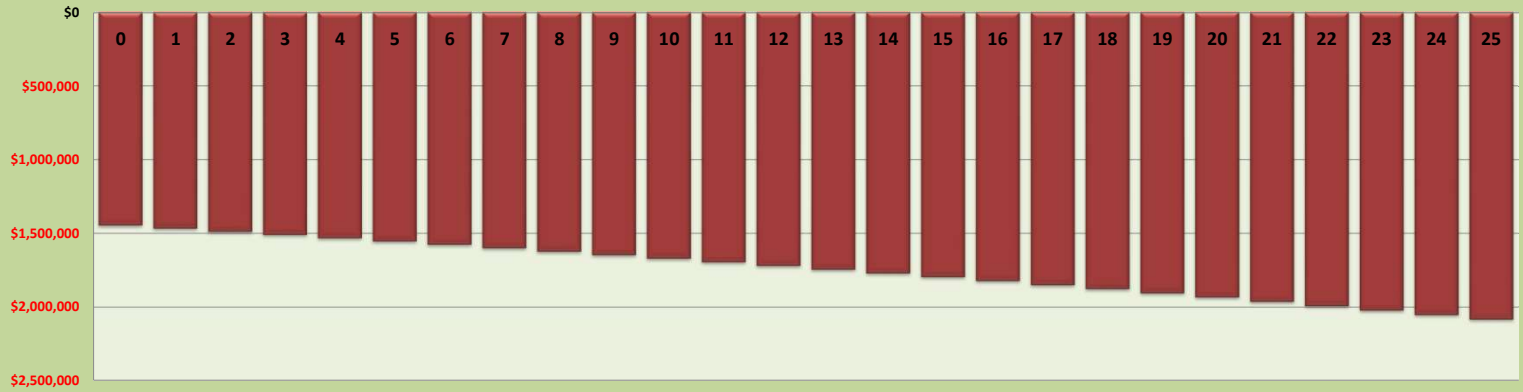
General Information

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Install New Traffic Signal	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		

Project Costs Only Cash Flows By Countermeasure Per Year



Return on Investment (Safety Benefits and Project Investments)



First year to observe a positive return on investiment: Unknown (Unknown years)

Percentage of Service Life to observe a continuous Positive Return on Investment: Unknown%

Project Information

General Information

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Construct a Single Lane Roundabout	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		
Perform Benefit Cost Analysis?	Yes		

Do the proposed improvements fundamentally change the conditions of the base safety performance function (SPF), Or is crash data unavailable for the analysis condition, Or is only predicted (and not expected) analysis needed for the existing or proposed condition?	**Yes**

(Examples: unsignalized to signalized, undivided to divided, increase or decrease in the number of lanes, change the number of approaches to an intersection, significant realignment of the roadway)

If Yes, are you analyzing the existing or proposed conditions?	**Proposed**

Project Elements Description Table

Project Element ID (Must be Unique)	Site Type	Intersection Control Type	Location Information					
			NLFID	Begin Logpoint/ Intersection Midpoint	End Logpoint *(Leave blank for Intersection)*	Length (mi) OR Intersection Radius Buffer (mi)	Cross Route NLFID(s)	Common Name
US250; 2.223	Roundabout	Unsignalized	STUSUS00250**C	2.223		0.05	STUSSR0002	SR21

Traffic Volume Growth Rate Calculation For Benefit Cost Analysis

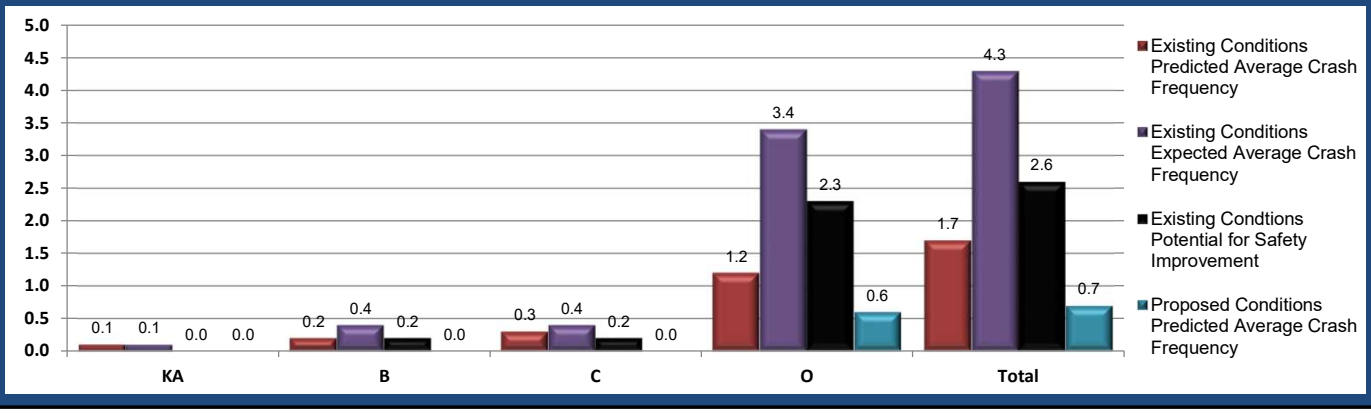
	Year	AADT	
Present ADT (PADT)	2028	11,657	veh / day
Future ADT (FADT)	2048	12,823	veh / day
Annual Linear Growth Rate		0.0050	

Project Safety Performance Report

General Information

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Construct a Single Lane Roundabout	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		

Summary of Anticipated Safety Performance of the Project (average crashes/year)



Project Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
$N_{predicted}$ - Existing Conditions	0.0613	0.2307	0.2644	1.1505	1.7069
$N_{expected}$ - Existing Conditions	0.1031	0.3873	0.4400	3.4067	4.3371
$N_{potential\ for\ improvement}$ - Existing Conditions	**0.0418**	**0.1566**	**0.1756**	**2.2562**	**2.6302**
$N_{expected}$ - Proposed Conditions	0.0046	0.0394	0.0491	0.6411	0.7342

Existing Conditions Project Element Predicted Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
US250; 2.223	SR21	0.0613	0.2307	0.2644	1.1505	1.7069

Existing Conditions Project Element Expected Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
US250; 2.223	SR21	0.1031	0.3873	0.44	3.4067	4.3371

Existing Conditions Project Element Potential for Safety Improvement Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
US250; 2.223	SR21	**0.0418**	**0.1566**	**0.1756**	**2.2562**	**2.6302**

Proposed Conditions Project Element Predicted Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
US250; 2.223	SR21	0.0046	0.0394	0.0491	0.6411	0.7342

Project Safety Performance Report

General Information

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Construct a Single Lane Roundabout	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		

Summary by Crash Type

Crash Type	Existing			Proposed
	Predicted Crash Frequency	Expected Crash Frequency	PSI	Predicted Crash Frequency
Unknown	0.0016	0.0015	-0.0001	0.0202
Head On	0.0440	0.1010	**0.0571**	0.0009
Rear End	0.7338	2.0181	**1.2843**	0.1162
Backing	0.0394	0.1260	**0.0866**	0.0065
Sideswipe - Meeting	0.0041	0.0105	**0.0064**	0.0000
Sideswipe - Passing	0.1570	0.4635	**0.3064**	0.2270
Angle	0.3210	0.8372	**0.5162**	0.2068
Parked Vehicle	0.0100	0.0115	**0.0015**	0.0000
Pedestrian	0.0071	0.0071	0.0000	0.0009
Animal	0.0000	0.0000	0.0000	0.0074
Train	0.0001	0.0001	0.0000	0.0000
Pedalcycles	0.0000	0.0000	0.0000	0.0009
Other Non-Vehicle	0.0001	0.0001	**0.0001**	0.0000
Fixed Object	0.1690	0.1980	**0.0291**	0.0742
Other Object	0.0053	0.0049	-0.0004	0.0000
Overturning	0.0058	0.0091	**0.0033**	0.0009
Other Non-Collision	0.0122	0.0128	**0.0006**	0.0139
Left Turn	0.1274	0.3332	**0.2058**	0.0167
Right Turn	0.0692	0.2025	**0.1333**	0.0491

Project Cost Estimate

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Construct a Single Lane	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		

Engineering Design %	25%
Contingency %	20%

Countermeasures	Construction Costs	Right of Way Costs	Engineering Design Costs	Contingency Amount	Total Cost of Countermeasure	Annual Maintenance & Energy Costs	Salvage Value
Construct modern single lane roundabout	$1,632,137.00	$20,000.00	$495,641.10	$330,427.40	**$2,478,205.50**	$0.00	$0.00
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
					$0.00		
Totals	**$1,632,137.00**	**$20,000.00**	**$495,641.10**	**$330,427.40**	**$2,478,205.50**	**$0.00**	**$0.00**

Inflation %	21%

Final Costruction Cost:	**$3,006,063.27**

*Final construction cost should match the Project Cost Estimate

Safety Benefit - Cost Analysis

General Information

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Construct a Single Lane Roundabout	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		

Select Site Types to be used in Benefit-Cost Analysis:

All Sites

Comments:

Countermeasure Service Lives, Costs, and Safety Benefits

Countermeasures	Service Life (Years)	Initial Cost of Countermeasure	Annual Maintenance & Energy Costs	Salvage Value	Net Present Cost of Countermeasure	Total Cost of Countermeasures	Summary of Annual Crash Modifications	Net Present Value of Safety Benefits
Construct modern single lane roundabout	30	$3,006,063.27	$0.00	$0.00	$3,006,063.27	$3,006,063.27	-0.973	$936,139
					$0.00	$0.00		
					$0.00	$0.00		
					$0.00	$0.00		
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
					$0.00	$0.00	0.000	$0
Totals		**$3,006,063.27**	**$0.00**	**$0.00**	**$3,006,063.27**	**$3,006,063.27**	**-0.973**	**$936,139**

Safety Benefit - Cost Analysis

ECAT Economic Crash Analysis Tool

General Information

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Construct a Single Lane Roundabout	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		

Benefit - Cost Calculator

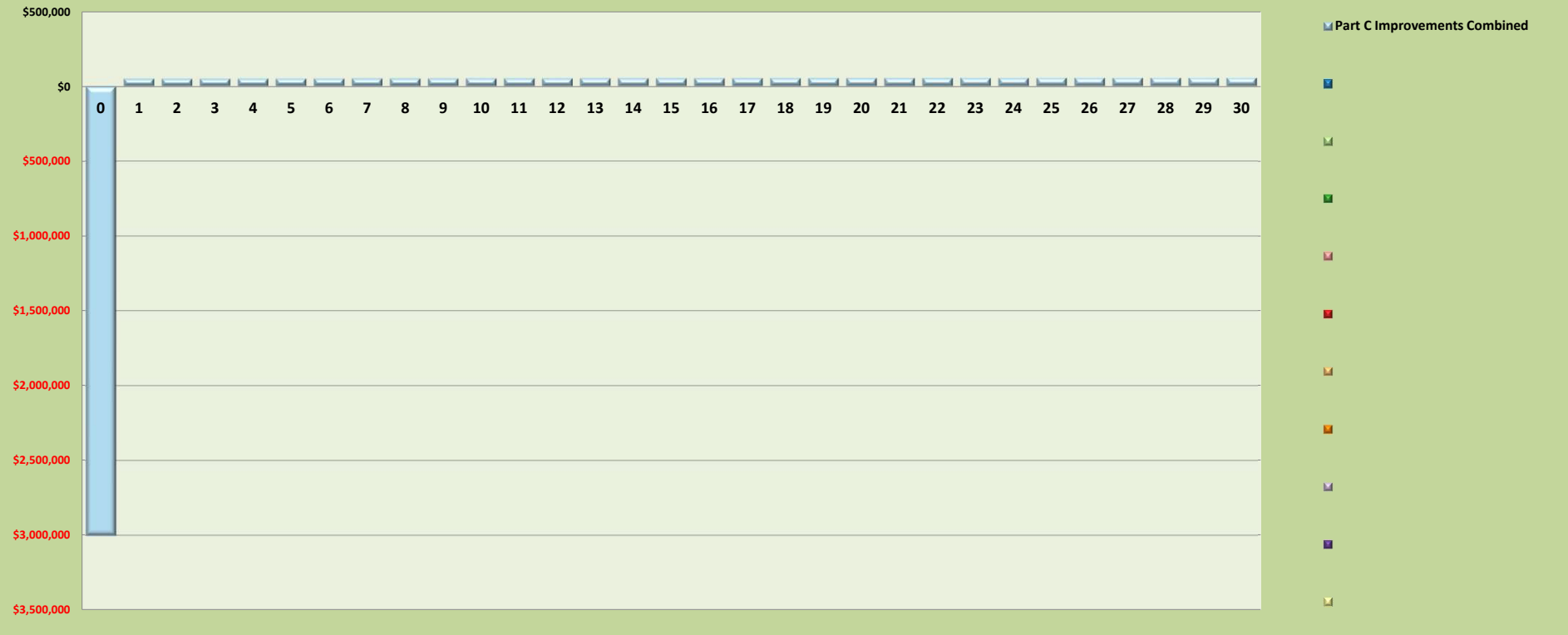
Net Present Value of Project	$3,006,063.27
Net Present Value of Safety Benefits	$936,138.78
Net Benefit	($2,069,924.49)
Benefit / Cost Ratio	0.31

Expected Annual Crash Adjustment

Number of Fatal & Incapacitating Injury Crashes	-0.057
Number of Injury Crashes	-0.463
Number of Total Crashes	-0.973

Comments:

Safety Benefits and Project Costs Combined Cash Flows By Countermeasure Per Year

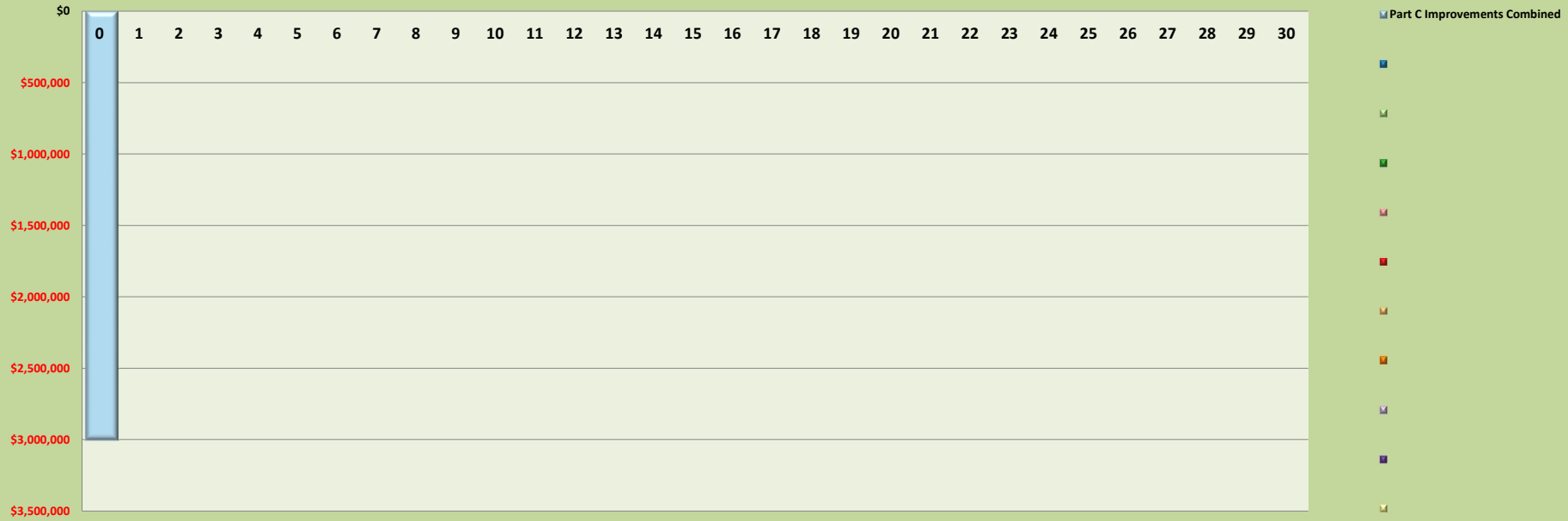


Safety Benefit - Cost Analysis

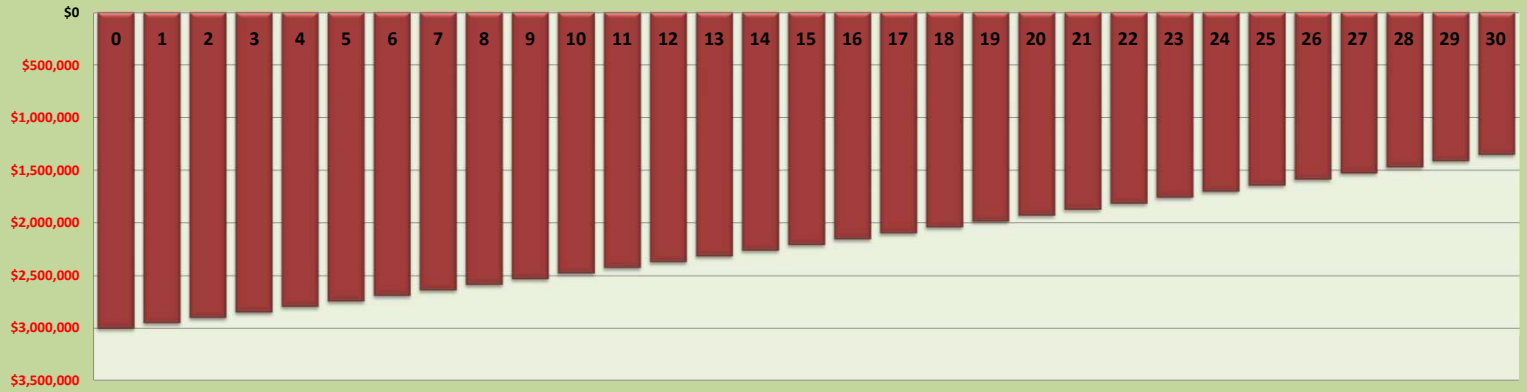
General Information

Project Name	TUS-250-2.223 Traffic Safety Study	Contact Email	David.Hoffman@dot.ohio.gov
Project Description	US 250 & SR 21 Intersection - Construct a Single Lane Roundabout	Contact Phone	330.308.3908
Reference Number		Date Performed	12/29/2023
Analyst	David A. Hoffman, P.E.	Analysis Year	2023
Agency/Company	ODOT District 11		

Project Costs Only Cash Flows By Countermeasure Per Year



Return on Investment (Safety Benefits and Project Investments)



First year to observe a positive return on investiment: 2054 (31 years)

Percentage of Service Life to observe a continuous Positive Return on Investment: 00.00%

APPENDIX K

2018 ProVia Window Plant Traffic Impact Study

TMS Engineers, Inc.

Traffic Impact Study

ProVia Window Plant
Strasburg, Ohio

June 25, 2018

Revised August 7, 2018

Prepared for:
George A. Fiedler & Associates
P.O. Box 146
Dover, Ohio 44622

TRAFFIC IMPACT STUDY

ProVia Window Plant
Strasburg, Ohio

June 25, 2018

Revised August 7, 2018

Prepared For:

George A. Fiedler & Associates
P.O. Box 146
Dover, Ohio 44622

Prepared By:

TMS Engineers, Inc.
2112 Case Parkway South
Unit #7
Twinsburg, Ohio 44087

REGISTERED ENGINEER NO. E56982
CERTIFICATION NO. 2234

"This document was prepared consistent with local agency requirements and/or applicable guidelines contained in this report."

Table of Contents

Appendices

List of Figures

List of Tables

Executive Summary

This traffic impact study has been prepared at the request of George A. Fiedler and Associates for a proposed ProVia Window Plant. The project site is located in Village of Strasburg, Franklin Township, Tuscarawas County, Ohio situated north of the intersection of State Route 21 and US Route 250.

The development is expected to consist of the following land uses:

ProVia Window Plant - 337,380 square feet

The development is proposed to have two access driveways, one on State Route 21 and one on US Route 250.

The development is expected to be constructed such that it will open in 2019. The year 2019 will be analyzed for the opening year conditions. The year 2039 will be analyzed as the design year for the twenty year conditions.

The weekday peak hours of traffic for the study area roadways was based on the traffic data collected for this report. The weekday AM peak hour of traffic was determined to be 7:00 AM to 8:00 AM on State Route 21 and US Route 250 at the site location. The weekday PM peak hour of traffic was found to be 4:00 PM to 5:00 PM. These periods were analyzed since they reflect the period of the highest volume of traffic flow for the study area roadways and the proposed development.

The proposed development is expected to generate the following hourly traffic volumes during the peak periods as shown in the table on the following page:

ITE TRIP GENERATION		SIZE	TRIP ENDS			
ITE Code	Description		AM Weekday Peak Hour (Enter/Exit)		PM Weekday Peak Hour (Enter/Exit)	
104	ProVia Window Plant	337,380 S.F.	173	67	102	136
TOTAL NEW TRIPS			**173**	**67**	**102**	**136**
			240		**238**	

Recommended Improvements to Serve Existing Conditions

No intersection improvements are recommended to accommodate the existing year 2018 traffic conditions at the study area intersections.

Recommended Improvements to Serve Future Conditions without the Development

The intersection of State Route 21 and US Route 250 / SR 21 was found to require signal control or modern roundabout improvements in order to provide an acceptable level of service to accommodate the Year 2019 No-Build traffic forecast. The improvements include the lengthening of the north bound left turn lane. These improvements were found to provide adequate capacity in the 2039 No-Build condition. However, its should be noted that the traffic volume forecast was predicated on a conservative 0.5% per year growth rate when in actuality traffic volumes were found to be decreasing in this area at a rate of about 1% per year. It is our opinion that this intersection should be studied on a periodic basis and that stop sign control remain in place until such time that a traffic signal or roundabout may be justified.

Recommended Improvements to Mitigate the Traffic Associated with the Development

The improvements recommended for the State Route 21 and US Route 250 / SR 21 intersection were

found to provide adequate capacity in the 2019 Build scenario. However, if signal control is becomes justified, an eastbound right turn lane would be necessary for the 2039 Build scenario.

Development Access Recommendations

The following lane use and traffic control are recommended to accommodate the 2019 and 2039 site generated (Build) traffic at the development access location along State Route 21 and US Route 250:

State Route 21 & ProVia Access Driveway

- Install stop sign control on the eastbound approach.
- Install a northbound left turn lane. The left turn lane was determined to require 235 feet of storage / deceleration and 50 feet of a diverging taper for total turn lane length of the 285 feet.

US Route 250 & ProVia Access Driveway

- Install stop sign control on the southbound approach.
- Install a eastbound left turn lane. The left turn lane was determined to require 295 feet of storage / deceleration and 50 feet of a diverging taper for total turn lane length of the 345 feet.

Conclusion

Based upon the results of the analysis in this study and the corresponding recommendations, it can be seen that the development traffic can be accommodated without adversely impacting the area roadway network.

Chapter 1
Introduction

1.1 Purpose of Report

This traffic impact study has been prepared at the request of George A. Fiedler and Associates for a proposed manufacturing development containing a ProVia Window Plant. The project site is located near the Village of Strasburg, Franklin Township, Tuscarawas County, Ohio situated north of the intersection of State Route 21 and US Route 250. **Figure 1.1, Page 2** shows the proposed location of the development.

The development is expected to consist of the following land uses:

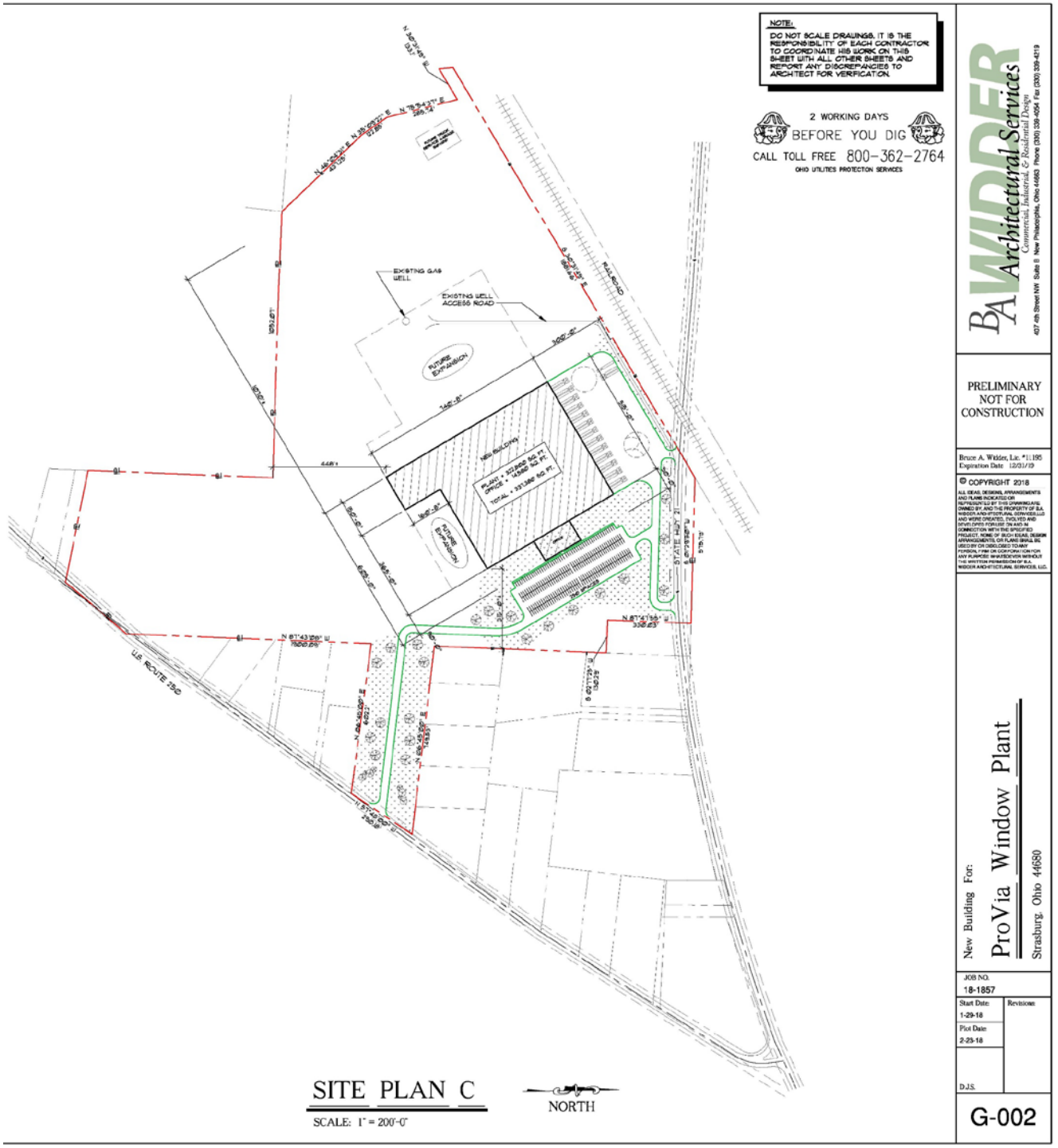
ProVia Window Plant - 337,380 square feet

Figure 1.2, Page 3 shows the proposed site plan for the development.

The development is proposed to have two access driveways, one on State Route 21 and one on US Route 250. A site plan illustrating the proposed location of the development access driveways can be seen in **Figure 1.2, Page 3**.

The development is expected to be open in 2019. The year 2019 will be analyzed for the opening year, full build conditions. The year 2039 will be analyzed as the design year for the twenty year conditions.


NOT TO SCALE
Development Site
Hensel St SW
Crestline St SW
Justus Ave SW
Smoketown
Mose St SW
93
Beach City
Johnsford Rd SW
Erie Ave SW
21
Dolphin St SW
Beach City Airport
250
CR-230 NW
Ridge Rd NW
Lake Rd NW
Kaylor Rd NW
Harwalk Rd NW
Sunset Blvd NW
State Route 93 NW
N Wooster Ave
Central Rd NW
Strasburg
Garber Dr NW
Yackey Dr NW
Dundee
516
Cherry Run Rd NW
78
87
74



SITE PLAN C

SCALE: 1" = 200'-0"

NORTH

1.2 Study Objectives

This study is structured for the following purposes;

- to adequately assess the traffic impacts associated with the proposed development and identify the level of off-site access and traffic,
- to provide a comprehensive study which evaluates and documents the traffic impacts and off-site improvements, where warranted,
- and to provide a technically sound basis to identify mitigation requirements to off-site traffic impacts.

This study documents the methodologies, findings and conclusions of the analysis, including the basis for all assumptions, traffic parameters utilized and conclusions reached.

The traffic impacts will be determined by comparing the existing intersection levels-of-service before the development of the proposed development to the anticipated levels-of-service after the development is completed. Levels-of-service for the study area and access driveway will be calculated using the computerized version of the Transportation Research Board's **Highway Capacity Manual 6TH Edition, HCM6E (HCS7, Release 7.5)**.

The justification for any changes in the intersections will be determined by comparing data collected of the existing traffic conditions to the criteria established by the **Ohio Manual of Uniform Traffic Control Devices** and professional engineering judgment from an on-site field review.

Intersection geometric design guidelines will be based in the information and procedures found in the Ohio Department of Transportation's **Location & Design Manual, Volume 1**.

Chapter 2
Area Conditions

2.1 Transportation Network Study Area

The Ohio Department of Transportation functionally classifies roadways to help define a roadway's characteristics as well as identify roadways that are eligible for federal funds. Functional classification is the grouping of roads, streets, and highways in a hierarchy based on the type of highway service they provide. Generally, streets and highways perform two types of service. They provide either traffic mobility or land access and can be ranked in terms of the proportion of service they provide. The ODOT functional classification of the roadways in the study area can be seen on ODOT's website.

The functional classification as determined by ODOT will be used in this report to apply growth and design hour factors to the study area roadways for use in forecasting the future traffic volumes in the study area. These factors are determined using data, guidelines, and methodology supplied by ODOT. These methods and the corresponding data are based on the roadways assigned functional classification. The ODOT methods for forecasting future traffic volumes are a recognized traffic engineering standard.

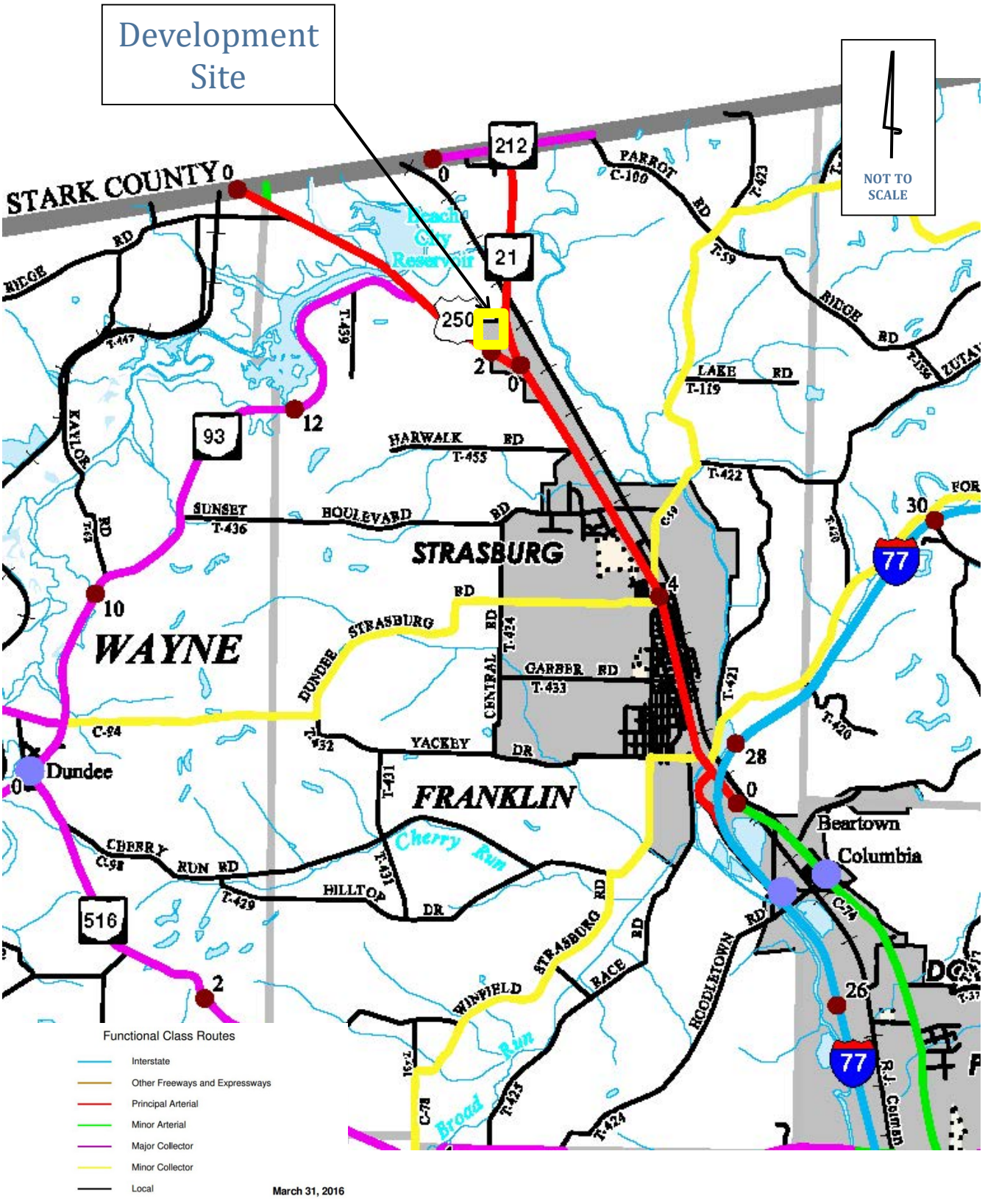
The following table lists the study area roadways that have an assigned functional classification as determined by ODOT and local government entities. Roadways that are not listed as having a functional classification can be assigned into one of two categories. The first category is a local roadway and the second category is that of an access drive.

Table 2.1 Functional Classification

ROADWAY	AREA	FC #	CLASSIFICATION
State Route 21	Urban	3	Principle Arterial
US Route 250	Urban	3	Principle Arterial

Figure 2.1, Page 7 details the section of the functional classification map for the study area. The classification map for Tuscarawas County can currently be found online at the following ODOT web address:

http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/MajorPrograms/MapRoom/Forms/AllItems.aspx


Development Site
NOT TO SCALE
STARK COUNTY
212
21
250
93
516
77
STRASBURG
WAYNE
FRANKLIN
Dundee
Beartown
Columbia
Cherry Run
Broad Run
SUNSET BOULEVARD RD
HARWALK RD
GARBER RD
YACKEY DR
HILLTOP DR
CHERRY RUN RD
WINFIELD RD
STRASBURG RD
RACE RD
HOOBLETOWN RD
RIDGE RD
LAKE RD
PARROT RD
Functional Class Routes
Interstate
Other Freeways and Expressways
Principal Arterial
Minor Arterial
Major Collector
Minor Collector
Local
March 31, 2016

The following table details the primary characteristics of the study area roadways:

Table 2.2 Roadway Characteristics

ROADWAY	# OF LANES	ORIENTATION	SPEED LIMIT (MPH)	ADT* (VPD)
State Route 21	2	North-South	50	23,200
US Route 250 / SR 21	2	East-West	50	19,800

*** 2018 Collected Traffic Data/Rounded to nearest 10TH**

The following section details the lane use and traffic control at the locations under study for this report.

State Route 21 & US Route 250 / SR 21

State Route 21 North Approach
- 1 Exclusive Through Lane
- 1 Exclusive Right Turn Lane

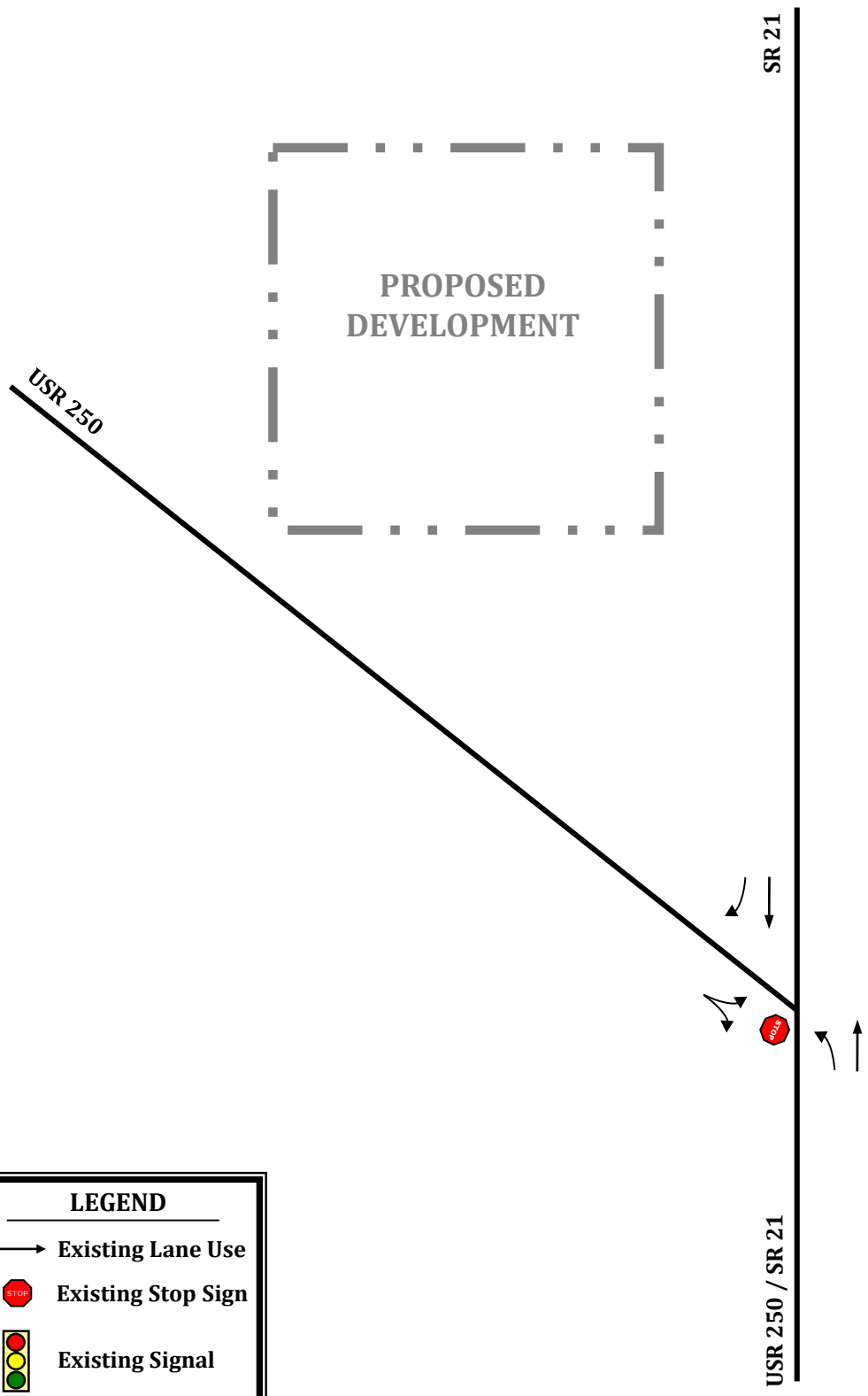
State Route 21 South Approach
- 1 Exclusive Left Turn Lane
- 1 Exclusive Through Lane

US Route 250 West Approach
- 1 Shared Left & Right Turn Lane

The intersection is controlled by a stop on the eastbound approach.

Figure 2.2, Page 9 shows an aerial view of the study area. **Figure 2.3, Page 10** shows the existing lane use and traffic control conditions in the study area. These will be considered the existing base conditions for this report.


NOT TO SCALE
SR 21
Beach City Lake
USR 250
DEVELOPMENT SITE
STOP
USR 250 / SR 21


NOT TO SCALE
SR 21
PROPOSED DEVELOPMENT
USR 250
STOP
USR 250 / SR 21
LEGEND
Existing Lane Use
STOP
Existing Stop Sign
Existing Signal

2.2 Traffic

Weekday turning movement counts were performed at the following locations:

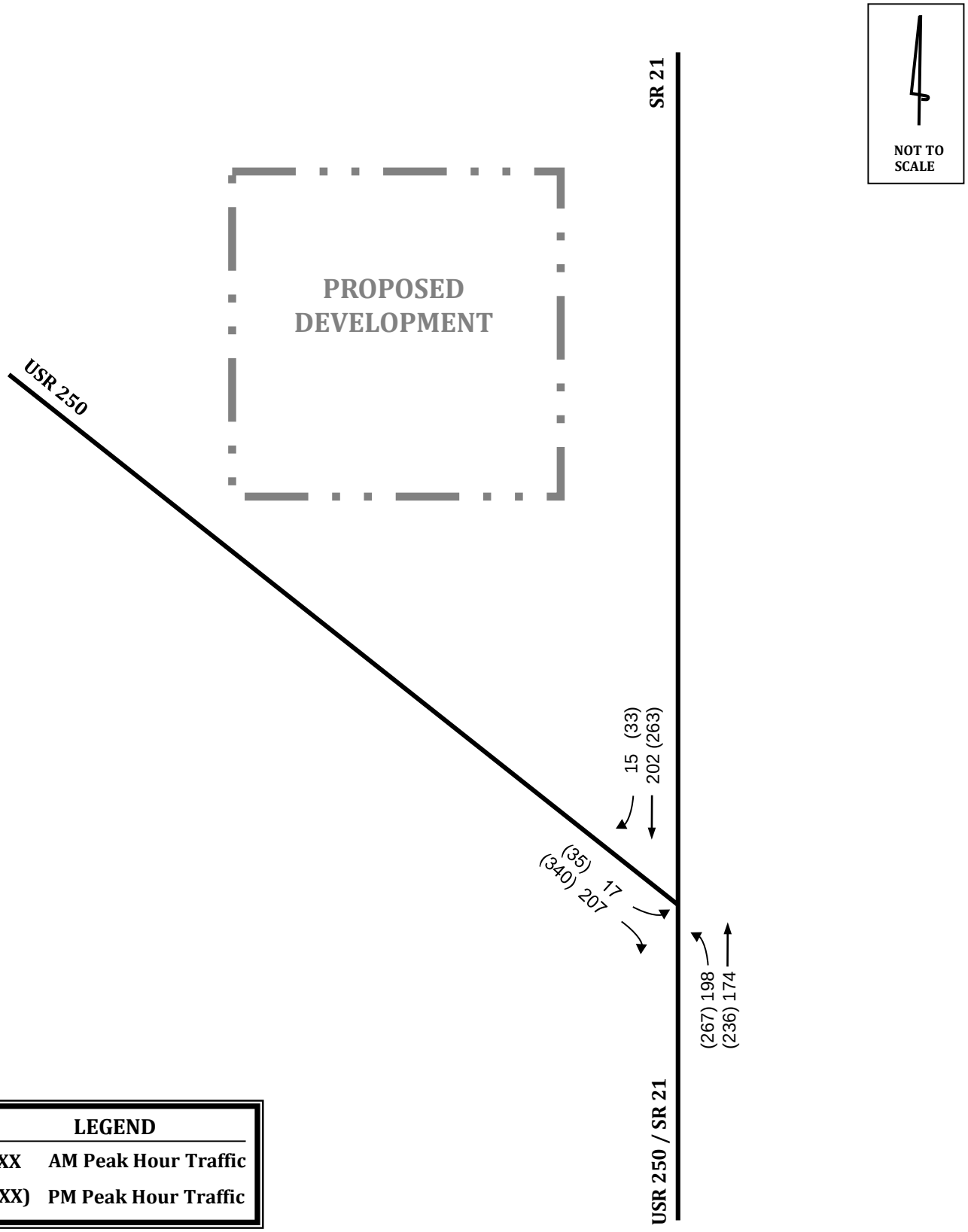
1. State Route 21 & US Route 250 / SR 21

The traffic count was performed on Tuesday, May 18, 2018. The weekday traffic count was conducted in fifteen (15) minute intervals between the hours of 7 AM - 10 AM, 11 AM - 1 PM, and 4 PM - 7 PM, then hourly totals were calculated. Cars, trucks, buses, pedestrians and bicyclists were recorded during these time periods. Copies of the intersection turn movement counts are included in **Appendix A**.

Average daily traffic was calculated for the roadways using expansion factors to account for daily and seasonal variations according to the recommendations and latest data from the Ohio Department of Transportation.

Based on the collected traffic data, the weekday AM peak hour of traffic was determined to be 7:00 AM to 8:00 AM at the intersection of State Route 21 and US Route 250. The weekday PM peak hour of traffic at that location was found to be 4:00 PM to 5:00 PM. These periods will be analyzed since they reflect the period of the highest volume of traffic flow for the study area roadways and the proposed development.

The existing AM and PM peak hour traffic volumes are shown in **Figure 2.4, Page 12**.


NOT TO SCALE
SR 21
PROPOSED DEVELOPMENT
USR 250
15 (33)
202 (263)
(35) 17
(340) 207
(267) 198
(236) 174
USR 250 / SR 21
LEGEND
XX AM Peak Hour Traffic
(XX) PM Peak Hour Traffic

Chapter 3
Projected Traffic Conditions

3.1 Site Traffic

Trip Generation

Calculating future total driveway trips requires an estimate of the traffic generated by the proposed development. The most widely accepted method of determining the amount of traffic that the proposed development will generate is to compare the proposed land use with existing facilities of the same use. The Institute of Transportation Engineers (ITE) has prepared a manual titled "**Trip Generation Manual**", which is a compilation of similar traffic generation studies to aide in making such a comparison. The most recent update of this manual is the 10TH edition and was utilized for this study.

The following table details the development land use from the site plan (**Figure 1.2**) and the corresponding ITE land use that will be used to forecast the site generated traffic volumes for the Build conditions:

Table 3.1 ITE Land Use Codes

SITE PLAN DESCRIPTION	SIZE	LAND USE	ITE CODE	ITE DESCRIPTION
ProVia Window Plant	337,380 sf	Industrial	104	Manufacturing

Primary Trips

The following table detail the development generated traffic volumes based on the previously described methods as outlined in the (ITE) **Trip Generation Handbook**. Copies of the trip generation worksheets can be seen in **Appendix B**.

Table 3.2 Net Trip Generation

ITE TRIP GENERATION		SIZE	TRIP ENDS			
ITE Code	Description		AM Weekday Peak Hour (Enter/Exit)		PM Weekday Peak Hour (Enter/Exit)	
104	ProVia Window Plant	337,380 S.F.	173	67	102	136
TOTAL NEW TRIPS			**173**	**67**	**102**	**136**
			240		**238**	

Distribution of Generated Traffic

The directional distribution for the new generated traffic is a function of the prevailing operating conditions on the existing roadways. The distribution pattern that was assumed is shown in the tables that follow and is based upon the existing traffic volumes on in the study area during the peak hours shown in **Figure 2.4**.

The following tables detail the distribution of the new and pass-by generated trips for the proposed development.

Table 3.3 AM New Trip Origins and Destinations

ORIGIN/ DESTINATION	ROUTE	FROM (ENTER)	% TOTAL	NEW TRIPS	TO (EXIT)	% TOTAL	NEW TRIPS
North	SR 21	217	27%	46	191	24%	16
South	SR 21 / USR 250	372	46%	79	409	50%	33
West	USR 250	224	27%	47	213	26%	18
	TOTALS	**813**	**100%**	**173**	**813**	**100%**	**67**

Table 3.4 PM New Trip Origins and Destinations

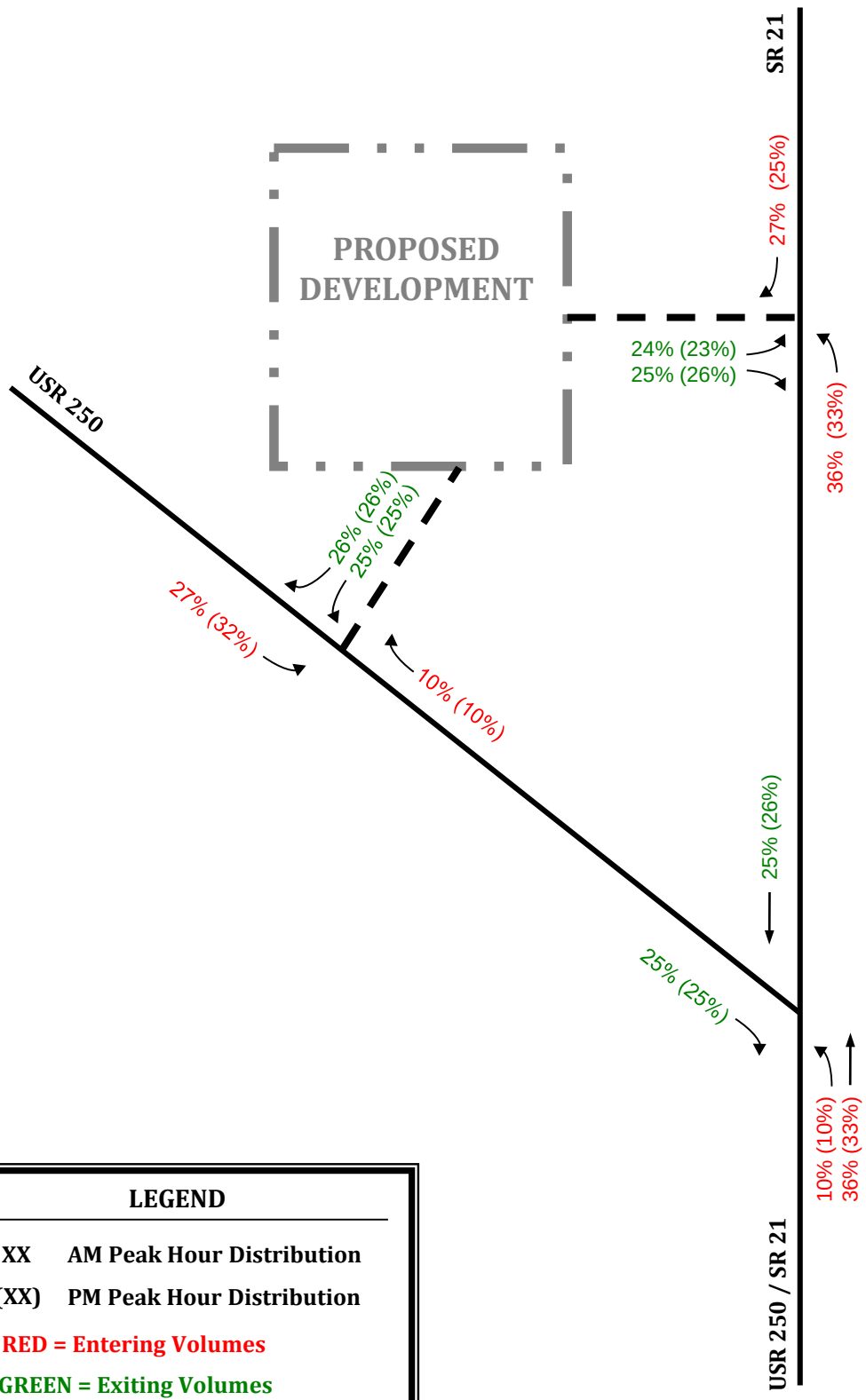
ORIGIN/ DESTINATION	ROUTE	FROM (ENTER)	% TOTAL	NEW TRIPS	TO (EXIT)	% TOTAL	NEW TRIPS
North	SR 21	296	25%	26	271	23%	31
South	SR 21 / USR 250	503	43%	43	603	51%	70
West	USR 250	375	32%	33	300	26%	35
	TOTALS	**1174**	**100%**	**102**	**1174**	**100%**	**136**

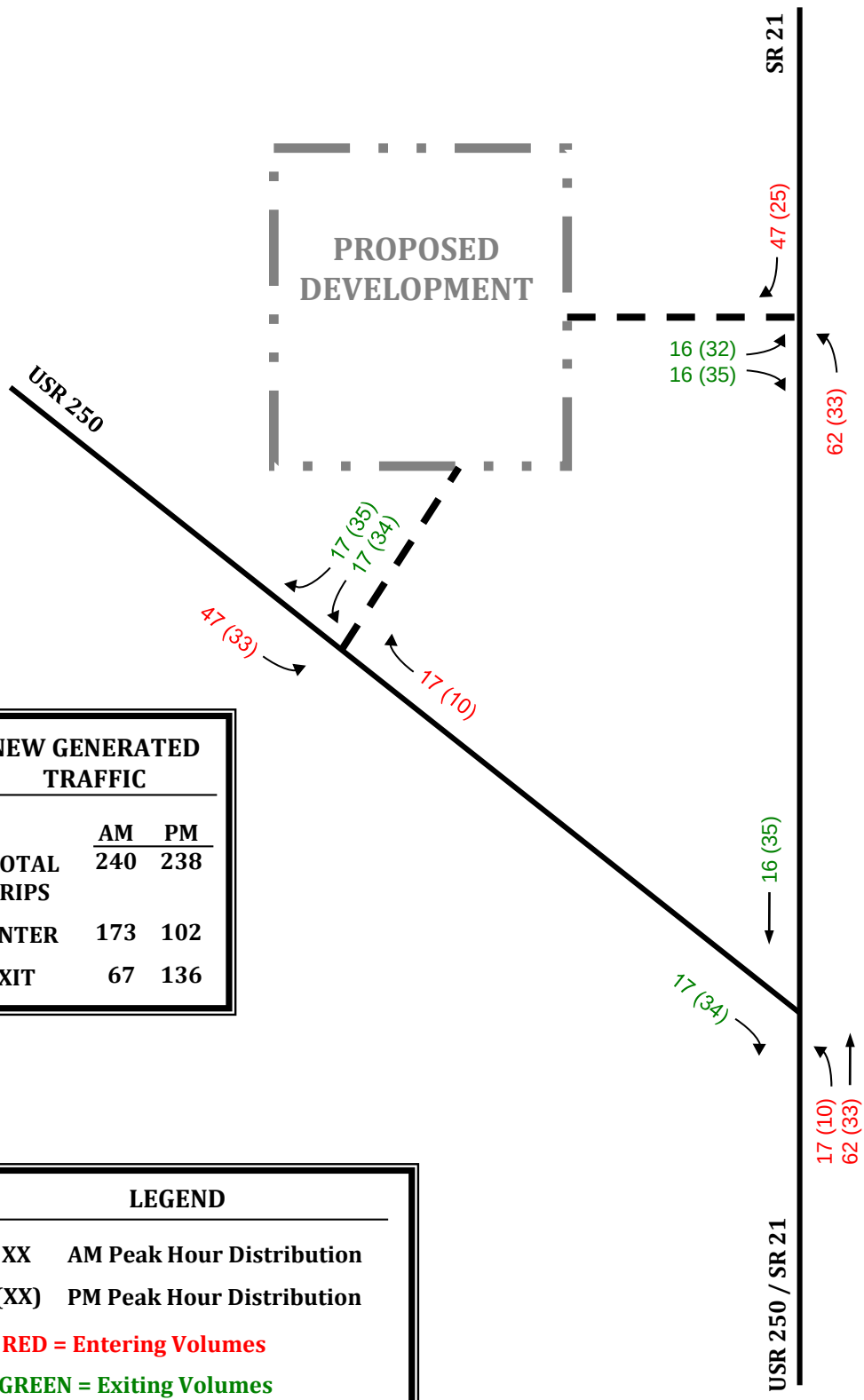
The directional distribution for the new peak hour generated traffic is shown graphically in **Figure 3.1, Page 17**.

Assignment of Generated Traffic

Based upon the distribution patterns shown in **Figure 3.1**, the new AM and PM peak generated traffic were assigned to the study intersections.

The assignments of the estimated new generated traffic for the proposed development are shown graphically in **Figure 3.2, Page 18.**


NOT TO SCALE
SR 21
PROPOSED DEVELOPMENT
27% (25%)
24% (23%)
25% (26%)
36% (33%)
USR 250
26% (26%)
25% (25%)
27% (32%)
10% (10%)
25% (26%)
25% (25%)
10% (10%)
36% (33%)
USR 250 / SR 21
LEGEND
XX AM Peak Hour Distribution
(XX) PM Peak Hour Distribution
RED = Entering Volumes
GREEN = Exiting Volumes



NEW GENERATED TRAFFIC

	AM	PM
TOTAL TRIPS	240	238
ENTER	173	102
EXIT	67	136

LEGEND

XX AM Peak Hour Distribution

(XX) PM Peak Hour Distribution

RED = Entering Volumes

GREEN = Exiting Volumes

3.2 Non-Site Traffic

Background Traffic Growth

Design of new roadways or improvements to existing roadways should not usually be based on current traffic volumes alone, but should consider future traffic volumes expected to make use of the facilities. Roadways should be designed to accommodate the traffic volume that is likely to occur within the design life of the facility. In a practical sense, this design volume should be a value that can be estimated with reasonable accuracy. It is believed that the maximum design period is in the range of 15 to 24 years. Therefore, a period of twenty years is widely used as a basis for design. Traffic cannot usually be forecasted accurately beyond this period on a specific facility because of probable changes in the general regional economy, population, and land development along the roadway. The ODOT **Access Management Manual** requires that opening year and twenty year design hour traffic volumes be analyzed for a proposed development.

Roadways, like those found in the study area, carry a significant amount of through traffic due to their functional characteristics. This through traffic component generally increases as regional growth occurs. Therefore, it is anticipated that existing traffic on the study area roadways will increase in future years.

Any recommended improvements for these intersections should adequately handle the transportation needs of the intersections for twenty years from the opening of the project based upon sound engineering practice and the likelihood of traffic growth due to the functional characteristics of the roadways.

The years 2019 and 2039 will be analyzed for the proposed industrial development. Therefore, it is necessary to estimate historical growth rates in order to establish the future traffic on the study area roadways due to non-site related conditions.

The ODOT Traffic Monitoring Management System (TMMS) was consulted to determine past historical trends on the study area roadways. The ODOT Traffic Monitoring Management System (TMMS) can be currently accessed at the following web address:

http://www.dot.state.oh.us/Divisions/Planning/TechServ/traffic/Pages/TMMS.aspx

The TMMS provided data at the following locations that were used to determine the study area growth rates:

1. State Route 21 - North of US Route 250 / SR 21 NW (Location ID 1579)
2. US Route 250 SE of SR 93 - NW of Strasburg (Location ID 779)

Based on the historical traffic data from the ODOT data, a decreasing trend was found. Traffic volumes have decreased at a rate of approximately 1% per year since 2000. There was no data available before 2000. It was our opinion that a linear growth rate of 0.5% per year should be applied for this study in order to provide a conservative estimate of future traffic flows. A copy of the growth rate data can be seen in **Appendix C**.

A linear growth rate was utilized to estimate non-site related traffic growth. These growth rates will be applied to the existing traffic volumes (**Figure 2.4**). The growth rate and factors for the study area roadways can be seen in the following table:

Table 3.5 - Growth Rates & Factors

ROADWAY	GROWTH RATE (Annual Growth)	2019 GROWTH FACTOR	2039 GROWTH FACTOR
State Route 21	0.5%	1.05	1.105
US Route 250 / SR 21	0.5%	1.05	1.105

Design Hour Traffic

The traffic patterns on any roadway typically show considerable variation in the traffic volumes experienced during the various hours of the day and in the hourly volumes experienced throughout the year. A key decision in the design process involves determining which of these hourly traffic volumes should be used as the basis for the design. It would be wasteful to predicate a design on the maximum peak hour traffic that occurs during the year and the use of the average hourly traffic would result in an inadequate design. The hourly traffic volumes used in a design should not be exceeded very often or by very much. On the other side of the spectrum, the hourly traffic volumes should not be so high that traffic would rarely be sufficient to make full use of the designed facility. Normal design policy in the State of Ohio is based upon a review of curves that depict the variation in hourly traffic volumes during the year. The Ohio Department of Transportation recommends using the 30^{TH} highest hour as a design control for urban streets. There is typically very little difference between the volumes in this range. The Ohio Department of Transportation provides factors or a methodology to determine factors that are applied to counted daily traffic volumes to determine appropriate design hour traffic volumes.

Following guidelines set forth in the **ODOT Access Management Manual**, all analyses are required to examine the design hour volume for the adjacent roadway and peak hour traffic volume of the proposed development.

The ODOT **Certified Traffic Manual** provides the methods for estimating design hour volumes. The preferred method is to compute the ratio of the peak hour volume against the daily traffic volume for the study area roadways. A K-factor is then selected from available ODOT data for routes with the same functional classification and a similar ADT. The selected K-factor is then divided by the ratio to determine the DHV factor that will be used to compute the design hour volumes.

The K-factors were determined using the ODOT 2016 K & D Report. The 2016 report can currently be found at the following web address:

http://www.dot.state.oh.us/Divisions/Planning/TechServ/traffic/Pages/KnDFctrs.aspx

For roadways without comparable site-specific data, the design hour factor is determined using the ODOT Peak Hour to Design Hour charts. These charts are based on the functional classification of the roadway, the day of the week and the month that the traffic data was collected.

For roadways classified as urban principal arterials, Site 630 from the 2016 ODOT K & D Report was chosen as a route with a similar functional classification (U3) and ADT to make a comparison between the previously calculated ratio and K-factor for study area roadways. Site 630 was reported to have a K-factor of 10.64%.

The following table details the calculation of the design hour factor for the sections of State Route 21 and USR 250 under study:

Table 3.6 - DHV Factor Calculations

LOCATION	PEAK HOUR VOLUME	ADT	RATIO	K-FACTOR	DHV FACTOR*
SR 21	799	9,102	0.0878	0.1064	1.21
USR 250	375	3,757	0.0998	0.1064	1.07

*** - If the resultant value is less than 1.00, the peak hour volumes should be used as the design hour volumes making the DHV factor 1.00.**

3.3 Future Traffic

No-Build Condition

In order to estimate the future traffic considering non-project traffic conditions, the previously discussed calculation of design hour factors and growth rates for each movement were applied to the existing 2018 traffic volumes shown in **Figure 2.4**.

The estimated 2019 and 2039 No-Build traffic volumes for the study area are shown graphically in **Figures 3.3 and 3.4, Pages 24 and 25**. This traffic is the expected traffic if the proposed development **is not** constructed, the **"No-Build"** condition.

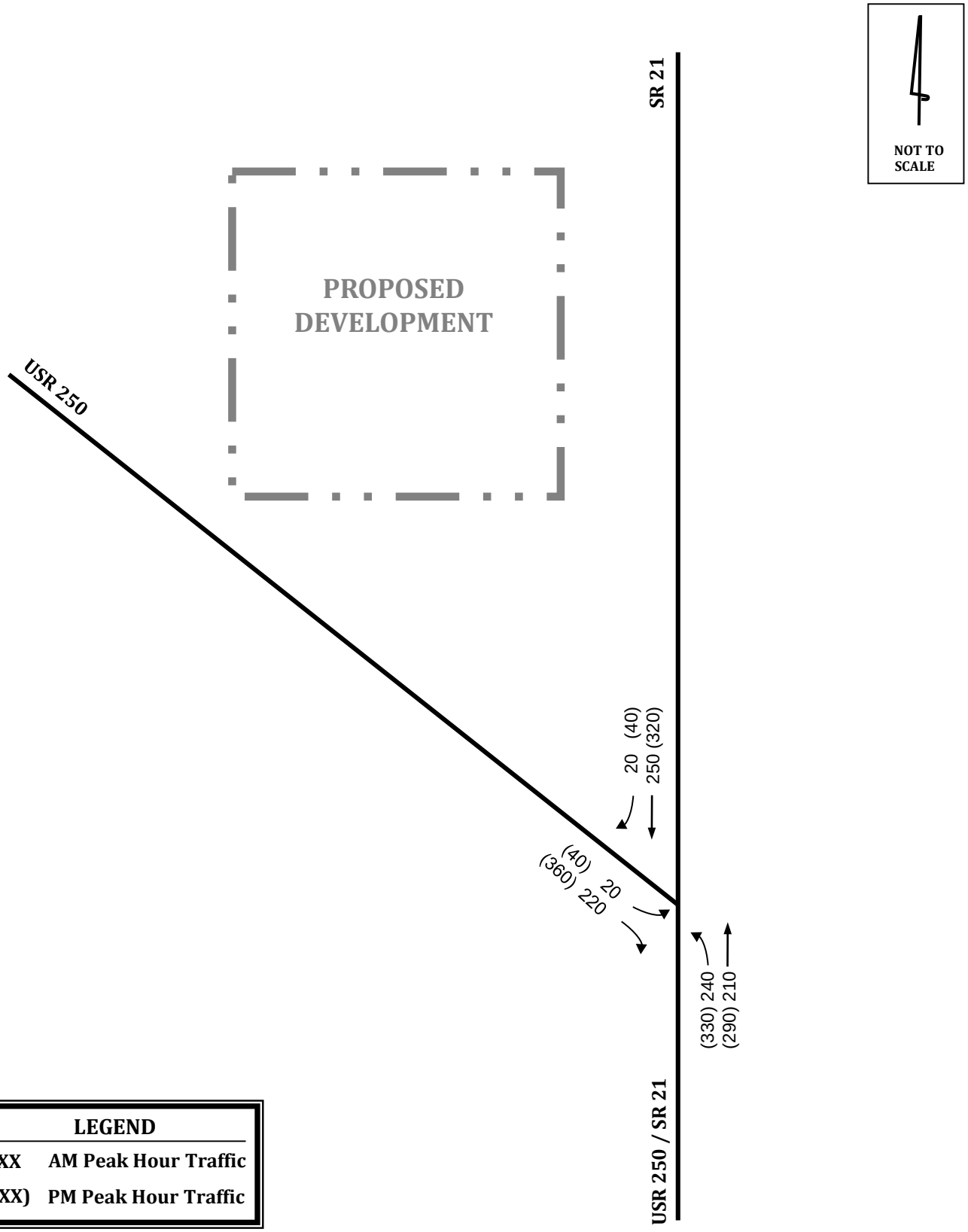
The No-Build traffic volumes have been rounded to the nearest 10 to adhere to preferred ODOT practices.

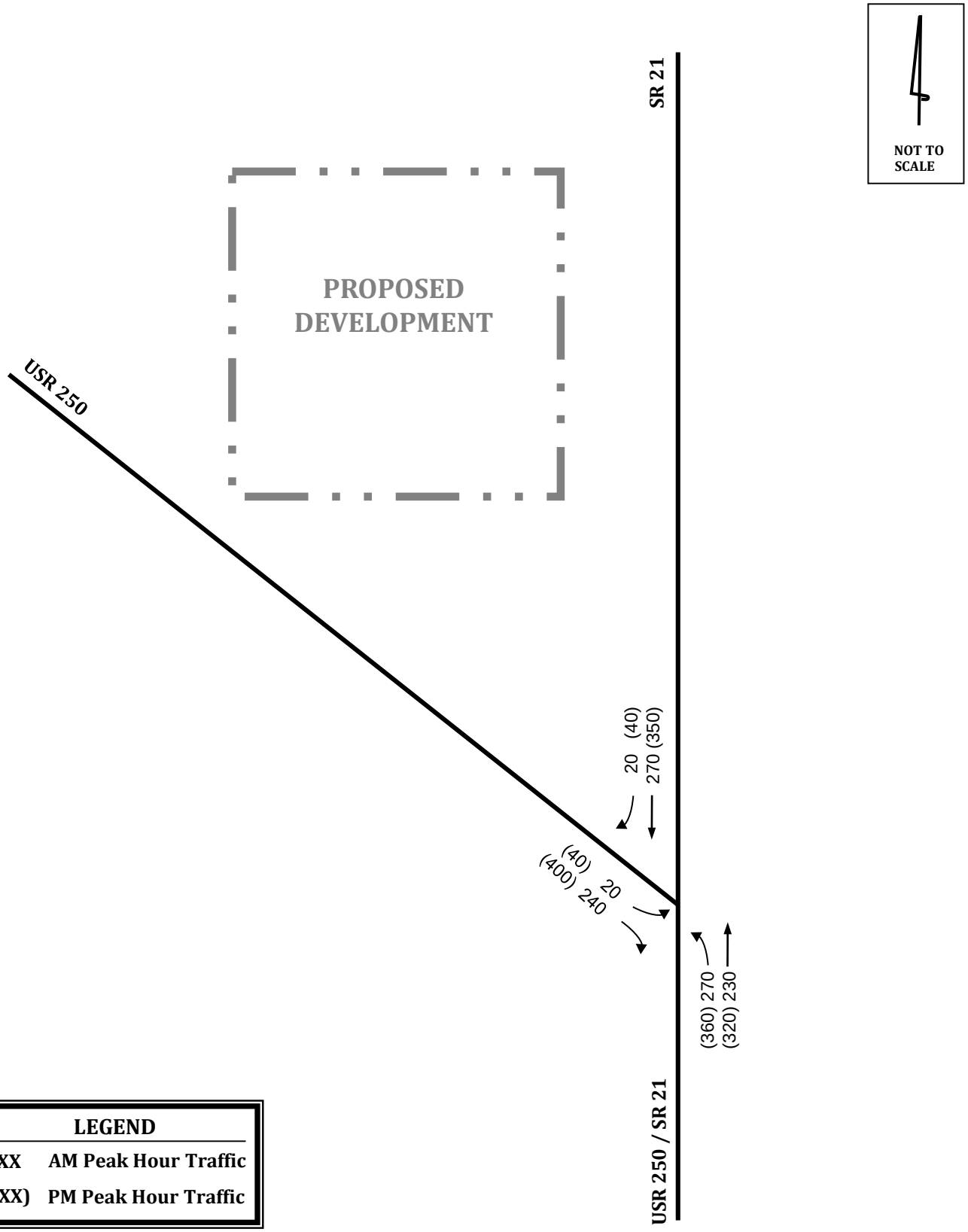
Build Condition

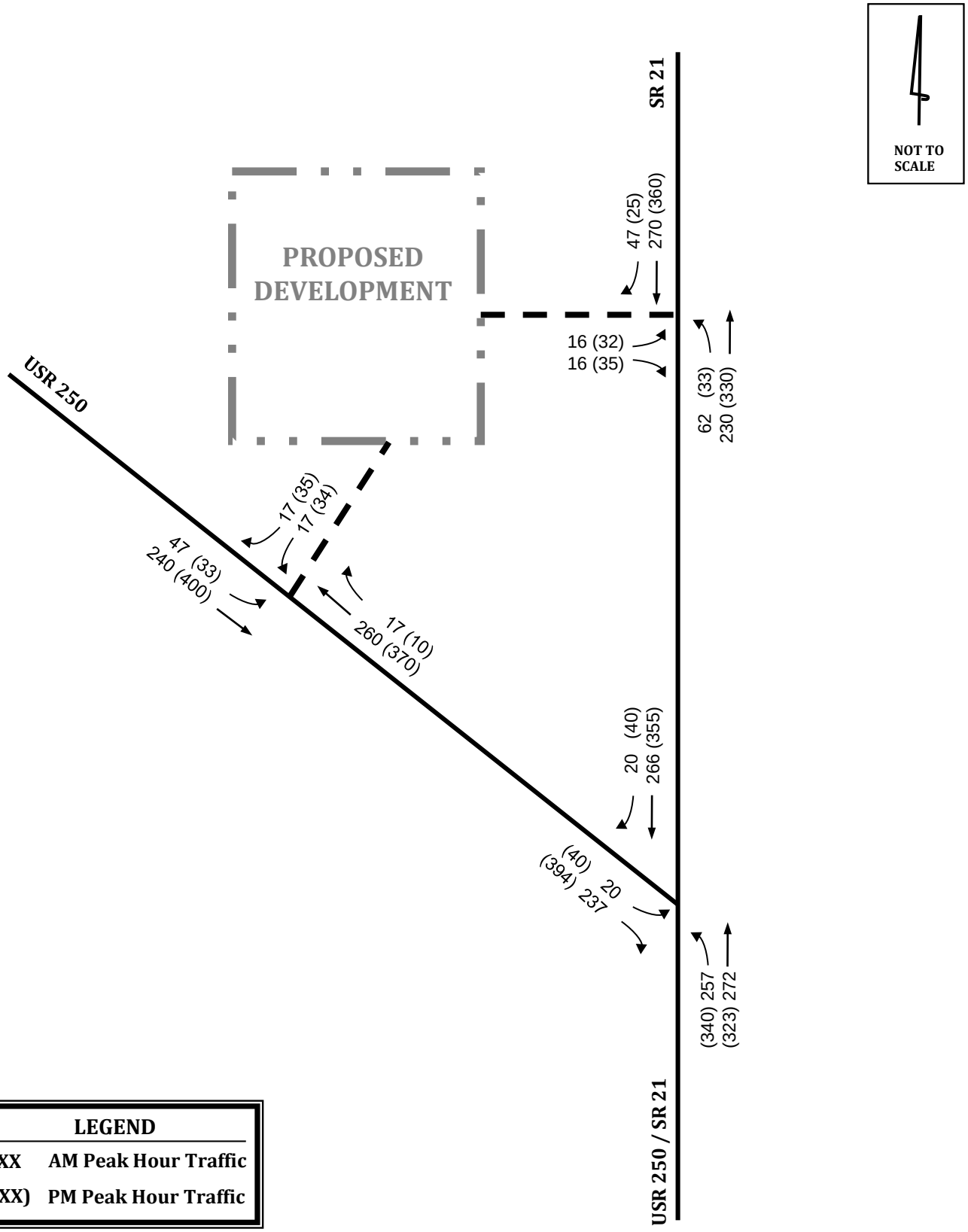
In order to estimate the future traffic considering project traffic conditions, the sum of the 2019 and 2039 No-Build volumes, shown in **Figures 3.3 and 3.4, Pages 24 and 25**, were added to the new generated traffic (**Figure 3.2**) to equal the future Build peak hour volumes.

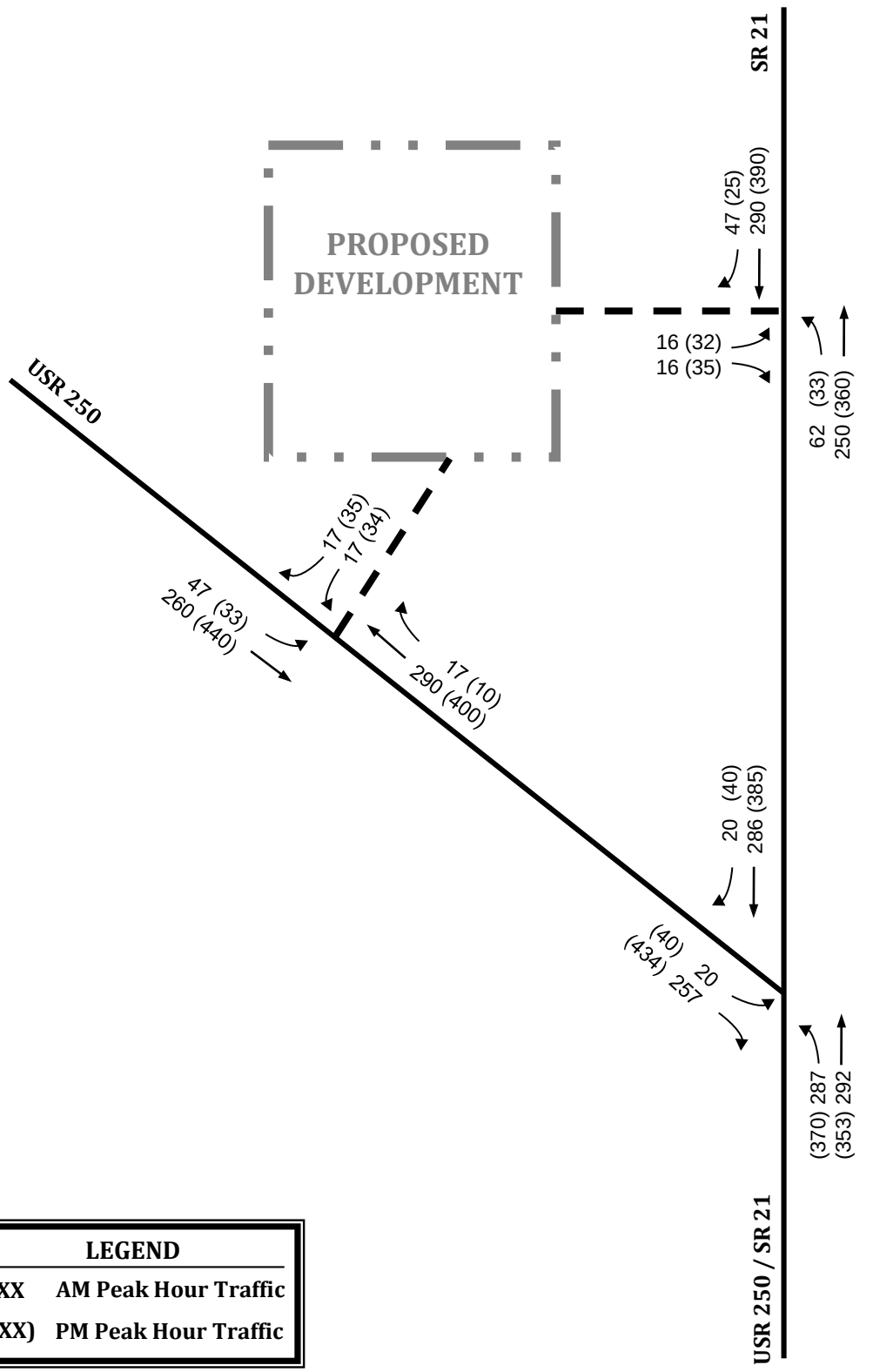
The estimated 2019 and 2039 Build traffic volumes for the study area are shown graphically in **Figures 3.5 and 3.6, Pages 26 and 27** for the proposed development. These traffic volumes are the expected volumes if the proposed development **is** constructed, or the **"Build"** condition.

It should be noted that all turn movements that were determined to be less than 10 vehicles have been rounded up to 10 vehicles to be able to provide an analysis of all movements at the intersection.


NOT TO SCALE
SR 21
PROPOSED DEVELOPMENT
USR 250
20 (40)
250 (320)
(40) 20
(360) 220
(330) 240
(290) 210
USR 250 / SR 21
LEGEND
XX AM Peak Hour Traffic
(XX) PM Peak Hour Traffic


NOT TO SCALE
SR 21
PROPOSED DEVELOPMENT
USR 250
20 (40)
270 (350)
(40) 20
(400) 240
(360) 270
(320) 230
USR 250 / SR 21
LEGEND
XX AM Peak Hour Traffic
(XX) PM Peak Hour Traffic


NOT TO SCALE
SR 21
PROPOSED DEVELOPMENT
47 (25)
270 (360)
16 (32)
16 (35)
62 (33)
230 (330)
USR 250
17 (35)
17 (34)
47 (33)
240 (400)
17 (10)
260 (370)
20 (40)
266 (355)
(40) 20
(394) 237
(340) 257
(323) 272
USR 250 / SR 21
LEGEND
XX AM Peak Hour Traffic
(XX) PM Peak Hour Traffic


NOT TO SCALE
SR 21
PROPOSED DEVELOPMENT
47 (25)
290 (390)
16 (32)
16 (35)
62 (33)
250 (360)
USR 250
17 (35)
17 (34)
47 (33)
260 (440)
17 (10)
290 (400)
20 (40)
286 (385)
(40) 20
(434) 257
(370) 287
(353) 292
USR 250 / SR 21
LEGEND
XX AM Peak Hour Traffic
(XX) PM Peak Hour Traffic

Chapter 4
Traffic Analysis

4.1 Capacity and LOS at Study Area Intersections

Intersection capacity analyses were performed at the study intersections using the computerized version of the Transportation Research Board's **Highway Capacity Manual 6TH Edition, HCM6E (HCS7, Release 7.5)**. The capacity analyses were performed in order to estimate the maximum amount of traffic that can be accommodated by a roadway facility while maintaining recommended operational qualities. Existing, No Build, and Build peak hour traffic volumes were analyzed to determine the level-of-service (LOS) at the study area intersections.

The capacity analysis procedures provide a calculated "average vehicle delay", which is based on traffic volumes, number of lanes, type of traffic control, channelization, grade, and percentage of large vehicles in the traffic stream at each intersection. The average delay calculated at an intersection is then assigned a "grade" or level of service (LOS) ranging from LOS A, the best, to LOS F, the worst based upon driver expectation. The intersection LOS "grades" as defined by the Transportation Research Board are as follows:

Table 4.1 Intersection LOS

LOS	UNSIGNALIZED AVERAGE DELAY PER VEHICLE (sec)	SIGNALIZED AVERAGE DELAY PER VEHICLE (sec)
A	≤ 10.0	≤ 10.0
B	10.1 to 15.0	10.1 to 20.0
C	15.1 to 25.0	20.1 to 35.0
D	25.1 to 35.0	35.1 to 55.0
E	35.1 to 50.0	55.1 to 80.0
F	> 50	> 80

The capacity analysis procedures and the resulting level of service grades and delays are a recognized traffic engineering standard for measuring the efficiency of intersection operations by such organizations as the Institute of Transportation Engineers, American Association of State Highway and Transportation Officials, and the Ohio Department of Transportation.

Existing Conditions - 2018 Capacity Analysis

Analyses were performed for the existing 2018 conditions. The traffic volumes used in the analyses can be seen in **Figure 2.4**. Copies of the capacity worksheets are included in **Appendix D.** The results of the Year 2018 Existing Conditions analyses are shown in the following tables:

Table 4.2 - 2018 Levels-of-Service (Existing Conditions)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & USR 250 / SR 21	Stop Sign	Eastbound	B (13.2)	D (28.9)
		Northbound Left	A (8.4)	A (9.0)

(XX.X) = Average vehicle delay in seconds per vehicle

The capacity of the critical movements at the stop controlled intersection of State Route 21 and US Route 250 / SR 21 was found to be at an acceptable level-of-service D or better during the AM and PM peak hours.

No-Build Conditions - 2019 Capacity Analysis

Analyses were performed for the projected 2019 opening day conditions under the No-Build scenario. These analyses will be used to compare to the conditions expected under the Build scenario. The traffic volumes used in the analyses can be seen in **Figure 3.3**. Copies of the capacity worksheets are included in **Appendix E.** The results of the Year 2019 No-Build analyses are shown in the following table:

Table 4.3 - 2019 Levels-of-Service
(No Build Conditions)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & USR 250 / SR 21	Stop Sign	Eastbound	C (15.7)	F (81.0)
		Northbound Left	A (8.8)	A (9.6)

(XX.X) = Average vehicle delay in seconds per vehicle

The capacity of the critical movements at the stop controlled intersection of State Route 21 and US Route 250 / SR 21 was calculated to be at a level-of-service F during the PM peak hour under the 2019 No-Build conditions.

In order to determine what mitigation would be necessary to improve the level-of-service of the eastbound approach at the intersection of State Route 21 and US Route 250, the following improvements were tested with further capacity analyses:

- Construct signal control.
- Construct modern roundabout.

The traffic volumes used in the analyses can be seen in **Figure 3.3**. Copies of the capacity worksheets are included in **Appendix F.** The results of the capacity analyses with the improvement are shown in the tables on the following page:

Table 4.4 - 2019 Levels-of-Service
(Intersection Improvement - Signal Control)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & USR 250 / SR 21	Traffic Signal	Intersection	B (19.2)	C (32.3)
		Eastbound	C (23.3)	D (37.5)
		Northbound	B (14.9)	C (26.7)
		Southbound	C (22.7)	D (36.3)

(XX.X) = Average vehicle delay in seconds per vehicle

Table 4.5 - 2019 Levels-of-Service
(Intersection Improvement - Roundabout Control)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & USR 250 / SR 21	Traffic Signal	Intersection	A (7.6)	B (11.6)
		Eastbound	A (7.5)	B (12.8)
		Northbound	A (7.6)	B (11.0)
		Southbound	A (7.6)	B (11.3)

(XX.X) = Average vehicle delay in seconds per vehicle

The capacity of the signalized intersection of State Route 21 and US Route 250 / SR 21 was found to be at an acceptable level-of-service D or better during the AM and PM peak hours. However, the storage length for the northbound left turn was found to be inadequate under signal control in the PM peak period. The turn lane will need to be extended to provide 260 feet of storage. The capacity of a roundabout at this intersection was found to be at an acceptable level of service B or better in both the AM and PM peak hours.

Traffic signal warrants were reviewed to determine if traffic signal control could be viable option to improve the levels of service. A signal warrant analysis was performed for the 2018 existing conditions.

The **Traffic Engineering Manual** from the Ohio Department of Transportation recommends a determination of how much, if any, right turn volume from the minor street should be reduced to account for right turns on red when evaluating a signal warrant . A copy of our analysis is provided in **Appendix G**. The analysis concludes that 60% of the right turn volume should be subtracted. Based upon the evaluation of the warrants established by the **Ohio Manual of Uniform Traffic Control Devices**, we conclude that a traffic signal is currently justified at the intersection of State Route 21 and the US Route 250 as required by the **Ohio Revised Code** based upon the existing 2018 conditions. Therefore, traffic signal control can be considered as a viable alternative to improve future forecasted conditions. Copies of the traffic signal warrant analysis worksheets can be found in **Appendix G**.

No-Build Conditions - 2039 Capacity Analysis

Analyses were performed for the projected 2039 design year conditions under the No-Build scenario. These analyses will be used to compare to the conditions expected under the Build scenario. The traffic volumes used in the analyses can be seen in **Figure 3.4**. Copies of the capacity worksheets are included in **Appendix H.** The results of the Year 2039 No-Build analyses are shown in the following table:

Table 4.6 - 2039 Levels-of-Service
(No Build Conditions)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & USR 250 / SR 21	Stop Sign	Eastbound	C (17.8)	F (157.1)
		Northbound Left	A (9.0)	B (10.1)

(XX.X) = Average vehicle delay in seconds per vehicle

The capacity of the critical movements of the un-signalized intersection of State Route 21 and US Route 250 / SR 21 was calculated to remain at a level-of-service F during the PM peak hour under the 2039 No-Build conditions with increased delay from the 2019 No-Build conditions.

In order to determine if the mitigation from the 2019 No-Build condition recommendation would still be valid to improve the level-of-service of the eastbound approach at the intersection of State Route 21 and US Route 250, the improvements were tested again with further capacity analyses for the following:

- Construct signal control.
- Construct modern roundabout.

The traffic volumes used in the analyses can be seen in **Figure 3.4**. Copies of the capacity worksheets are included in **Appendix I.** The results of the capacity analyses with the improvement are shown in the tables on the following page:

Table 4.7 - 2039 Levels-of-Service
(Intersection Improvement - Signal Control)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & USR 250 / SR 21	Traffic Signal	Intersection	C (21.0)	D (42.7)
		Eastbound	C (24.1)	D (51.0)
		Northbound	B (17.8)	C (34.1)
		Southbound	C (23.6)	D (48.4)

(XX.X) = Average vehicle delay in seconds per vehicle

Table 4.8 - 2039 Levels-of-Service
(Intersection Improvement - Roundabout Control)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & USR 250 / SR 21	Traffic Signal	Intersection	A (8.3)	B (13.6)
		Eastbound	A (8.1)	C (15.6)
		Northbound	A (8.3)	B (12.5)
		Southbound	A (8.4)	B (13.1)

(XX.X) = Average vehicle delay in seconds per vehicle

The capacity of the signalized intersection of State Route 21 and US Route 250 / SR 21 was found to be at an acceptable level-of-service D or better during the AM and PM peak hours. However, the storage length for the northbound left turn was found to be inadequate under signal control in the PM peak period. The turn lane will need to be extended to provide 330 feet of storage. The capacity of a roundabout at this intersection was found to be at an acceptable level of service C or better in both the AM and PM peak hours.

Build Condition - 2019 Capacity Analysis

Analyses were performed for the projected 2019 opening day Build conditions. The traffic volumes used in this analysis can be seen in **Figure 3.5**. Copies of the capacity worksheets are included in **Appendix J**. The results of the 2019 Build analyses are shown in the following tables:

Table 4.9 2019 Levels-of-Service
(Build Conditions)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & USR 250 / SR 21	Stop Sign	Eastbound	C (17.6)	F (138.6)
		Northbound Left	A (8.9)	A (10.0)

(XX.X) = Average vehicle delay in seconds per vehicle

The capacity of the critical movements at the un-signalized intersection of State Route 21 and US Route 250 / SR 21 was calculated to be at a level-of-service F during the PM peak hour under the 2019 Build conditions just as predicted for the no-build scenario.

In order to determine if the improvements recommended for the no-build scenario were viable improve the level-of-service of the eastbound approach at the intersection of State Route 21 and US Route 250, further capacity analyses were performed for:

- Construct signal control.
- Construct modern roundabout.

The traffic volumes used in the analyses can be seen in **Figure 3.5**. Copies of the capacity worksheets are included in **Appendix K.** The results of the capacity analyses with the improvement are shown in the tables on the following page:

Table 4.10 - 2019 Levels-of-Service
(Intersection Improvement - Signal Control)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & USR 250 / SR 21	Traffic Signal	Intersection	C (20.1)	D (39.5)
		Eastbound	C (24.0)	D (47.6)
		Northbound	B (16.4)	C (31.2)
		Southbound	C (23.4)	D (44.7)

(XX.X) = Average vehicle delay in seconds per vehicle

Table 4.11 - 2019 Levels-of-Service
(Intersection Improvement - Roundabout Control)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & USR 250 / SR 21	Traffic Signal	Intersection	A (8.4)	B (13.2)
		Eastbound	A (8.0)	C (15.4)
		Northbound	A (8.7)	B (12.0)
		Southbound	A (8.2)	B (12.7)

(XX.X) = Average vehicle delay in seconds per vehicle

The capacity of the signalized intersection of State Route 21 and US Route 250 / SR 21 was found to be at an acceptable level-of-service D or better during the AM and PM peak hours. However, the storage length for the northbound left turn was found to be inadequate under signal control in the PM peak period. The turn lane will need to be extended to provide 300 feet of storage. The capacity of a roundabout at this intersection was found to be at an acceptable level of service C or better in both the AM and PM peak hours.

Build Condition - 2039 Capacity Analysis

Analyses were performed for the projected 2039 design year Build conditions. The traffic volumes used in this analysis can be seen in **Figure 3.6**. Copies of the capacity worksheets are included in **Appendix L.** The results of the 2039 Build analyses are shown in the following tables:

Table 4.12 2039 Levels-of-Service
(Build Conditions)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & USR 250 / SR 21	Stop Sign	Eastbound	C (20.4)	F (240.8)
		Northbound Left	A (9.2)	B (10.4)

(XX.X) = Average vehicle delay in seconds per vehicle

The capacity of the critical movements at the un-signalized intersection of State Route 21 and US Route 250 / SR 21 was calculated to be at a level-of-service F during the PM peak hour under the 2039 Build conditions just as predicted for the no-build scenario.

In order to determine if the improvements recommended for the no-build scenario were still viable improve the level-of-service of the eastbound approach at the intersection of State Route 21 and US Route 250, further capacity analyses were performed for:

- Construct signal control.
- Construct modern roundabout.

The traffic volumes used in the analyses can be seen in **Figure 3.6**. Copies of the capacity worksheets are included in **Appendix M.** The results of the capacity analyses with the improvement are shown in the tables on the following page:

Table 4.13 - 2039 Levels-of-Service
(Intersection Improvement - Signal Control)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & USR 250 / SR 21	Traffic Signal	Intersection	C (22.0)	E (58.1)
		Eastbound	C (25.7)	E (71.7)
		Northbound	B (18.6)	D (44.0)
		Southbound	C (25.0)	E (67.0)

(XX.X) = Average vehicle delay in seconds per vehicle

Table 4.14 - 2039 Levels-of-Service
(Intersection Improvement - Roundabout Control)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & USR 250 / SR 21	Traffic Signal	Intersection	A (9.2)	C (15.9)
		Eastbound	A (8.7)	C (19.5)
		Northbound	A (9.6)	B (13.9)
		Southbound	A (9.0)	C (15.0)

(XX.X) = Average vehicle delay in seconds per vehicle

The capacity of the intersection of State Route 21 and US Route 250 / SR 21 under traffic signal control was found to be at an unacceptable level-of-service E during the PM peak hour. Lane additions were evaluated in order to determine the mitigation needed to improve the levels of service to D or better. It was found that, under signal control, an eastbound right turn lane would be necessary. Copies of the capacity worksheets are included in **Appendix N.** The results of the analyses are shown in the chart on the following page:

Table 4.15 - 2039 Levels-of-Service
(Intersection Improvement - Signal Control w Eastbound Right Turn Lane)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & USR 250 / SR 21	Traffic Signal	Intersection	B (18.3)	C (26.8)
		Eastbound	C (21.2)	C (31.6)
		Northbound	B (15.5)	C (21.4)
		Southbound	C (20.8)	C (30.7)

(XX.X) = Average vehicle delay in seconds per vehicle

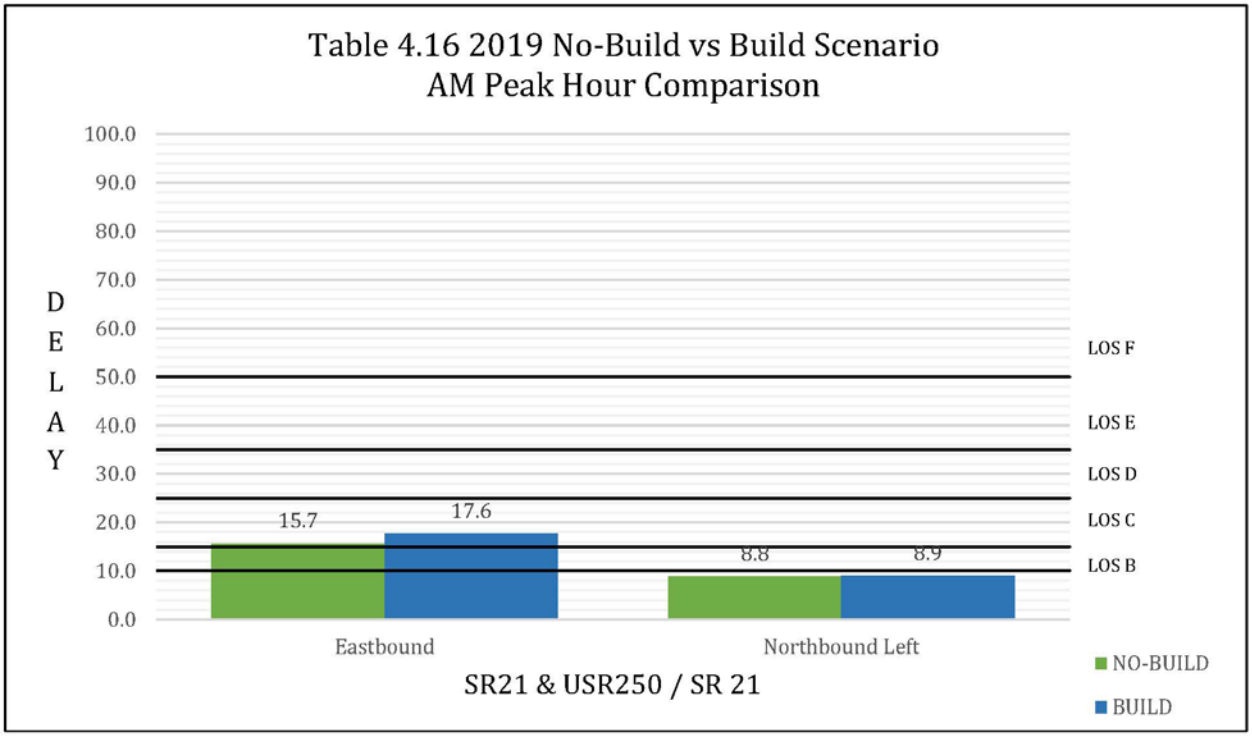
The analyses shows that in order for traffic signal control to be a viable option under the 2039 Build scenario, an eastbound right turn lane addition and the lengthening of the northbound left turn lane will be necessary. The storage length for the eastbound right turn lane should be 350 feet. The northbound left turn lane storage should be 245 feet.

4.2 Comparative Analysis

A comparison was performed to show the incremental effects on the capacity of the State Route 21 and US Route 250 / SR 21 intersection due to the development of the proposed industrial development.

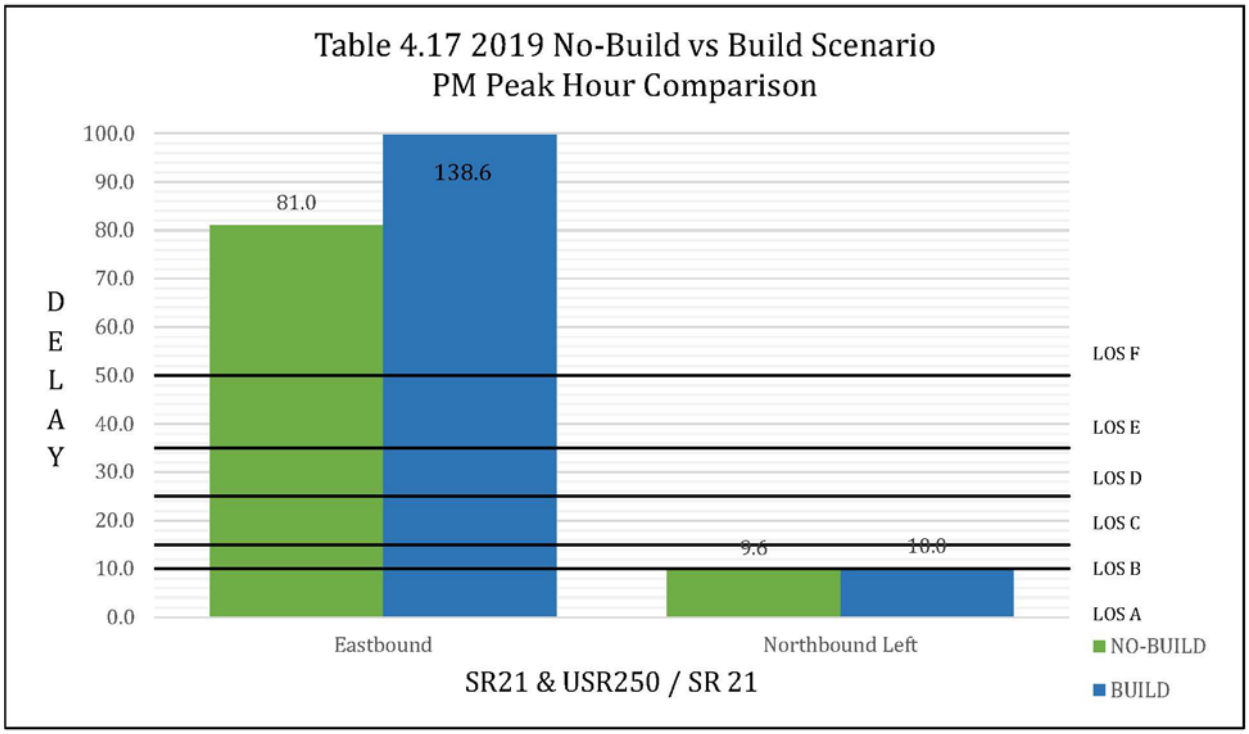
A comparison of the 2019 No-Build vs Build conditions for the AM peak hour indicates the approach levels-of-service are expected to remain at acceptable levels with the addition of the development generated traffic under the 2019 AM peak hour conditions.

The graphical results of the comparison analysis can be seen below in **Table 4.16**.



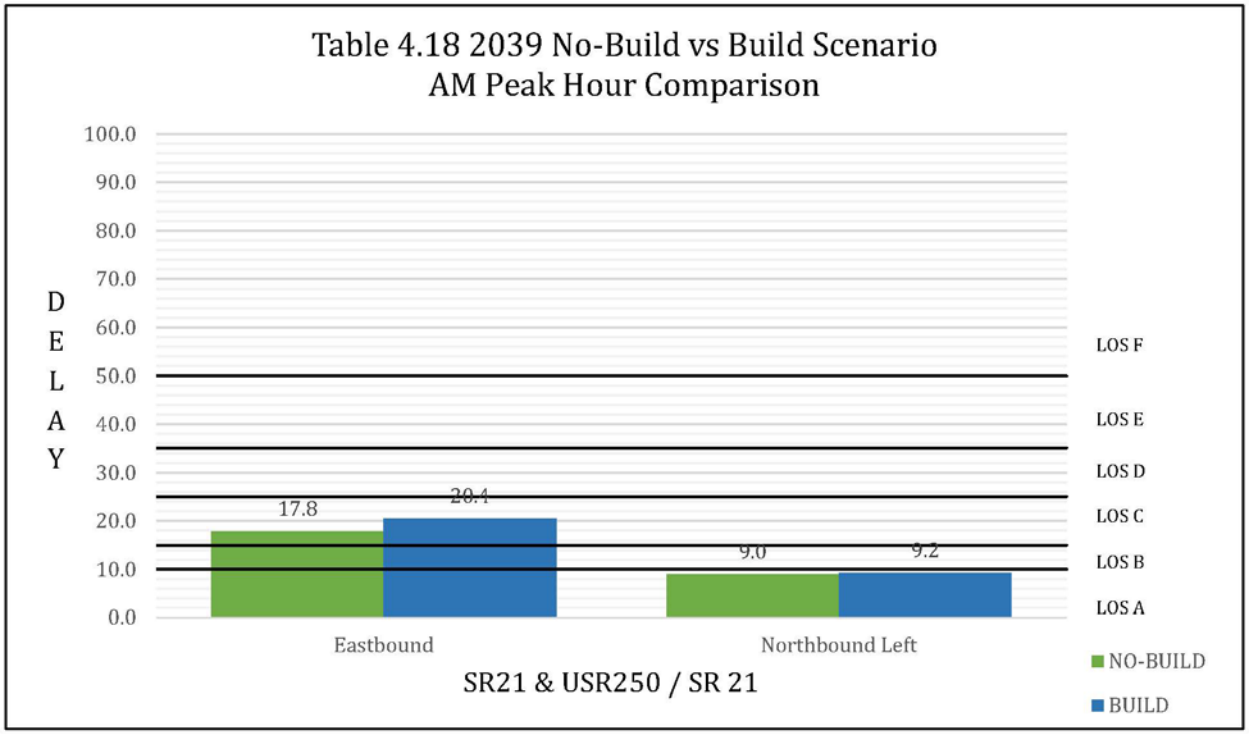
A comparison of the 2019 No-Build vs Build conditions for the PM peak hour indicates the approach levels-of-service are expected to remain unchanged with the addition of the development generated traffic under the 2019 PM peak hour conditions.

The graphical results of the comparison analysis can be seen below in **Table 4.17**.



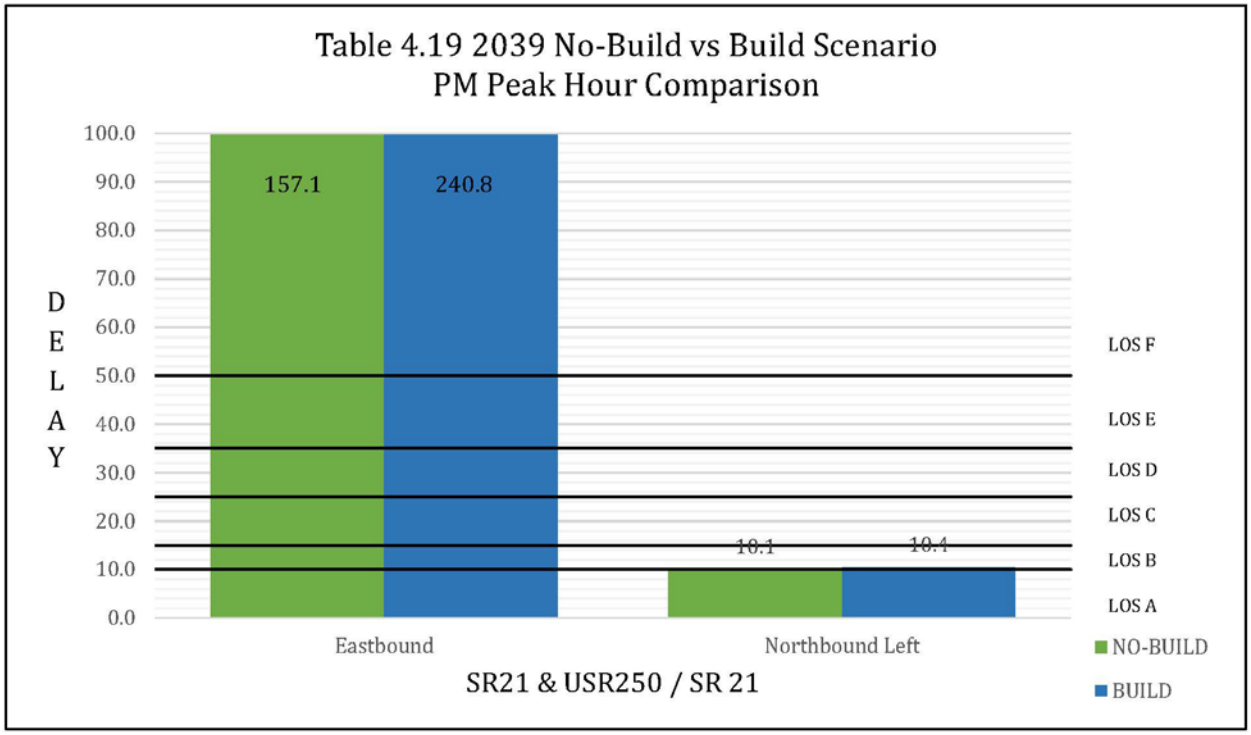
A comparison of the 2039 No-Build vs Build conditions for the AM peak hour indicates the approach levels-of-service are expected to remain unchanged with the addition of the development generated traffic under the 2039 AM peak hour conditions.

The graphical results of the comparison analysis can be seen below in **Table 4.18**.



A comparison of the 2039 No-Build vs Build conditions for the PM peak hour indicates the approach levels-of-service are expected to remain unchanged with the addition of the development generated traffic under the 2039 PM peak hour conditions.

The graphical results of the comparison analysis can be seen below in **Table 4.19**.



4.3 Capacity & LOS at Development Access Intersections

Capacity analyses were performed for the access driveways on State Route 21 and on US Route 250 using the procedures outlined in the computerized version of the Transportation Research Board's **Highway Capacity Manual 6TH Edition, (Release 7.5)**.

Build Condition - 2019 Capacity Analysis

Analyses were performed for the projected 2019 opening day conditions under the Build scenario to determine the future level-of-service at the access driveways on State Route 21 and on US Route 250 . The results of the 2019 Build analyses are shown in the following table. Copies of the capacity worksheets are included in **Appendix O**.

Table 4.20 2019 Levels-of-Service
(Build Conditions - Proposed Driveways)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & Development Driveway	Stop Sign	Eastbound	B (12.7)	B (14.7)
		Northbound Left	A (8.1)	A (8.2)
USR 250 & Development Driveway	Stop Sign	Southbound	B (12.2)	C (15.8)
		Eastbound Left	A (7.9)	A (8.2)

(XX.X) = Average vehicle delay in seconds per vehicle

All movements at each of the development driveways are expected to operate with an acceptable levels-of-service C or better during the opening day, 2019 AM and PM peak hours.

Build Condition - 2039 Capacity Analysis

Analyses were performed for the forecasted 2039 design year conditions under the Build scenario to determine the future level-of-service at the access driveways on State Route 21 and on US Route 250 . The results of the 2039 Build analyses are shown in the following table. Copies of the capacity worksheets are included in **Appendix P**.

Table 4.21 2039 Levels-of-Service
(Build Conditions - Proposed Driveways)

LOCATION	TRAFFIC CONTROL	MOVEMENT	AM PEAK LOS (DELAY)	PM PEAK LOS (DELAY)
SR 21 & Development Driveway	Stop Sign	Eastbound	B (13.1)	C (15.6)
		Northbound Left	A (8.2)	A (8.3)
USR 250 & Development Driveway	Stop Sign	Southbound	B (12.7)	C (17.0)
		Eastbound Left	A (8.0)	A (8.3)

(XX.X) = Average vehicle delay in seconds per vehicle

All movements at each of the development driveways are expected to operate with an acceptable levels-of-service C or better during the design year, 2039 AM and PM peak hours.

4.4 Auxiliary Turning Lane Warrant Analysis

The ODOT **Location and Design Manual, Volume 1** and the **Access Management Manual** recommends that the need for auxiliary turn lanes at unsignalized intersections on state routes to be determined by using the Auxiliary Lane Graphs found in Section 401-6 of the **Location and Design Manual, Volume 1**. This recommendation is made for the free-flow approaches at unsignalized intersections. Section 401.6.3 of the ODOT **Location and Design Manual** states that:

"To determine the number and use of left/right turn lanes, intersection capacity analysis procedures of the current edition of the Highway Capacity Manual should be used. For unsignalized intersections, left/right turn lanes may also be needed if they meet warrants provided in Figures 401-6a, b, c and d. The warrants apply only to the free-flow approach of the unsignalized intersection."

It is the intent of this report to evaluate the need for an exclusive turn / deceleration lanes at the proposed unsignalized access driveway on State Route 21 and US Route 250.

The need for an exclusive turn lanes at the access driveway on State Route 21 was based on a two-lane roadway with a posted speed limit of 50 miles per hour. The following table shows the results of the analysis of the need for the exclusive turn lane at the proposed access driveway on the state route. Copies of the ODOT turn lane warrant graphs can be seen in **Appendix Q**.

Table 4.22 Turning Lane Warrants
Proposed SR 21 Unsignalized Access Driveway

TURN LANE & LOCATION	2019		2039	
	AM	PM	AM	PM
SR 21 SB Right Turn Lane @ Access Drive	No	No	No	No
SR 21 NB Left Turn Lane @ Access Drive	Yes	Yes	Yes	Yes

The results of the turn lane analyses indicate that an exclusive left turn lane on State Route 21 at the ProVia Trading access drive *is* warranted under the expected 2019 and 2039 Build conditions. A right turn deceleration lane was found not to be justified for either 2019 or 2039 Build conditions.

The need for an exclusive turn lanes at the access driveway on US Route 250 was based on a two-lane roadway with a posted speed limit of 55 miles per hour. The following table shows the results of the analysis of the need for the exclusive turn lane at the proposed access driveway on the state route. Copies of the ODOT turn lane warrant graphs can be seen in **Appendix R**.

Table 4.23 Turning Lane Warrants
Proposed USR 250 Unsignalized Access Driveway

TURN LANE & LOCATION	2019		2039	
	AM	PM	AM	PM
USR 250 WB Right Turn Lane @ Access Drive	No	No	No	No
USR 250 EB Left Turn Lane @ Access Drive	Yes	Yes	Yes	Yes

The results of the turn lane analyses indicate that an exclusive left turn lane on US Route 250 at the ProVia Trading access drive *is* warranted under the expected 2019 and 2039 Build conditions. A right turn deceleration lane was found not to be justified for either 2019 or 2039 Build conditions.

4.5 Turn Lane Analysis

An analysis was performed to determine the necessary turn lane storage length in order to accommodate the warranted northbound left turn lane on State Route 21 and the eastbound left turn lane on US Route 250 at the proposed ProVia Window plant access driveways.

The analysis was performed in accordance with the procedure recommended by the Ohio Department of Transportation in their **Location and Design Manual, Volume 1**, Section 401. The ODOT criteria and procedures are furnished in **Appendix S**. It should be noted that the recommended maximum left turn lane length is 600 feet and the maximum right turn length is 900 feet, however if the calculated turn lane length is lower than these values, the maximum length will not be applicable.

The calculation for the turn lane length for State Route 21 will be based on a design speed of 55 miles per hour due to the principal arterial functional classification of the roadway and the posted speed limit of 50 miles per hour. The following table shows the result of the analysis based upon the highest anticipated left volume at the driveway intersection.

Table 4.24 - Turn Lane Length Analysis

SR 21 & ProVia Driveway

Movement Direction	DHV	No. of Lanes	Cycles / Hour	Average Veh/ Cycle/ Lane	Design Speed (mph)	Fig. 401-10 Storage Length (ft)	Fig. 401-9 Condition			Backup Length (ft)	Turn Lane Length* (ft)
							A*	B*	C*		
NB LT	62	1	60	1.0	55	50		285	215	--	**285***

* Includes 50' taper

The calculated turn lane length was based on the higher of Condition B or C as the left turn volume was greater than 10% of the approach traffic volume. The northbound left turn lane was determined to require 235 feet of storage / deceleration and 50 feet of a diverging taper for total turn lane length of the 285 feet.

The calculation for the turn lane length for US Route 25 will be based on a design speed of 60 miles per hour due to the principal arterial functional classification of the roadway and the posted speed limit of 55 miles per hour. The table on the following page shows the result of the analysis based upon the highest anticipated left turn volume at the driveway intersection.

Table 4.25 - Turn Lane Length Analysis

USR 250 & ProVia Driveway

Movement Direction	DHV	No. of Lanes	Cycles / Hour	Average Veh/ Cycle/ Lane	Design Speed (mph)	Fig. 401-10 Storage Length (ft)	Fig. 401-9 Condition			Backup Length (ft)	Turn Lane Length* (ft)
							A*	B*	C*		
EB LT	47	1	60	0.8	60	50		345	235	--	**345***

* Includes 50' taper

The calculated turn lane length was based on the higher of Condition B or C as the left turn volume was greater than 10% of the approach traffic volume. The eastbound left turn lane was determined to require 295 feet of storage / deceleration and 50 feet of a diverging taper for total turn lane length of the 345 feet.

4.6 Improvements to Accommodate Study Area Traffic

No intersection improvements were recommended to accommodate the existing year 2018 traffic conditions at the study area intersections.

The intersection of State Route 21 and US Route 250 / SR 21 was found to require signal control or modern roundabout improvements in order to provide an acceptable level of service to accommodate the Year 2019 No-Build traffic forecast. The signal control improvements will necessitate the lengthening of the north bound left turn lane. These improvements were found to provide adequate capacity in the 2039 No-Build condition. However, it should be noted that the traffic volume forecast for the intersection of State Route 21 and US Route 250 / SR 21 was predicated on a conservative 0.5% per year growth rate when in actuality traffic volumes were found to be decreasing in this area at a rate of about 1% per year. It is our opinion that this intersection be studied on a periodic basis and that stop sign control remain in place until such time that a traffic signal or roundabout is justified.

The improvements recommended for the State Route 21 and US Route 250 / SR 21 intersection were found to provide adequate capacity in the 2019 Build scenario. However, if signal control becomes justified an eastbound right turn lane will be necessary in the 2039 scenario.

The following lane use and traffic control are recommended to accommodate the 2019 and 2039 site generated (Build) traffic at the development access location for ProVia Trading along State Route 21 and US Route 250:

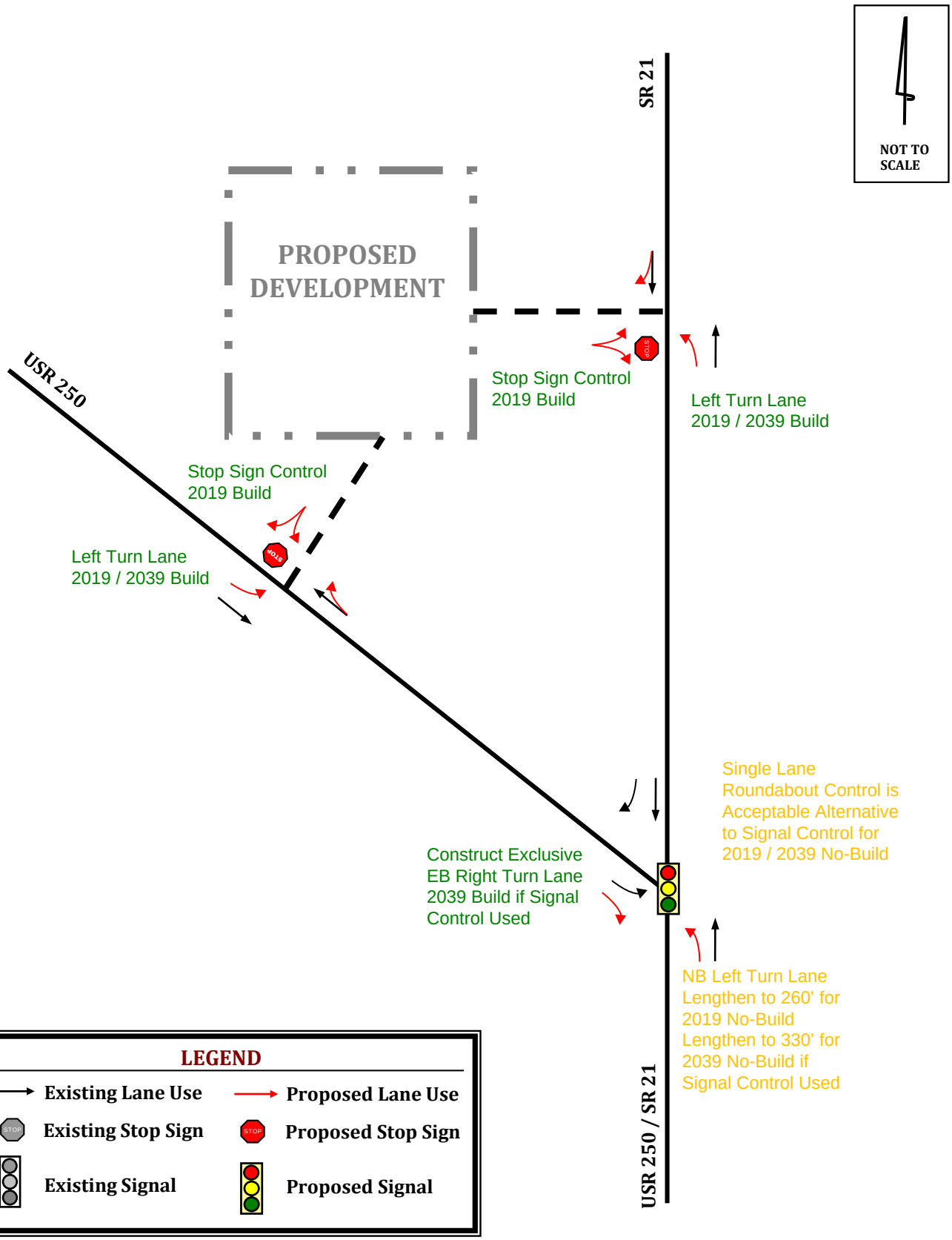
State Route 21 & Development Access Driveway

- Install stop sign control on the eastbound approach.
- Install a northbound left turn lane. The left turn lane was determined to require 235 feet of storage / deceleration and 50 feet of a diverging taper for total turn lane length of the 285 feet.

State Route 250 & Development Access Driveway

- Install stop sign control on the southbound approach.
- Install an eastbound left turn lane. The left turn lane was determined to require 295 feet of storage / deceleration and 50 feet of a diverging taper for total turn lane length of the 345 feet.

The recommended lane use and traffic control for the study area to accommodate the proposed development can be seen in **Figure 4.1, Page 52**.


NOT TO SCALE
SR 21
PROPOSED DEVELOPMENT
USR 250
Stop Sign Control 2019 Build
Left Turn Lane 2019 / 2039 Build
Stop Sign Control 2019 Build
Left Turn Lane 2019 / 2039 Build
Single Lane Roundabout Control is Acceptable Alternative to Signal Control for 2019 / 2039 No-Build
Construct Exclusive EB Right Turn Lane 2039 Build if Signal Control Used
NB Left Turn Lane Lengthen to 260' for 2019 No-Build Lengthen to 330' for 2039 No-Build if Signal Control Used
USR 250 / SR 21
LEGEND
Existing Lane Use
Proposed Lane Use
Existing Stop Sign
Proposed Stop Sign
Existing Signal
Proposed Signal

Chapter 5
Conclusions

Based on the results of the analyses, we offer the following conclusions and recommendations:

5.1 This traffic impact study has been prepared at the request of George A. Fiedler and Associates for a proposed manufacturing development containing a ProVia Window Plant. The project site is located near the Village of Strasburg, Franklin Township, Tuscarawas County, Ohio situated north of the intersection of State Route 21 and US Route 250.

5.2 The proposed development is expected to consist of the following land uses:

ProVia Window Plant - 377,380 square feet

5.3 The development is proposed to have two access driveways, one on State Route 21 and one on US Route 250.

5.4 The development is expected to be open in 2019. The year 2019 was analyzed for the full build out of the development. The year 2039 was analyzed as the design year for the twenty year conditions.

5.5 The weekday peak hours of traffic for the study area roadways was based on the traffic data collected for this report. The weekday AM peak hour of traffic was determined to be 7:00 AM to 8:00 AM. The weekday PM peak hour of traffic was found to be 4:00 PM to 5:00 PM. These periods were analyzed since they reflect the period of the highest volume of traffic flow for the study area roadways and the proposed development.

5.6 The proposed development is expected to generate the hourly traffic volumes during the peak periods as shown in the table on the following page:

ITE TRIP GENERATION		SIZE	TRIP ENDS			
ITE Code	Description		AM Weekday Peak Hour (Enter/Exit)		PM Weekday Peak Hour (Enter/Exit)	
104	ProVia Window Plant	337,380 S.F.	173	67	102	136
TOTAL NEW TRIPS			**173**	**67**	**102**	**136**
			240		**238**	

5.7 No intersection improvements are recommended to accommodate the existing year 2018 traffic conditions at the study area intersections.

5.8 The intersection of State Route 21 and US Route 250 / SR 21 was found to require signal control or modern roundabout improvements in order to provide an acceptable level of service to accommodate the Year 2019 No-Build traffic forecast. The improvements include the lengthening of the north bound left turn lane. These improvements were found to provide adequate capacity in the 2039 No-Build condition.

5.9 The traffic volume forecast for the intersection of State Route 21 and US Route 250 / SR 21 was predicated on a conservative 0.5% per year growth rate when in actuality traffic volumes were found to be decreasing in this area at a rate of about 1% per year. It is our opinion that this intersection should be studied on a periodic basis and that stop sign control remain in place until such time that a traffic signal or roundabout may be justified.

5.10 The improvements recommended for the State Route 21 and US Route 250 / SR 21 intersection were found to provide adequate capacity in the 2019 Build scenario. However, if signal control becomes warranted, an eastbound right turn lane will be necessary.

5.11 The following lane use and traffic control are recommended to accommodate the 2019 and 2039 site generated (Build) traffic at the development access driveways for the ProVia Window plant at State Route 21 and US Route 250:

State Route 21 & Development Access Driveway

- Install stop sign control on the eastbound approach.
- Install a northbound left turn lane. The left turn lane was determined to require 235 feet of storage / deceleration and 50 feet of a diverging taper for total turn lane length of the 285 feet.

State Route 250 & Development Access Driveway

- Install stop sign control on the southbound approach.
- Install a eastbound left turn lane. The left turn lane was determined to require 295 feet of storage / deceleration and 50 feet of a diverging taper for total turn lane length of the 345 feet.

5.12 Based upon the results of the analysis in this study and the corresponding recommendations, it can be seen that the development traffic can be accommodated without adversely impacting the area roadway network.

Appendix A
Traffic Count Data

VEHICULAR TRAFFIC COUNT SUMMARY

Municipality: Strasburg At Intersection of SR 21 and USR 250

Date: 5/8/2018 Day: Tue. Comments: Project: 18-064

Weather: Clear Recorder(s): DJS Data entry by: JJO Date entered: May. 11, 2018 SR 21 & USR 250 050818

TIME BEGINS	SR 21 FROM NORTH						USR 250 / SR 21 FROM SOUTH						TOTAL NORTH SOUTH	FROM EAST						USR 250 FROM WEST						TOTAL EAST WEST	TOTAL ALL DIREC.	PEAK HOUR FACTOR			
	Left	Thru	Right	Total	Trk	Bus	Left	Thru	Right	Total	Trk	Bus		Left	Thru	Right	Total	Trk	Bus	Left	Thru	Right	Total	Trk	Bus			North	South	East	West
06:00																														
07:00	0	202	15	217	28	0	198	174	0	372	58	0	589							17	0	207	224	41	0	224	813	0.798	0.830		0.903
08:00	0	156	20	176	29	1	163	166	0	329	71	2	505							20	0	181	201	49	2	201	706	0.957	0.894		0.852
09:00	0	155	21	176	24	0	205	126	0	331	68	0	507							20	0	165	185	41	0	185	692	0.917	0.890		0.873
10:00																														
11:00	0	162	23	185	32	0	181	137	0	318	72	1	503							20	0	182	202	50	0	202	705	0.944	0.837		0.902
12:00	0	162	32	194	45	0	168	165	0	333	78	0	527							18	0	189	207	48	0	207	734	0.915	0.816		0.892
1:00	0	149	11	160	29	2	210	174	0	384	65	1	544							27	0	184	211	52	0	211	755	0.784	0.873		0.925
2:00																														
3:00	0	241	32	273	33	1	287	201	0	488	73	0	761							28	0	321	349	37	1	349	1110	0.898	0.897		0.899
4:00	0	263	33	296	21	1	267	236	0	503	66	2	799							35	0	340	375	35	1	375	1174	0.860	0.886		0.928
5:00	0	295	32	327	27	0	259	219	0	478	55	1	805							27	0	306	333	32	0	333	1138	0.843	0.948		0.793
6:00																														
7:00																														
8:00																														
9:00																														
TOTALS	0	1785	219	2004	268	5	1938	1598	0	3536	606	7	5540							212	0	2075	2287	385	4	2287	7827				
ADT	0	2933	360	3293	13.6%		3184	2625	0	5810	17.3%		9102							348	0	3409	3757	17.0%		3757	12860				

N-S HOURLY FACTOR: 1.72 E-W HOURLY FACTOR: 1.72 MONTHLY FACTOR: 0.96 N-S COMBINED FACTOR: 1.64 E-W COMBINED FACTOR: 1.64

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Page #:

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City: Strasburg
Intersection: SR 21 & USR 250
Counter: DJS
Day of the Week: Tuesday

File Name : sr 21 usr 250 050818a
Site Code : 00000000
Start Date : 5/8/2018
Page No : 1

Groups Printed- Cars - Trucks - Buses

	STATE ROUTE 21 From North					USR 250 From East					STATE ROUTE 21 From South					USR 250 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	3	34	0	0	37	0	0	0	0	0	0	36	44	0	80	45	0	2	0	47	164
07:15 AM	3	49	0	0	52	0	0	0	0	0	0	54	42	0	96	48	0	6	0	54	202
07:30 AM	4	64	0	0	68	0	0	0	0	0	0	50	62	0	112	55	0	7	0	62	242
07:45 AM	5	55	0	0	60	0	0	0	0	0	0	34	50	0	84	59	0	2	0	61	205
Total	15	202	0	0	217	0	0	0	0	0	0	174	198	0	372	207	0	17	0	224	813
08:00 AM	8	35	0	0	43	0	0	0	0	0	0	39	38	0	77	39	0	2	0	41	161
08:15 AM	5	40	0	0	45	0	0	0	0	0	0	35	42	0	77	48	0	11	0	59	181
08:30 AM	4	42	0	0	46	0	0	0	0	0	0	48	44	0	92	53	0	2	0	55	193
08:45 AM	3	39	0	0	42	0	0	0	0	0	0	44	39	0	83	41	0	5	2	48	173
Total	20	156	0	0	176	0	0	0	0	0	0	166	163	0	329	181	0	20	2	203	708
09:00 AM	6	40	0	0	46	0	0	0	0	0	0	37	53	0	90	48	0	5	0	53	189
09:15 AM	8	36	0	0	44	0	0	0	0	0	0	31	62	0	93	38	0	6	0	44	181
09:30 AM	4	44	0	0	48	0	0	0	0	0	0	32	51	0	83	40	0	7	1	48	179
09:45 AM	3	35	0	0	38	0	0	0	0	0	0	26	39	0	65	39	0	2	0	41	144
Total	21	155	0	0	176	0	0	0	0	0	0	126	205	0	331	165	0	20	1	186	693

*** BREAK ***

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File Name : sr 21 usr 250 050818a
Site Code : 00000000
Start Date : 5/8/2018
Page No : 2

Groups Printed- Cars - Trucks - Buses

	STATE ROUTE 21 From North					USR 250 From East					STATE ROUTE 21 From South					USR 250 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
11:00 AM	7	39	0	0	46	0	0	0	0	0	0	46	49	0	95	49	0	7	0	56	197
11:15 AM	6	42	0	0	48	0	0	0	0	0	0	34	39	0	73	48	0	6	0	54	175
11:30 AM	3	39	0	0	42	0	0	0	0	0	0	30	43	0	73	45	0	3	0	48	163
11:45 AM	7	42	0	0	49	0	0	0	0	0	0	27	50	0	77	40	0	4	0	44	170
Total	23	162	0	0	185	0	0	0	0	0	0	137	181	0	318	182	0	20	0	202	705
12:00 PM	8	45	0	0	53	0	0	0	0	0	0	45	38	0	83	46	0	2	0	48	184
12:15 PM	13	36	0	0	49	0	0	0	0	0	0	42	31	0	73	49	0	5	0	54	176
12:30 PM	5	37	0	0	42	0	0	0	0	0	0	36	39	0	75	43	0	4	0	47	164
12:45 PM	6	44	0	0	50	0	0	0	0	0	0	42	60	0	102	51	0	7	0	58	210
Total	32	162	0	0	194	0	0	0	0	0	0	165	168	0	333	189	0	18	0	207	734
01:00 PM	3	48	0	0	51	0	0	0	0	0	0	45	45	0	90	45	0	10	0	55	196
01:15 PM	4	33	0	0	37	0	0	0	0	0	0	53	57	0	110	47	0	3	0	50	197
01:30 PM	0	37	0	0	37	0	0	0	0	0	0	37	47	0	84	43	0	6	0	49	170
01:45 PM	4	31	0	0	35	0	0	0	0	0	0	39	61	0	100	49	0	8	0	57	192
Total	11	149	0	0	160	0	0	0	0	0	0	174	210	0	384	184	0	27	0	211	755
*** BREAK ***																					
03:00 PM	6	50	0	0	56	0	0	0	0	0	0	49	52	0	101	85	0	12	0	97	254
03:15 PM	4	72	0	0	76	0	0	0	0	0	0	55	72	0	127	74	0	5	0	79	282
03:30 PM	12	57	0	0	69	0	0	0	0	0	0	55	81	0	136	72	0	6	1	79	284

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Site Code : 00000000
Start Date : 5/8/2018
Page No : 3

Groups Printed- Cars - Trucks - Buses

	STATE ROUTE 21 From North					USR 250 From East					STATE ROUTE 21 From South					USR 250 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
03:45 PM	10	62	0	0	72	0	0	0	0	0	0	42	82	0	124	90	0	5	0	95	291
Total	32	241	0	0	273	0	0	0	0	0	0	201	287	0	488	321	0	28	1	350	1111
04:00 PM	9	60	0	0	69	0	0	0	0	0	0	66	66	0	132	90	0	11	0	101	302
04:15 PM	6	80	0	0	86	0	0	0	0	0	0	53	58	0	111	87	0	6	0	93	290
04:30 PM	7	58	0	0	65	0	0	0	0	0	0	68	74	0	142	74	0	10	1	85	292
04:45 PM	11	65	0	0	76	0	0	0	0	0	0	49	69	0	118	89	0	8	0	97	291
Total	33	263	0	0	296	0	0	0	0	0	0	236	267	0	503	340	0	35	1	376	1175
05:00 PM	6	73	0	0	79	0	0	0	0	0	0	53	73	0	126	98	0	7	0	105	310
05:15 PM	10	87	0	0	97	0	0	0	0	0	0	61	65	0	126	81	0	10	0	91	314
05:30 PM	10	60	0	0	70	0	0	0	0	0	0	55	70	0	125	63	0	6	0	69	264
05:45 PM	6	75	0	0	81	0	0	0	0	0	0	50	51	0	101	64	0	4	0	68	250
Total	32	295	0	0	327	0	0	0	0	0	0	219	259	0	478	306	0	27	0	333	1138
Grand Total	219	1785	0	0	2004	0	0	0	0	0	0	1598	1938	0	3536	2075	0	212	5	2292	7832
Apprch %	10.9	89.1	0	0		0	0	0	0		0	45.2	54.8	0		90.5	0	9.2	0.2		
Total %	2.8	22.8	0	0	25.6	0	0	0	0	0	0	20.4	24.7	0	45.1	26.5	0	2.7	0.1	29.3	
Cars	170	1561	0	0	1731	0	0	0	0	0	0	1341	1582	0	2923	1725	0	173	2	1900	6554
% Cars	77.6	87.5	0	0	86.4	0	0	0	0	0	0	83.9	81.6	0	82.7	83.1	0	81.6	40	82.9	83.7
Trucks	47	221	0	0	268	0	0	0	0	0	0	251	355	0	606	348	0	37	3	388	1262
% Trucks	21.5	12.4	0	0	13.4	0	0	0	0	0	0	15.7	18.3	0	17.1	16.8	0	17.5	60	16.9	16.1
Buses	2	3	0	0	5	0	0	0	0	0	0	6	1	0	7	2	0	2	0	4	16
% Buses	0.9	0.2	0	0	0.2	0	0	0	0	0	0	0.4	0.1	0	0.2	0.1	0	0.9	0	0.2	0.2

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File Name : sr 21 usr 250 050818a
Site Code : 00000000
Start Date : 5/8/2018

	STATE ROUTE 21 From North					USR 250 From East					STATE ROUTE 21 From South					USR 250 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 09:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	3	34	0	0	37	0	0	0	0	0	0	36	44	0	80	45	0	2	0	47	164
07:15 AM	3	49	0	0	52	0	0	0	0	0	0	54	42	0	96	48	0	6	0	54	202
07:30 AM	4	64	0	0	68	0	0	0	0	0	0	50	62	0	112	55	0	7	0	62	242
07:45 AM	5	55	0	0	60	0	0	0	0	0	0	34	50	0	84	59	0	2	0	61	205
Total Volume	15	202	0	0	217	0	0	0	0	0	0	174	198	0	372	207	0	17	0	224	813
% App. Total	6.9	93.1	0	0		0	0	0	0		0	46.8	53.2	0		92.4	0	7.6	0		
PHF	.750	.789	.000	.000	.798	.000	.000	.000	.000	.000	.000	.806	.798	.000	.830	.877	.000	.607	.000	.903	.840
Cars	13	176	0	0	189	0	0	0	0	0	0	157	157	0	314	169	0	14	0	183	686
% Cars	86.7	87.1	0	0	87.1	0	0	0	0	0	0	90.2	79.3	0	84.4	81.6	0	82.4	0	81.7	84.4
Trucks	2	26	0	0	28	0	0	0	0	0	0	17	41	0	58	38	0	3	0	41	127
% Trucks	13.3	12.9	0	0	12.9	0	0	0	0	0	0	9.8	20.7	0	15.6	18.4	0	17.6	0	18.3	15.6
Buses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Buses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak Hour Analysis From 02:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:30 PM																					
04:30 PM	7	58	0	0	65	0	0	0	0	0	0	68	74	0	142	74	0	10	1	85	292
04:45 PM	11	65	0	0	76	0	0	0	0	0	0	49	69	0	118	89	0	8	0	97	291
05:00 PM	6	73	0	0	79	0	0	0	0	0	0	53	73	0	126	98	0	7	0	105	310
05:15 PM	10	87	0	0	97	0	0	0	0	0	0	61	65	0	126	81	0	10	0	91	314
Total Volume	34	283	0	0	317	0	0	0	0	0	0	231	281	0	512	342	0	35	1	378	1207
% App. Total	10.7	89.3	0	0		0	0	0	0		0	45.1	54.9	0		90.5	0	9.3	0.3		
PHF	.773	.813	.000	.000	.817	.000	.000	.000	.000	.000	.000	.849	.949	.000	.901	.872	.000	.875	.250	.900	.961
Cars	28	267	0	0	295	0	0	0	0	0	0	211	243	0	454	310	0	33	1	344	1093
% Cars	82.4	94.3	0	0	93.1	0	0	0	0	0	0	91.3	86.5	0	88.7	90.6	0	94.3	100	91.0	90.6
Trucks	6	16	0	0	22	0	0	0	0	0	0	17	38	0	55	32	0	2	0	34	111
% Trucks	17.6	5.7	0	0	6.9	0	0	0	0	0	0	7.4	13.5	0	10.7	9.4	0	5.7	0	9.0	9.2
Buses	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	3
% Buses	0	0	0	0	0	0	0	0	0	0	0	1.3	0	0	0.6	0	0	0	0	0	0.2

Appendix B
Trip Generation Data

Manufacturing

ITE Code = 104

Date: **8/1/2015**

Trip Generation based on: **1,000 Square Feet Gross Floor Area**

Size of Analysis Area: **337.38** **1000 Sq Ft**

	Average Rate	Standard Deviation	Adjustment factor	Driveway Volume
Average Weekday 2-way Volume	3.63	2.62	1.00	1226
Weekday Peak Hour of Generator				
7-9 AM Peak Hour Enter	0.51	0.00	1.00	173
7-9 AM Peak Hour Exit	0.20	0.00	1.00	67
7-9 AM Peak Hour Total	0.71	0.96	1.00	240
4-6 PM Peak Hour Enter	0.30	0.00	1.00	102
4-6 PM Peak Hour Exit	0.40	0.00	1.00	136
4-6 PM Peak Hour Total	0.71	0.92	1.00	238

***The above rates were calculated from the equations shown below:**

Average Weekday 2-way Volume: $T = 3.16\ (X) + 160.04$

Peak Hour of Generator

7-9 AM Peak Hour Total: $T = 0.61\ (X) + 34.25$ — Enter 0.72, Exit 0.28

4-6 PM Peak Hour Total: $T = 0.62\ (X) + 29.00$ — Enter 0.43, Exit 0.57

Source: Institute of Transportation Engineers
Trip Generartion, 10th Edition, 2017.

Appendix C
Growth Rate Calculations

SR21 N OF US250, NW OF STRASBURG, ID 1579 - COUNT DATA FROM ODOT WEBSITE

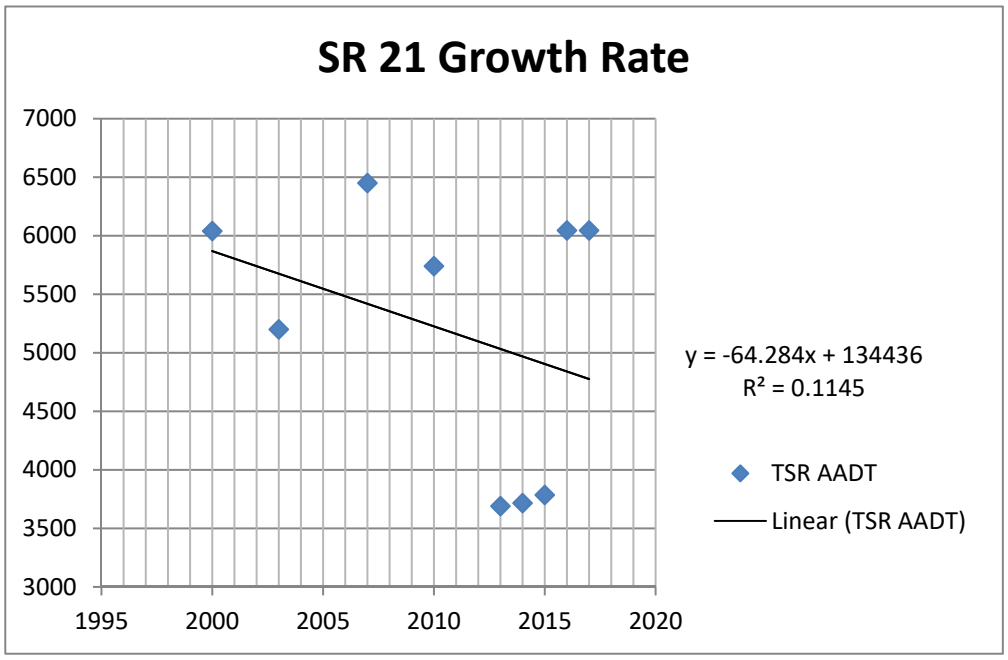
Year	*Volume*	*% Diff per Yr to Prev Yr Count*	*% Diff per Yr Since 2017*
2017	6045	0.00%	
2016	6045	59.71%	0.00%
2015	3785	1.86%	29.85%
2014	3716	0.70%	20.89%
2013	3690	-11.90%	15.96%
2010	5740	-3.67%	0.76%
2007	6450	6.01%	-0.63%
2003	5200	-4.64%	1.16%
2000	6040		0.00%

AVG/YEAR Since 2000
0.005%

AVG/YEAR Since 2003
1.16%

AVG/YEAR Since 2010
0.76%

Fitted Curve Growth: ***-1.10%***



US 250 SE OF SR93, NW OF STRASBURG , ID 779 - COUNT DATA FROM ODOT WEBSITE

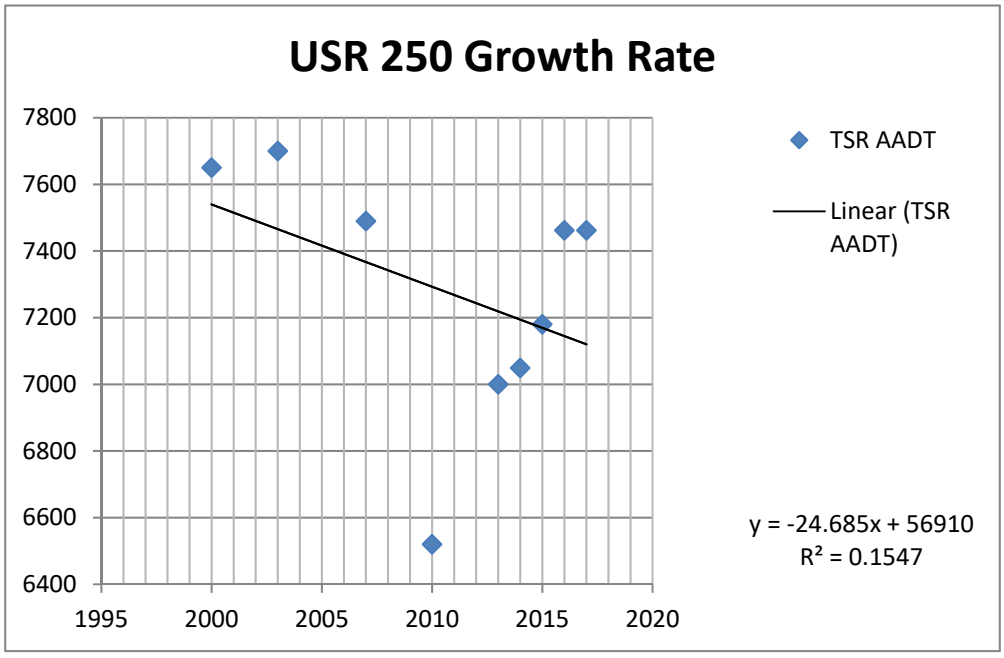
Year	*Volume*	*% Diff per Yr to Prev Yr Count*	*% Diff per Yr Since 2017*
2017	7462	0.00%	
2016	7462	3.93%	0.00%
2015	7180	1.86%	1.96%
2014	7049	0.70%	1.95%
2013	7000	2.45%	1.65%
2010	6520	-4.32%	2.06%
2007	7490	-0.68%	-0.04%
2003	7700	0.22%	-0.22%
2000	7650		-0.14%

AVG/YEAR Since 2000
-0.14%

AVG/YEAR Since 2003
-0.22%

AVG/YEAR Since 2010
2.06%

Fitted Curve Growth: ***-0.33%***



Appendix D
Existing Capacity Analyses Worksheets - 2018

HCS7 Two-Way Stop-Control Report

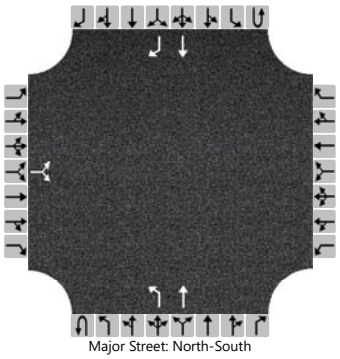
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2018
Time Analyzed	AM Peak
Intersection Orientation	North-South
Project Description	Existing Conditions

Site Information

Intersection	SR 21 & USR 250 / SR 21
Jurisdiction	Strasburg, Ohio
East/West Street	USR 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		17		207						198	174				202	15
Percent Heavy Vehicles (%)		17		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.57		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.65		3.45						2.35						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			243							215						
Capacity, c (veh/h)			681							1266						
v/c Ratio			0.36							0.17						
95% Queue Length, Q_{95} (veh)			1.6							0.6						
Control Delay (s/veh)			13.2							8.4						
Level of Service (LOS)			B							A						
Approach Delay (s/veh)		13.2								4.5						
Approach LOS		B														

HCS7 Two-Way Stop-Control Report

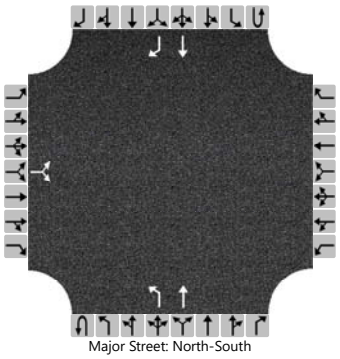
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2018
Time Analyzed	PM Peak
Intersection Orientation	North-South
Project Description	Existing Conditions

Site Information

Intersection	SR 21 & USR 250 / SR 21
Jurisdiction	Strasburg, Ohio
East/West Street	USR 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		35		340						267	236				263	33
Percent Heavy Vehicles (%)		17		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.57		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.65		3.45						2.35						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			408							290						
Capacity, c (veh/h)			543							1195						
v/c Ratio			0.75							0.24						
95% Queue Length, Q_{95} (veh)			6.5							1.0						
Control Delay (s/veh)			28.9							9.0						
Level of Service (LOS)			D							A						
Approach Delay (s/veh)		28.9								4.8						
Approach LOS		D														

Appendix E
No Build Capacity Analysis Worksheets - 2019

HCS7 Two-Way Stop-Control Report

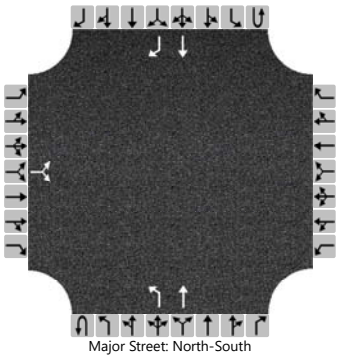
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2019
Time Analyzed	AM Peak
Intersection Orientation	North-South
Project Description	No Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
Jurisdiction	Strasburg, Ohio
East/West Street	USR 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		20		220						240	210				250	20
Percent Heavy Vehicles (%)		17		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.57		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.65		3.45						2.35						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			261							261						
Capacity, c (veh/h)			593							1210						
v/c Ratio			0.44							0.22						
95% Queue Length, Q_{95} (veh)			2.2							0.8						
Control Delay (s/veh)			15.7							8.8						
Level of Service (LOS)			C							A						
Approach Delay (s/veh)		15.7								4.7						
Approach LOS		C														

HCS7 Two-Way Stop-Control Report

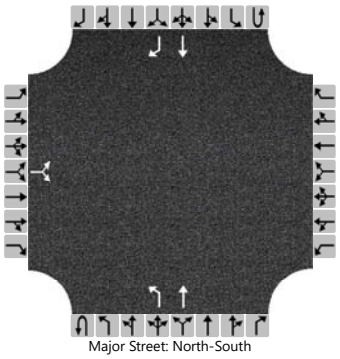
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2019
Time Analyzed	PM Peak
Intersection Orientation	North-South
Project Description	No Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
Jurisdiction	Strasburg, Ohio
East/West Street	USR 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		40		360						330	290				320	40
Percent Heavy Vehicles (%)		17		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.57		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.65		3.45						2.35						

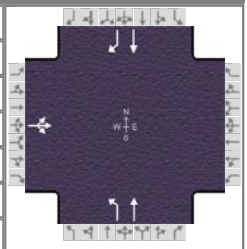
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			435							359						
Capacity, c (veh/h)			425							1132						
v/c Ratio			1.02							0.32						
95% Queue Length, Q_{95} (veh)			13.4							1.4						
Control Delay (s/veh)			81.0							9.6						
Level of Service (LOS)			F							A						
Approach Delay (s/veh)		81.0								5.1						
Approach LOS		F														

Appendix F
No Build Capacity Analysis Worksheets - 2019
Signal & Roundabout Control

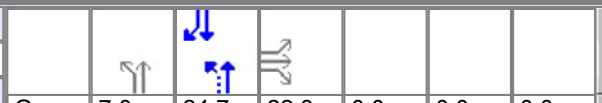
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	TMS Engineers, Inc.			Duration, h	0.25
Analyst	MWS	Analysis Date	6/23/2018	Area Type	Other
Jurisdiction	City of Strasburg, Ohio	Time Period	AM Peak	PHF	0.92
Urban Street	SR 21	Analysis Year	2019	Analysis Period	1> 7:00
Intersection	SR 21 & USR 250 / SR 21	File Name	2019 NB AM 21 250.xus		
Project Description	No Build w Improvements				

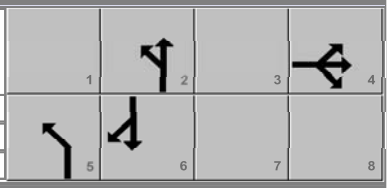


Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	20	0	220				240	210			250	20

Signal Information			
Cycle, s	75.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	7.0	24.7	22.3	0.0	0.0	0.0
Yellow	5.0	5.0	5.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0



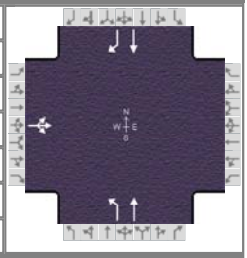
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		12.0			1.0	4.0		7.3
Phase Duration, s		29.3			14.0	45.7		31.7
Change Period, ($Y+R_c$), s		7.0			7.0	7.0		7.0
Max Allow Headway (*MAH*), s		4.2			4.0	0.0		0.0
Queue Clearance Time (g_s), s		12.1			9.0			
Green Extension Time (g_e), s		0.7			0.0	0.0		0.0
Phase Call Probability		1.00			1.00			
Max Out Probability		0.03			1.00			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h		261					261	228			272	22
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1625					1570	1648			1693	1434
Queue Service Time (g_s), s		10.1					7.0	5.8			9.6	0.8
Cycle Queue Clearance Time (g_c), s		10.1					7.0	5.8			9.6	0.8
Green Ratio (*g/C*)		0.30					0.45	0.52			0.33	0.33
Capacity (*c*), veh/h		483					439	850			557	472
Volume-to-Capacity Ratio (*X*)		0.540					0.595	0.268			0.488	0.046
Back of Queue (*Q*), ft/ln (85 th percentile)		137.2					123.3	92.7			160.9	12.5
Back of Queue (*Q*), veh/ln (85 th percentile)		5.5					4.3	3.3			5.8	0.4
Queue Storage Ratio (*RQ*) (85 th percentile)		0.00					0.62	0.00			0.00	0.12
Uniform Delay (d_1), s/veh		22.1					16.2	10.2			20.1	17.1
Incremental Delay (d_2), s/veh		1.2					2.2	0.8			3.0	0.2
Initial Queue Delay (d_3), s/veh		0.0					0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh		23.3					18.4	11.0			23.1	17.3
Level of Service (LOS)		C					B	B			C	B
Approach Delay, s/veh / LOS	23.3	C		0.0			14.9	B		22.7	C	
Intersection Delay, s/veh / LOS	19.2						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS7 Signalized Intersection Results Summary

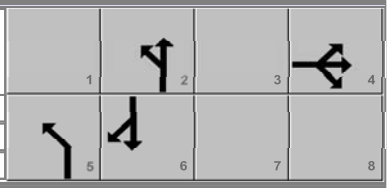
General Information				Intersection Information	
Agency	TMS Engineers, Inc.			Duration, h	0.25
Analyst	MWS	Analysis Date	6/23/2018	Area Type	Other
Jurisdiction	City of Strasburg, Ohio	Time Period	PM Peak	PHF	0.92
Urban Street	SR 21	Analysis Year	2019	Analysis Period	1> 7:00
Intersection	SR 21 & USR 250 / SR 21	File Name	2019 NB PM 21 250.xus		
Project Description	No Build w Improvements				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	40	0	360				330	290			320	40

Signal Information			
Cycle, s	90.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	13.9	25.7	29.4	0.0	0.0	0.0
Yellow	5.0	5.0	5.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		12.0			1.0	4.0		7.3
Phase Duration, s		36.4			20.9	53.6		32.7
Change Period, ($Y+R_c$), s		7.0			7.0	7.0		7.0
Max Allow Headway (*MAH*), s		4.2			4.0	0.0		0.0
Queue Clearance Time (g_s), s		24.1			15.9			
Green Extension Time (g_e), s		0.9			0.0	0.0		0.0
Phase Call Probability		1.00			1.00			
Max Out Probability		0.63			1.00			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h		435					359	315			348	43
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1628					1570	1648			1693	1434
Queue Service Time (g_s), s		22.1					13.9	10.3			16.6	2.0
Cycle Queue Clearance Time (g_c), s		22.1					13.9	10.3			16.6	2.0
Green Ratio (*g/C*)		0.33					0.46	0.52			0.29	0.29
Capacity (*c*), veh/h		532					414	853			483	410
Volume-to-Capacity Ratio (*X*)		0.817					0.866	0.369			0.720	0.106
Back of Queue (*Q*), ft/ln (85 th percentile)		308.4					258.6	155.2			283.1	34.5
Back of Queue (*Q*), veh/ln (85 th percentile)		12.3					9.1	5.5			10.2	1.2
Queue Storage Ratio (*RQ*) (85 th percentile)		0.00					0.94	0.00			0.00	0.35
Uniform Delay (d_1), s/veh		27.8					20.4	12.9			28.9	23.7
Incremental Delay (d_2), s/veh		9.7					17.3	1.2			8.9	0.5
Initial Queue Delay (d_3), s/veh		0.0					0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh		37.5					37.7	14.2			37.8	24.2
Level of Service (LOS)		D					D	B			D	C
Approach Delay, s/veh / LOS	37.5	D		0.0			26.7	C		36.3	D	
Intersection Delay, s/veh / LOS	32.3						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS7 Roundabouts Report

General Information

Analyst	MWS
Agency or Co.	TMS Engineers, Inc.
Date Performed	6/24/2018
Analysis Year	2019
Time Analyzed	AM Peak
Project Description	No-Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
E/W Street Name	USR 250
N/S Street Name	SR 21
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.92
Jurisdiction	City of Strasburg, Ohio

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0
Lane Assignment			LR								LT				TR	
Volume (V), veh/h	0	20		220					0	240	210		0		250	20
Percent Heavy Vehicles, %	3	17		17					3	17	17		3		13	13
Flow Rate (v_{PCE}), pc/h	0	25		280					0	305	267		0		307	25
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1								1				1			
Pedestrians Crossing, p/h	0								0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763						4.9763			4.9763	
Follow-Up Headway (s)		2.6087						2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		305						572			332	
Entry Volume veh/h		261						489			294	
Circulating Flow (v_c), pc/h	307			597			25			305		
Exiting Flow (v_{ex}), pc/h	0			330			292			587		
Capacity (c_{pce}), pc/h		1009						1345			1011	
Capacity (c), veh/h		862						1150			895	
v/c Ratio (x)		0.30						0.43			0.33	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		7.5						7.6			7.6	
Lane LOS		A						A			A	
95% Queue, veh		1.3						2.2			1.4	
Approach Delay, s/veh	7.5						7.6			7.6		
Approach LOS	A						A			A		
Intersection Delay, s/veh | LOS	7.6						A					

HCS7 Roundabouts Report

General Information		Site Information	
Analyst	MWS	Intersection	SR 21 & USR 250 / SR 21
Agency or Co.	TMS Engineers, Inc.	E/W Street Name	USR 250
Date Performed	6/24/2018	N/S Street Name	SR 21
Analysis Year	2019	Analysis Time Period (hrs)	0.25
Time Analyzed	PM Peak	Peak Hour Factor	0.92
Project Description	No-Build	Jurisdiction	City of Strasburg, Ohio

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0
Lane Assignment			LR								LT				TR	
Volume (V), veh/h	0	40		360					0	330	290		0		320	40
Percent Heavy Vehicles, %	3	17		17					3	17	17		3		13	13
Flow Rate (v_{PCE}), pc/h	0	51		458					0	420	369		0		393	49
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1								1				1			
Pedestrians Crossing, p/h	0								0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763						4.9763			4.9763	
Follow-Up Headway (s)		2.6087						2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		509						789			442	
Entry Volume veh/h		435						674			391	
Circulating Flow (v_c), pc/h		393			840			51			420	
Exiting Flow (v_{ex}), pc/h		0			469			420			851	
Capacity (c_{pce}), pc/h		924						1310			899	
Capacity (c), veh/h		790						1120			796	
v/c Ratio (x)		0.55						0.60			0.49	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		12.8						11.0			11.3	
Lane LOS		B						B			B	
95% Queue, veh		3.4						4.2			2.8	
Approach Delay, s/veh	12.8						11.0			11.3		
Approach LOS	B						B			B		
Intersection Delay, s/veh | LOS	11.6						B					

Appendix G
Signal Warrant Analysis

RIGHT TURN FACTORIZATION SHEET

Intersection: SR 21 & USR 250 | Conditions: 2018 Existing
Municpality: Strasburg, OH | County: Tuscarawas

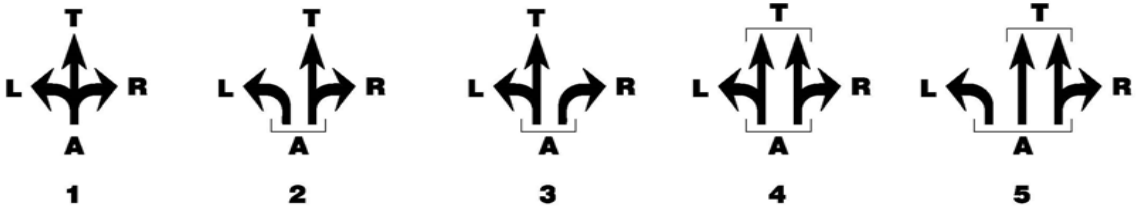
		MINOR STREET Approach: EB Config: *1*																								
		VOLUMES				MAINLINE APPROACH VOLUME	BASE RIGHT TURN REDUCTION	MAINLINE CONGESTION FACTOR	ADJUSTED RIGHT TURN REDUCTION	ADJUSTED RIGHT TURNS	ADJUSTED MINOR STREET VOLUMES	LEFT	THRU	RIGHT	TOTAL											
DIR	HOUR BEGIN	LEFT	THRU	RIGHT	TOTAL	PER LANE	%	%	%			L	T	R	A	0.7A	0.35A	3T	T/3	(T+L)	(T+R)	3R	3L	T/2	T/4	BASE REDUCTION
					0		0%	0%	0%	0	*0*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
	7:00	*17*	*0*	*207*	224	*224*	60%	0%	60%	83	*100*	17	0	207	224	157	78	0	0	17	207	621	51	0	0	60%
	8:00	*20*	*0*	*181*	201	*201*	60%	0%	60%	72	*92*	20	0	181	201	141	70	0	0	20	181	543	60	0	0	60%
	9:00	*20*	*0*	*165*	185	*185*	60%	0%	60%	66	*86*	20	0	165	185	130	65	0	0	20	165	495	60	0	0	60%
	10:00				0		0%	0%	0%	0	*0*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
	11:00	*20*	*0*	*182*	202	*202*	60%	0%	60%	73	*93*	20	0	182	202	141	71	0	0	20	182	546	60	0	0	60%
	12:00	*18*	*0*	*189*	207	*207*	60%	0%	60%	76	*94*	18	0	189	207	145	72	0	0	18	189	567	54	0	0	60%
	1:00	*27*	*0*	*211*	238	*211*	60%	0%	60%	84	*111*	27	0	211	238	167	83	0	0	27	211	633	81	0	0	60%
	2:00				0		0%	0%	0%	0	*0*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
	3:00	*28*	*0*	*321*	349	*349*	60%	0%	60%	128	*156*	28	0	321	349	244	122	0	0	28	321	963	84	0	0	60%
	4:00	*35*	*0*	*340*	375	*375*	60%	0%	60%	136	*171*	35	0	340	375	263	131	0	0	35	340	1020	105	0	0	60%
	5:00	*27*	*0*	*306*	333	*333*	60%	0%	60%	122	*149*	27	0	306	333	233	117	0	0	27	306	918	81	0	0	60%
	6:00				0		0%	0%	0%	0	*0*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
					0		0%	0%	0%	0	*0*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
					0		0%	0%	0%	0	*0*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
					0		0%	0%	0%	0	*0*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%

Mainline Congestion Factors	
Volume	Factor (%)
0-399	0%
400-499	5%
500-599	10%
600-699	15%
700-799	20%
800-899	25%
900-999	30%
1000-1099	35%
1100-1199	40%
1200-1299	45%
1300-1399	50%
1400-1499	55%

REVIEW INFORMATION

Counts Used:	
Count Dated:	5/8/2018
Date Reviewed:	5/1/2018
Reviewed By:	MWS

LANE CONFIGURATIONS



Any Configuration with any exclusive right turn lane

2018 EXISTING CONDITIONS
TRAFFIC SIGNAL WARRANT SUMMARY

City: Strasburg, Ohio
County: Tuscarawas
Engineer: MWS
Date: June 27, 2018

Major Street: SR 21 — Lanes: 1 — Critical Approach Speed: 55
Minor Street: USR 250 — Lanes: 1

Volume Level Criteria

1. Is the critical speed of major street traffic > 70 km/h (40 mph) ? ☒ Yes ☐ No
2. Is the intersection in a built-up area of isolated community of <10,000 population? ☒ Yes ☐ No

If Question 1 or 2 above is answered "Yes", then use "70%" volume level ☒ 70% ☐ 100%

WARRANT 1 - EIGHT-HOUR VEHICULAR VOLUME

Applicable: ☒ Yes ☐ No
Satisfied: ☒ Yes ☐ No

Warrant 1 is satisfied if Condition A or Condition B is "100%" satisfied.
Warrant is also satisfied if both Condition A and Condition B are "80%" satisfied.

Condition A - Minimum Vehicular Volume

100% Satisfied: ☐ Yes ☒ No
80% Satisfied: ☒ Yes ☐ No

(volumes in veh/hr)	Minimum Requirements (80% Shown in Brackets)				Eight Highest Hours							
Approach Lanes	1		2 or more		7:00 AM - 8:00 AM	8:00 AM - 9:00 AM	9:00 AM - 10:00 AM	12:00 PM - 1:00 PM	1:00 PM - 2:00 PM	3:00 PM - 4:00 PM	4:00 PM - 5:00 PM	5:00 PM - 6:00 PM
Volume Level	100%	70%	100%	70%								
Both Approaches on Major Street	500 (400)	**350 (280)**	600 (480)	420 (336)	589	505	503	527	544	761	799	805
Highest Approach on Minor Street	150 (120)	**105 (84)**	200 (160)	140 (112)	100	92	93	94	111	156	171	149

Record 8 highest hours and the corresponding volumes in boxes provided. Condition is 100% satisfied if the minimum volumes are met for eight hours. Condition is 80% satisfied if parenthetical volumes are met for eight hours.

Condition B - Interruption of Continuous Traffic

Condition B is intended for application where the traffic volume is so heavy that traffic on the minor street suffers excessive delay.

Applicable: ☒ Yes ☐ No
Excessive Delay: ☒ Yes ☐ No
100% Satisfied: ☐ Yes ☒ No
80% Satisfied: ☒ Yes ☐ No

(volumes in veh/hr)	Minimum Requirements (80% Shown in Brackets)				Eight Highest Hours							
Approach Lanes	1		2 or more		7:00 AM - 8:00 AM	8:00 AM - 9:00 AM	9:00 AM - 10:00 AM	12:00 PM - 1:00 PM	1:00 PM - 2:00 PM	3:00 PM - 4:00 PM	4:00 PM - 5:00 PM	5:00 PM - 6:00 PM
Volume Level	100%	70%	100%	70%								
Both Approaches on Major Street	750 (600)	**525 (420)**	900 (720)	630 (504)	589	505	503	527	544	761	799	805
Highest Approach on Minor Street	75 (60)	**53 (42)**	100 (80)	70 (56)	100	92	93	94	111	156	171	149

Record 8 highest hours and the corresponding volumes in boxes provided. Condition is 100% satisfied if the minimum volumes are met for eight hours. Condition is 80% satisfied if parenthetical volumes are met for eight hours.

Source: Revised from NCHRP Report 457

2018 EXISTING CONDITIONS
TRAFFIC SIGNAL WARRANT SUMMARY

City: Strasburg, Ohio
County: Tuscarawas
Engineer: MWS
Date: June 25, 2018

Major Street: SR 21 Lanes: 1
Minor Street: USR 250 Lanes: 1
Critical Approach Speed: 55

Volume Level Criteria

1. Is the critical speed of major street traffic > 70 km/h (40 mph) ? ☒ Yes ☐ No
2. Is the intersection in a built-up area of isolated community of <10,000 population? ☒ Yes ☐ No

If Question 1 or 2 above is answered "Yes", then use "70%" volume level ☒ 70% ☐ 100%

WARRANT 2 - FOUR-HOUR VEHICULAR VOLUME

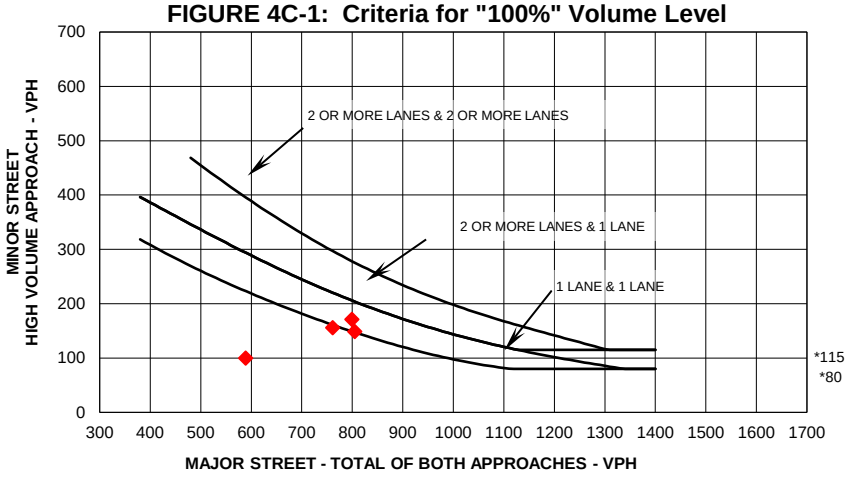
If all four points lie above the appropriate line, then the warrant is satisfied.

Applicable: ☒ Yes ☐ No
Satisfied: ☒ Yes ☐ No

Four Highest Hours	Volumes	
	Major Street	Minor Street
7:00 AM - 8:00 AM	589	100
8:00 AM - 9:00 AM	761	156
4:00 PM - 5:00 PM	799	171
5:00 PM - 6:00 PM	805	149

Plot four volume combinations on the applicable figure below.

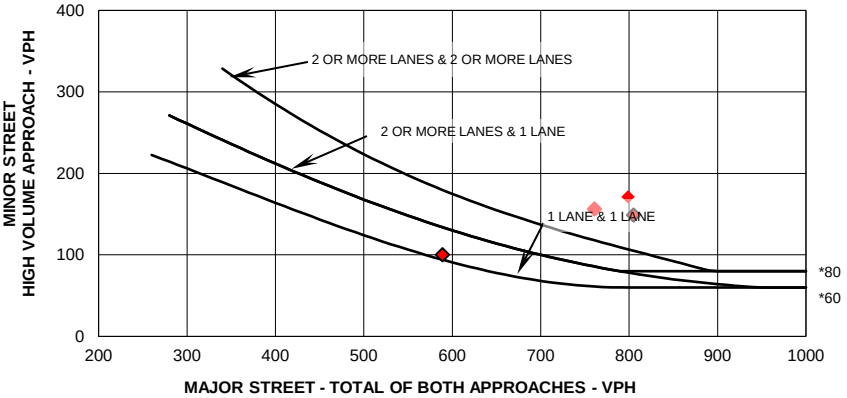
FIGURE 4C-1: Criteria for "100%" Volume Level



** Note: 115 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 80 vph applies as the lower threshold volume threshold for a minor street approach with one lane.*

FIGURE 4C-2: Criteria for "70%" Volume Level

(Community Less than 10,000 population or above 70 km/hr (40 mph) on Major Street)



** Note: 80 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 60 vph applies as the lower threshold volume threshold for a minor street approach with one lane.*

Source: Revised from NCHRP Report 457

2018 EXISTING CONDITIONS
TRAFFIC SIGNAL WARRANT SUMMARY

City: Strasburg, Ohio
County: Tuscarawas
Engineer: MWS
Date: June 25, 2018

Major Street: SR 21 Lanes: 1 Critical Approach Speed: 55
Minor Street: USR 250 Lanes: 1

Volume Level Criteria

1. Is the critical speed of major street traffic > 70 km/h (40 mph) ? ☒ Yes ☐ No
2. Is the intersection in a built-up area of isolated community of <10,000 population? ☒ Yes ☐ No

If Question 1 or 2 above is answered "Yes", then use "70%" volume level ☒ 70% ☐ 100%

WARRANT 3 - PEAK HOUR

Applicable: ☐ Yes ☒ No
Satisfied: ☐ Yes ☒ No

If all three criteria are fullfilled or the plotted point lies above the appropriate line, then the warrant is satisfed.

Unusual condition justifying use of warrant:
No Unusual conditions

Record hour when criteria are fulfilled and the corresponding delay or volume in boxes provided.

Peak Hour		

Criteria

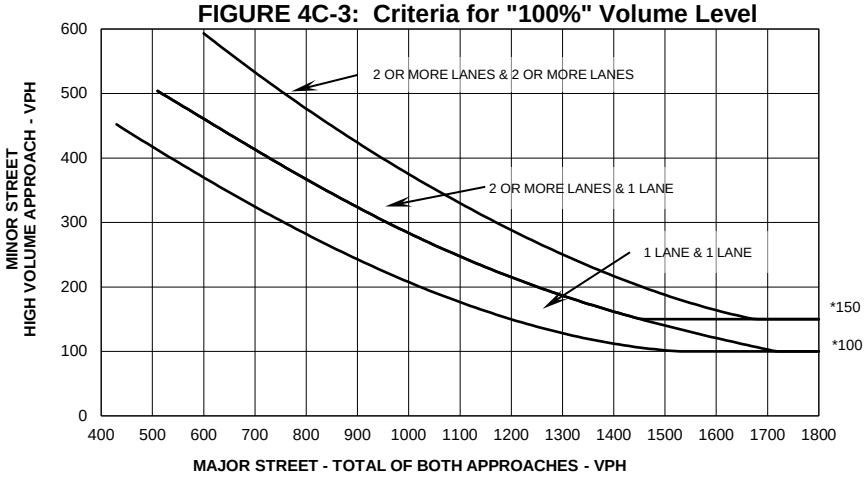
1. Delay on Minor Approach *(vehicle-hours)		
Approach Lanes	1	2
Delay Criteria*	4.0	5.0
Delay*		
Fulfilled?: ☐ Yes ☐ No		

2. Volume on Minor Approach *(vehicles per hour)		
Approach Lanes	1	2
Volume Criteria*	100	150
Volume*		
Fulfilled?: ☐ Yes ☐ No		

3. Total Entering Volume *(vehicles per hour)		
No. of Approaches	3	4
Volume Criteria*	650	800
Volume*		
Fulfilled?: ☐ Yes ☐ No		

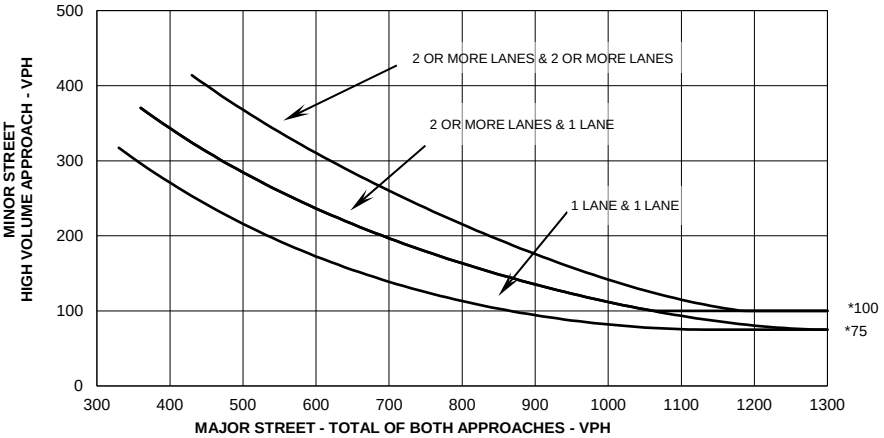
Plot volume combination on the applicable figure below.

FIGURE 4C-3: Criteria for "100%" Volume Level



** Note: 150 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 100 vph applies as the lower threshold volume threshold for a minor street approach with one lane.*

FIGURE 4C-4: Criteria for "70%" Volume Level
(Community Less than 10,000 population or above 70 km/hr (40 mph) on Major Street)



** Note: 100 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 75 vph applies as the lower threshold volume threshold for a minor street approach with one lane.*

Source: Revised from NCHRP Report 457

2018 EXISTING CONDITIONS
TRAFFIC SIGNAL WARRANT SUMMARY

City: Strasburg, Ohio
County: Tuscarawas
Engineer: MWS
Date: June 25, 2018

Major Street: SR 21 Lanes: 1 Critical Approach Speed: 55
Minor Street: USR 250 Lanes: 1

WARRANT 4 - PEDESTRIAN VOLUME

Applicable: ☐ Yes ☒ No
Satisfied: ☐ Yes ☒ No

Record hours where criteria are fulfilled and the corresponding volume or gap frequency in the boxes provided. The warrant is satisfied if condition 1 or 2 is fulfilled and condition 3 is fulfilled.

Criteria	Hour	Pedestrian Volume	Pedestrian Gaps	Fulfilled? Yes	Fulfilled? No
1. Pedestrian volume crossing the major street is 100 ped/hr or more for each of any four hours and there are less than 60 gaps per hour in the major street traffic stream of adequate length.					☒
2. Pedestrian volume crossing the major street is 190 ped/hr or more for any one hour and there are less than 60 gaps per hour in the major street traffic stream of adequate length.					☒
3. The nearest traffic signal along the major street is located more than 90 m (300 ft) away, or the nearest signal is within 90 m (300 ft) but the proposed traffic signal will not restrict the progressive movement of traffic.					☒

WARRANT 5 - SCHOOL CROSSING

Applicable: ☐ Yes ☒ No
Satisfied: ☐ Yes ☒ No

Record hours where criteria are fulfilled and the corresponding volume or gap frequency in the boxes provided. The warrant is satisfied if all three of the criteria are fulfilled.

Criteria				Fulfilled? Yes	Fulfilled? No
1. There are a minimum of 20 students crossing the major street during the highest crossing hour.	Students:	Hour:			x
2. There are fewer adequate gaps in the major street traffic stream during the period when the children are using the crossing than the number of minutes in the same period.		Minutes:	Gaps:		x
3. The nearest traffic signal along the major street is located more than 90 m (300 ft) away, or the nearest signal is within 90 m (300 ft) but the proposed traffic signal will not restrict the progressive movement of traffic.					x

WARRANT 6 - COORDINATED SIGNAL SYSTEM

Applicable: ☐ Yes ☒ No
Satisfied: ☐ Yes ☒ No

Indicate if the criteria are fulfilled in the boxes provided. The warrant is satisfied if either criterion is fulfilled. This warrant should not be applied when the resulting signal spacing would be less than 300 m (1,000 ft).

Criteria	Fulfilled? Yes	Fulfilled? No
1. On a one-way street or a street that has traffic predominately in one direction, the adjacent signals are so far apart that they do not provide the necessary degree of vehicle platooning.		x
2. On a two-way street, adjacent signals do not provide the necessary degree of platooning, and the proposed and adjacent signals will collectively provide a progressive operation.		x

Source: Revised from NCHRP Report 457

2018 EXISTING CONDITIONS
TRAFFIC SIGNAL WARRANT SUMMARY

City: Strasburg, Ohio
County: Tuscarawas
Engineer: MWS
Date: June 25, 2018

Major Street: SR 21 — Lanes: 1
Minor Street: USR 250 — Lanes: 1
Critical Approach Speed: 55

WARRANT 7 - CRASH EXPERIENCE

Applicable: ☒ Yes ☐ No
Satisfied: ☐ Yes ☒ No

Record hours where criteria are fulfilled, the corresponding volume, and other information in the boxes provided. The warrant is satisfied if all three of the criteria are fulfilled.

Criteria		Hour	Volume	Met? Yes	Met? No	Fulfilled? Yes	Fulfilled? No
1. One of the warrants to the right is met.	Warrant 1, Condition A (80% satisfied)			☒		☒	
	Warrant 1, Condition B (80% satisfied)			☒			
	Warrant 4, Pedestrian Volume at 80% of volume requirements: 80 ped/hr for four (4) hours or 152 ped/hr for one (1) hour						
2. Adequate trial of other remedial measure has failed to reduce crash frequency.		Measure tried:					☒
3. Five or more reported crashes, of types susceptible to correction by signal, have occurred within a 12-mo. period.		Number of crashes per 12 months:	0				

WARRANT 8 - ROADWAY NETWORK

Applicable: ☒ Yes ☐ No
Satisfied: ☒ Yes ☐ No

Record hours where criteria are fulfilled, and the corresponding volume or other information in the boxes provided. The warrant is satisfied if at least one of the criteria is fulfilled and if all intersecting routes have one or more of the characteristics listed.

Criteria							Met? Yes	Met? No	Fulfilled? Yes	Fulfilled? No
1. Both of the criteria to the right are met.	a. Total entering volume of at least 1,000 veh/hr during a typical weekday peak hour.		Entering Volume: 1,174				☒		☒	
	b. Five-year projected volumes that satisfy one or more of Warrants 1, 2, or 3.	Warrant:	1	2	3		☒			
		Satisfied?:	☒							
2. Total entering volume at least 1,000 veh/hr for each of any 5 hrs of a non-normal business day (Sat. or Sun.)							← Hour			☒
							← Volume			

Characteristics of Major Routes		Met? Yes	Met? No	Fulfilled? Yes	Fulfilled? No
1. Part of the street or highway system that serves as the principal roadway network for through traffic flow.	Major Street:	☒		☒	
	Minor Street:	☒			
2. Rural or suburban highway outside of, entering, or traversing a city.	Major Street:	☒			
	Minor Street:	☒			
3. Appears as a major route on an official plan.	Major Street:	☒			
	Minor Street:	☒			

CONCLUSIONS

Warrants Satisfied: 1 2 8

Remarks: Warrant #9 Not Applicable due to no railroad grade crossing
Intersection meets warrant criteria 1,2 & 8 under existing conditions

Source: Revised from NCHRP Report 457

Appendix H
No Build Capacity Analysis Worksheets - 2039

HCS7 Two-Way Stop-Control Report

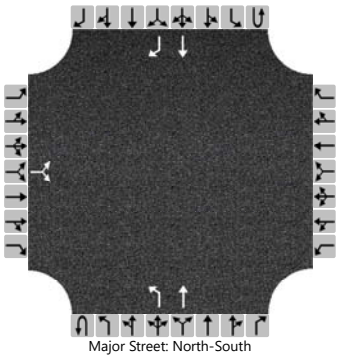
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2039
Time Analyzed	AM Peak
Intersection Orientation	North-South
Project Description	No Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
Jurisdiction	Strasburg, Ohio
East/West Street	USR 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		20		240						270	230				270	20
Percent Heavy Vehicles (%)		17		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.57		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.65		3.45						2.35						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			283							293						
Capacity, c (veh/h)			561							1187						
v/c Ratio			0.50							0.25						
95% Queue Length, Q_{95} (veh)			2.8							1.0						
Control Delay (s/veh)			17.8							9.0						
Level of Service (LOS)			C							A						
Approach Delay (s/veh)		17.8								4.9						
Approach LOS		C														

HCS7 Two-Way Stop-Control Report

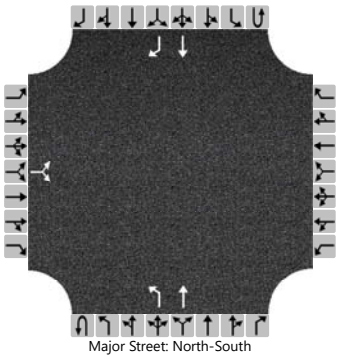
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2039
Time Analyzed	PM Peak
Intersection Orientation	North-South
Project Description	No Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
Jurisdiction	Strasburg, Ohio
East/West Street	USR 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		40		400						360	320				350	40
Percent Heavy Vehicles (%)		17		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.57		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.65		3.45						2.35						

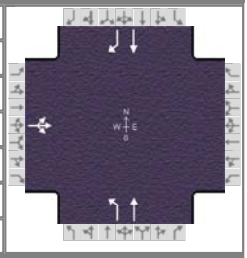
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			478							391						
Capacity, c (veh/h)			387							1100						
v/c Ratio			1.24							0.36						
95% Queue Length, Q_{95} (veh)			20.3							1.6						
Control Delay (s/veh)			157.1							10.1						
Level of Service (LOS)			F							B						
Approach Delay (s/veh)		157.1								5.3						
Approach LOS		F														

Appendix I
No-Build Capacity Analysis Worksheets - 2039
Signal & Roundabout Control

HCS7 Signalized Intersection Results Summary

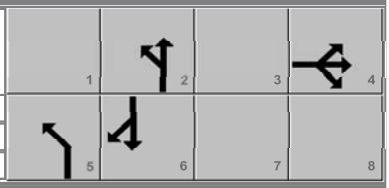
General Information				Intersection Information	
Agency	TMS Engineers, Inc.			Duration, h	0.25
Analyst	MWS	Analysis Date	6/23/2018	Area Type	Other
Jurisdiction	City of Strasburg, Ohio	Time Period	AM Peak	PHF	0.92
Urban Street	SR 21	Analysis Year	2039	Analysis Period	1> 7:00
Intersection	SR 21 & USR 250 / SR 21	File Name	2039 NB AM 21 250.xus		
Project Description	No Build w Improvements				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	20	0	240				270	230			270	20

Signal Information			
Cycle, s	75.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	7.0	24.6	22.4	0.0	0.0	0.0
Yellow	5.0	5.0	5.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0



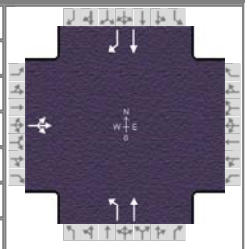
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		12.0			1.0	4.0		7.3
Phase Duration, s		29.4			14.0	45.6		31.6
Change Period, ($Y+R_c$), s		7.0			7.0	7.0		7.0
Max Allow Headway (*MAH*), s		4.2			4.0	0.0		0.0
Queue Clearance Time (g_s), s		13.1			9.0			
Green Extension Time (g_e), s		0.7			0.0	0.0		0.0
Phase Call Probability		1.00			1.00			
Max Out Probability		0.06			1.00			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h		283					293	250			293	22
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1624					1570	1648			1693	1434
Queue Service Time (g_s), s		11.1					7.0	6.5			10.6	0.8
Cycle Queue Clearance Time (g_c), s		11.1					7.0	6.5			10.6	0.8
Green Ratio (*g/C*)		0.30					0.45	0.51			0.33	0.33
Capacity (*c*), veh/h		485					421	848			555	470
Volume-to-Capacity Ratio (*X*)		0.583					0.696	0.295			0.529	0.046
Back of Queue (*Q*), ft/ln (85 th percentile)		150.5					149.3	101.3			175.3	12.5
Back of Queue (*Q*), veh/ln (85 th percentile)		6.0					5.3	3.6			6.3	0.4
Queue Storage Ratio (*RQ*) (85 th percentile)		0.00					0.75	0.00			0.00	0.12
Uniform Delay (d_1), s/veh		22.3					18.4	10.4			20.5	17.2
Incremental Delay (d_2), s/veh		1.8					5.0	0.9			3.6	0.2
Initial Queue Delay (d_3), s/veh		0.0					0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh		24.1					23.3	11.3			24.1	17.4
Level of Service (LOS)		C					C	B			C	B
Approach Delay, s/veh / LOS	24.1	C		0.0			17.8	B		23.6	C	
Intersection Delay, s/veh / LOS	21.0						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS7 Signalized Intersection Results Summary

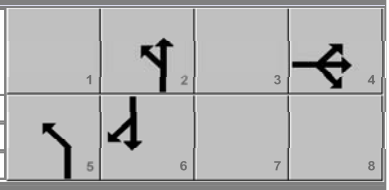
General Information				Intersection Information	
Agency	TMS Engineers, Inc.			Duration, h	0.25
Analyst	MWS	Analysis Date	6/23/2018	Area Type	Other
Jurisdiction	City of Strasburg, Ohio	Time Period	PM Peak	PHF	0.92
Urban Street	SR 21	Analysis Year	2039	Analysis Period	1> 7:00
Intersection	SR 21 & USR 250 / SR 21	File Name	2039 NB PM 21 250.xus		
Project Description	No Build w Improvements				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	40	0	400				360	320			350	40

Signal Information			
Cycle, s	90.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	16.7	23.5	28.8	0.0	0.0	0.0	
Yellow	5.0	5.0	5.0	0.0	0.0	0.0	
Red	2.0	2.0	2.0	0.0	0.0	0.0	



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		12.0			1.0	4.0		7.3
Phase Duration, s		35.8			23.7	54.2		30.5
Change Period, ($Y+R_c$), s		7.0			7.0	7.0		7.0
Max Allow Headway (*MAH*), s		4.2			4.0	0.0		0.0
Queue Clearance Time (g_s), s		27.5			17.9			
Green Extension Time (g_e), s		0.3			0.0	0.0		0.0
Phase Call Probability		1.00			1.00			
Max Out Probability		1.00			1.00			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h		478					391	348			380	43
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1626					1570	1648			1693	1434
Queue Service Time (g_s), s		25.5					15.9	11.4			19.3	2.1
Cycle Queue Clearance Time (g_c), s		25.5					15.9	11.4			19.3	2.1
Green Ratio (*g/C*)		0.32					0.47	0.52			0.26	0.26
Capacity (*c*), veh/h		520					413	864			442	375
Volume-to-Capacity Ratio (*X*)		0.919					0.948	0.402			0.861	0.116
Back of Queue (*Q*), ft/ln (85 th percentile)		391.6					328.3	169.8			355.2	36.2
Back of Queue (*Q*), veh/ln (85 th percentile)		15.7					11.6	6.0			12.8	1.3
Queue Storage Ratio (*RQ*) (85 th percentile)		0.00					0.88	0.00			0.00	0.36
Uniform Delay (d_1), s/veh		29.5					20.3	12.9			31.7	25.3
Incremental Delay (d_2), s/veh		21.5					31.3	1.4			19.3	0.6
Initial Queue Delay (d_3), s/veh		0.0					0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh		51.0					51.6	14.3			51.0	26.0
Level of Service (LOS)		D					D	B			D	C
Approach Delay, s/veh / LOS	51.0	D		0.0			34.1	C		48.4	D	
Intersection Delay, s/veh / LOS	42.7						D					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS7 Roundabouts Report

General Information

Analyst	MWS
Agency or Co.	TMS Engineers, Inc.
Date Performed	6/24/2018
Analysis Year	2039
Time Analyzed	AM Peak
Project Description	No-Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
E/W Street Name	USR 250
N/S Street Name	SR 21
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.92
Jurisdiction	City of Strasburg, Ohio

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0
Lane Assignment			LR								LT				TR	
Volume (V), veh/h	0	20		240					0	270	230		0		270	20
Percent Heavy Vehicles, %	3	17		17					3	17	17		3		13	13
Flow Rate (v_{PCE}), pc/h	0	25		305					0	343	292		0		332	25
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1								1				1			
Pedestrians Crossing, p/h	0								0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763						4.9763			4.9763	
Follow-Up Headway (s)		2.6087						2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		330						635			357	
Entry Volume veh/h		282						543			316	
Circulating Flow (v_c), pc/h	332			660			25			343		
Exiting Flow (v_{ex}), pc/h	0			368			317			637		
Capacity (c_{pce}), pc/h		984						1345			973	
Capacity (c), veh/h		841						1150			861	
v/c Ratio (x)		0.34						0.47			0.37	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		8.1						8.3			8.4	
Lane LOS		A						A			A	
95% Queue, veh		1.5						2.6			1.7	
Approach Delay, s/veh	8.1						8.3			8.4		
Approach LOS	A						A			A		
Intersection Delay, s/veh | LOS	8.3						A					

HCS7 Roundabouts Report

General Information

Analyst	MWS
Agency or Co.	TMS Engineers, Inc.
Date Performed	6/24/2018
Analysis Year	2039
Time Analyzed	PM Peak
Project Description	No-Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
E/W Street Name	USR 250
N/S Street Name	SR 21
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.92
Jurisdiction	City of Strasburg, Ohio

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0
Lane Assignment			LR								LT				TR	
Volume (V), veh/h	0	40		400					0	360	320		0		350	40
Percent Heavy Vehicles, %	3	17		17					3	17	17		3		13	13
Flow Rate (v_{PCE}), pc/h	0	51		509					0	458	407		0		430	49
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1								1				1			
Pedestrians Crossing, p/h	0								0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763						4.9763			4.9763	
Follow-Up Headway (s)		2.6087						2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		560						865			479	
Entry Volume veh/h		479						739			424	
Circulating Flow (v_c), pc/h	430			916			51			458		
Exiting Flow (v_{ex}), pc/h	0			507			458			939		
Capacity (c_{pce}), pc/h		890						1310			865	
Capacity (c), veh/h		761						1120			765	
v/c Ratio (x)		0.63						0.66			0.55	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		15.6						12.5			13.1	
Lane LOS		C						B			B	
95% Queue, veh		4.5						5.3			3.4	
Approach Delay, s/veh	15.6						12.5			13.1		
Approach LOS	C						B			B		
Intersection Delay, s/veh | LOS	13.6						B					

Appendix J
Build Capacity Analysis Worksheets - 2019

HCS7 Two-Way Stop-Control Report

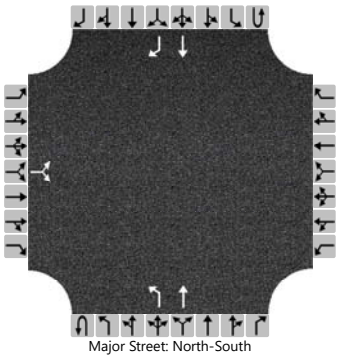
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2019
Time Analyzed	AM Peak
Intersection Orientation	North-South
Project Description	Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
Jurisdiction	Strasburg, Ohio
East/West Street	USR 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		20		237						257	272				266	20
Percent Heavy Vehicles (%)		17		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.57		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.65		3.45						2.35						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			279							279						
Capacity, c (veh/h)			562							1192						
v/c Ratio			0.50							0.23						
95% Queue Length, Q_{95} (veh)			2.8							0.9						
Control Delay (s/veh)			17.6							8.9						
Level of Service (LOS)			C							A						
Approach Delay (s/veh)		17.6								4.3						
Approach LOS		C														

HCS7 Two-Way Stop-Control Report

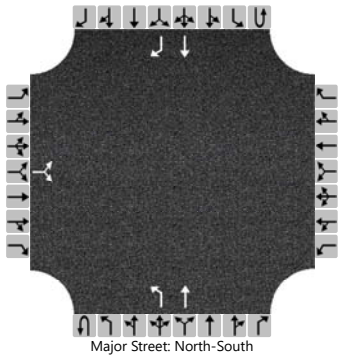
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2019
Time Analyzed	PM Peak
Intersection Orientation	North-South
Project Description	Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
Jurisdiction	Strasburg, Ohio
East/West Street	USR 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		40		394						340	323				355	40
Percent Heavy Vehicles (%)		17		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.57		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.65		3.45						2.35						

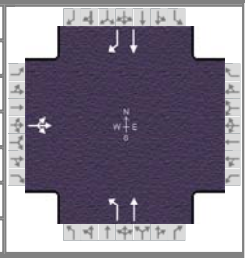
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			472							370						
Capacity, c (veh/h)			396							1095						
v/c Ratio			1.19							0.34						
95% Queue Length, Q_{95} (veh)			18.8							1.5						
Control Delay (s/veh)			138.6							10.0						
Level of Service (LOS)			F							A						
Approach Delay (s/veh)		138.6								5.1						
Approach LOS		F														

Appendix K
Build Capacity Analysis Worksheets - 2019
Signal & Roundabout Control

HCS7 Signalized Intersection Results Summary

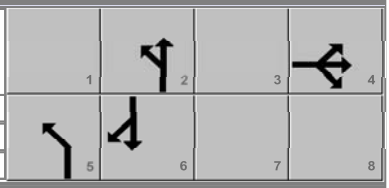
General Information				Intersection Information	
Agency	TMS Engineers, Inc.			Duration, h	0.25
Analyst	MWS	Analysis Date	6/23/2018	Area Type	Other
Jurisdiction	City of Strasburg, Ohio	Time Period	AM Peak	PHF	0.92
Urban Street	SR 21	Analysis Year	2019	Analysis Period	1> 7:00
Intersection	SR 21 & USR 250 / SR 21	File Name	2019 Build AM 21 250 w Improve.xus		
Project Description	Build w Improvements				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	20	0	237				257	272			266	20

Signal Information			
Cycle, s	75.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	7.0	24.6	22.4	0.0	0.0	0.0
Yellow	5.0	5.0	5.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0



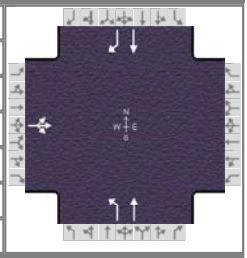
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		12.0			1.0	4.0		7.3
Phase Duration, s		29.4			14.0	45.6		31.6
Change Period, ($Y+R_c$), s		7.0			7.0	7.0		7.0
Max Allow Headway (*MAH*), s		4.2			4.0	0.0		0.0
Queue Clearance Time (g_s), s		12.9			9.0			
Green Extension Time (g_e), s		0.7			0.0	0.0		0.0
Phase Call Probability		1.00			1.00			
Max Out Probability		0.05			1.00			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h		279					279	296			289	22
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1624					1570	1648			1693	1434
Queue Service Time (g_s), s		10.9					7.0	8.0			10.4	0.8
Cycle Queue Clearance Time (g_c), s		10.9					7.0	8.0			10.4	0.8
Green Ratio (*g/C*)		0.30					0.45	0.51			0.33	0.33
Capacity (*c*), veh/h		485					425	848			555	470
Volume-to-Capacity Ratio (*X*)		0.576					0.658	0.349			0.521	0.046
Back of Queue (*Q*), ft/ln (85 th percentile)		148.5					137.9	119.3			172.3	12.5
Back of Queue (*Q*), veh/ln (85 th percentile)		5.9					4.9	4.2			6.2	0.4
Queue Storage Ratio (*RQ*) (85 th percentile)		0.00					0.69	0.00			0.00	0.12
Uniform Delay (d_1), s/veh		22.3					17.6	10.8			20.4	17.2
Incremental Delay (d_2), s/veh		1.7					3.7	1.1			3.5	0.2
Initial Queue Delay (d_3), s/veh		0.0					0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh		24.0					21.3	11.9			23.9	17.4
Level of Service (LOS)		C					C	B			C	B
Approach Delay, s/veh / LOS	24.0	C		0.0			16.4	B		23.4	C	
Intersection Delay, s/veh / LOS	20.1						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS7 Signalized Intersection Results Summary

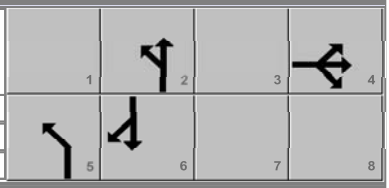
General Information				Intersection Information	
Agency	TMS Engineers, Inc.			Duration, h	0.25
Analyst	MWS	Analysis Date	6/23/2018	Area Type	Other
Jurisdiction	City of Strasburg, Ohio	Time Period	PM Peak	PHF	0.92
Urban Street	SR 21	Analysis Year	2019	Analysis Period	1> 7:00
Intersection	SR 21 & USR 250 / SR 21	File Name	2019 Build PM 21 250 w Improve.xus		
Project Description	Build w Improvements				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	40	0	394				340	323			355	40

Signal Information			
Cycle, s	90.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	15.4	24.6	29.0	0.0	0.0	0.0
Yellow	5.0	5.0	5.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		12.0			1.0	4.0		7.3
Phase Duration, s		36.0			22.4	54.0		31.6
Change Period, ($Y+R_c$), s		7.0			7.0	7.0		7.0
Max Allow Headway (*MAH*), s		4.2			4.0	0.0		0.0
Queue Clearance Time (g_s), s		26.9			16.8			
Green Extension Time (g_e), s		0.4			0.0	0.0		0.0
Phase Call Probability		1.00			1.00			
Max Out Probability		1.00			1.00			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h		472					370	351			386	43
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1627					1570	1648			1693	1434
Queue Service Time (g_s), s		24.9					14.8	11.6			19.3	2.0
Cycle Queue Clearance Time (g_c), s		24.9					14.8	11.6			19.3	2.0
Green Ratio (*g/C*)		0.32					0.47	0.52			0.27	0.27
Capacity (*c*), veh/h		524					400	861			463	392
Volume-to-Capacity Ratio (*X*)		0.900					0.923	0.408			0.834	0.111
Back of Queue (*Q*), ft/ln (85 th percentile)		373.7					297	172			344.7	35.4
Back of Queue (*Q*), veh/ln (85 th percentile)		14.9					10.5	6.1			12.4	1.3
Queue Storage Ratio (*RQ*) (85 th percentile)		0.00					0.91	0.00			0.00	0.35
Uniform Delay (d_1), s/veh		29.1					20.3	13.1			30.8	24.5
Incremental Delay (d_2), s/veh		18.5					26.8	1.4			16.1	0.6
Initial Queue Delay (d_3), s/veh		0.0					0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh		47.6					47.1	14.5			46.9	25.1
Level of Service (LOS)		D					D	B			D	C
Approach Delay, s/veh / LOS	47.6	D		0.0			31.2	C		44.7	D	
Intersection Delay, s/veh / LOS	39.5						D					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS7 Roundabouts Report

General Information

Analyst	MWS
Agency or Co.	TMS Engineers, Inc.
Date Performed	6/24/2018
Analysis Year	2019
Time Analyzed	AM Peak
Project Description	Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
E/W Street Name	USR 250
N/S Street Name	SR 21
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.92
Jurisdiction	City of Strasburg, Ohio

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0
Lane Assignment			LR								LT				TR	
Volume (V), veh/h	0	20		237					0	257	272		0		266	20
Percent Heavy Vehicles, %	3	17		17					3	17	17		3		13	13
Flow Rate (v_{PCE}), pc/h	0	25		301					0	327	346		0		327	25
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1								1				1			
Pedestrians Crossing, p/h	0								0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763						4.9763			4.9763	
Follow-Up Headway (s)		2.6087						2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		326						673			352	
Entry Volume veh/h		279						575			312	
Circulating Flow (v_c), pc/h	327			698			25			327		
Exiting Flow (v_{ex}), pc/h	0			352			371			628		
Capacity (c_{pce}), pc/h		989						1345			989	
Capacity (c), veh/h		845						1150			875	
v/c Ratio (x)		0.33						0.50			0.36	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		8.0						8.7			8.2	
Lane LOS		A						A			A	
95% Queue, veh		1.4						2.9			1.6	
Approach Delay, s/veh	8.0						8.7			8.2		
Approach LOS	A						A			A		
Intersection Delay, s/veh | LOS	8.4						A					

HCS7 Roundabouts Report

General Information

Analyst	MWS
Agency or Co.	TMS Engineers, Inc.
Date Performed	6/24/2018
Analysis Year	2019
Time Analyzed	PM Peak
Project Description	Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
E/W Street Name	USR 250
N/S Street Name	SR 21
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.92
Jurisdiction	City of Strasburg, Ohio

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0
Lane Assignment			LR								LT				TR	
Volume (V), veh/h	0	40		394					0	340	323		0		355	40
Percent Heavy Vehicles, %	3	17		17					3	17	17		3		13	13
Flow Rate (v_{PCE}), pc/h	0	51		501					0	432	411		0		436	49
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1								1				1			
Pedestrians Crossing, p/h	0								0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763						4.9763			4.9763	
Follow-Up Headway (s)		2.6087						2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		552						843			485	
Entry Volume veh/h		472						721			429	
Circulating Flow (v_c), pc/h	436			894			51			432		
Exiting Flow (v_{ex}), pc/h	0			481			462			937		
Capacity (c_{pce}), pc/h		885						1310			888	
Capacity (c), veh/h		756						1120			786	
v/c Ratio (x)		0.62						0.64			0.55	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		15.4						12.0			12.7	
Lane LOS		C						B			B	
95% Queue, veh		4.4						4.9			3.4	
Approach Delay, s/veh	15.4						12.0			12.7		
Approach LOS	C						B			B		
Intersection Delay, s/veh | LOS	13.2						B					

Appendix L
Build Capacity Analysis Worksheets - 2039

HCS7 Two-Way Stop-Control Report

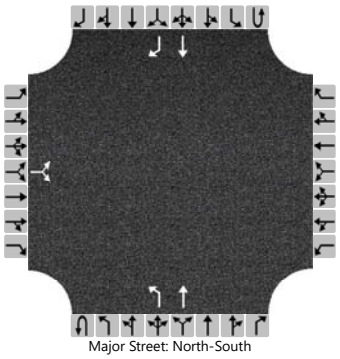
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2039
Time Analyzed	AM Peak
Intersection Orientation	North-South
Project Description	Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
Jurisdiction	Strasburg, Ohio
East/West Street	USR 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		20		257						287	292				286	20
Percent Heavy Vehicles (%)		17		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.57		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.65		3.45						2.35						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			301							312						
Capacity, c (veh/h)			529							1169						
v/c Ratio			0.57							0.27						
95% Queue Length, Q_{95} (veh)			3.5							1.1						
Control Delay (s/veh)			20.4							9.2						
Level of Service (LOS)			C							A						
Approach Delay (s/veh)		20.4								4.6						
Approach LOS		C														

HCS7 Two-Way Stop-Control Report

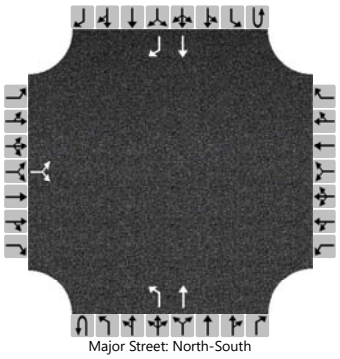
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2039
Time Analyzed	PM Peak
Intersection Orientation	North-South
Project Description	Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
Jurisdiction	Strasburg, Ohio
East/West Street	USR 250
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	1
Configuration			LR							L	T				T	R
Volume (veh/h)		40		434						370	353				385	40
Percent Heavy Vehicles (%)		17		17						17						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized														Yes		
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.57		6.37						4.27						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.65		3.45						2.35						

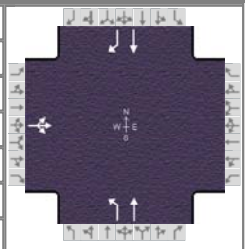
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			515							402						
Capacity, c (veh/h)			358							1065						
v/c Ratio			1.44							0.38						
95% Queue Length, Q_{95} (veh)			26.8							1.8						
Control Delay (s/veh)			240.8							10.4						
Level of Service (LOS)			F							B						
Approach Delay (s/veh)		240.8								5.3						
Approach LOS		F														

Appendix M
Build Capacity Analysis Worksheets - 2039
Signal & Roundabout Control

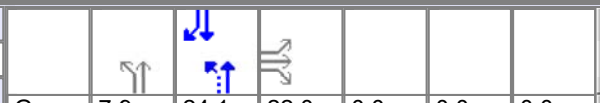
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	TMS Engineers, Inc.			Duration, h	0.25
Analyst	MWS	Analysis Date	6/23/2018	Area Type	Other
Jurisdiction	City of Strasburg, Ohio	Time Period	AM Peak	PHF	0.92
Urban Street	SR 21	Analysis Year	2039	Analysis Period	1> 7:00
Intersection	SR 21 & USR 250 / SR 21	File Name	2039 Build AM 21 250 w Improve.xus		
Project Description	Build w Improvements				

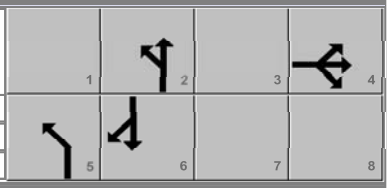


Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	20	0	257				287	292			286	20

Signal Information			
Cycle, s	75.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	7.9	24.1	22.0	0.0	0.0	0.0
Yellow	5.0	5.0	5.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0



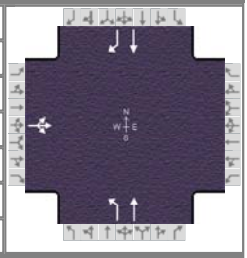
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		12.0			1.0	4.0		7.3
Phase Duration, s		29.0			14.9	46.0		31.1
Change Period, ($Y+R_c$), s		7.0			7.0	7.0		7.0
Max Allow Headway (*MAH*), s		4.2			4.0	0.0		0.0
Queue Clearance Time (g_s), s		14.1			9.9			
Green Extension Time (g_e), s		0.7			0.0	0.0		0.0
Phase Call Probability		1.00			1.00			
Max Out Probability		0.14			1.00			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h		301					312	317			311	22
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1623					1570	1648			1693	1434
Queue Service Time (g_s), s		12.1					7.9	8.6			11.5	0.8
Cycle Queue Clearance Time (g_c), s		12.1					7.9	8.6			11.5	0.8
Green Ratio (*g/C*)		0.29					0.45	0.52			0.32	0.32
Capacity (*c*), veh/h		476					420	857			544	461
Volume-to-Capacity Ratio (*X*)		0.632					0.743	0.370			0.572	0.047
Back of Queue (*Q*), ft/ln (85 th percentile)		164.5					164.3	126.2			189.3	12.7
Back of Queue (*Q*), veh/ln (85 th percentile)		6.6					5.8	4.4			6.8	0.5
Queue Storage Ratio (*RQ*) (85 th percentile)		0.00					0.82	0.00			0.00	0.13
Uniform Delay (d_1), s/veh		23.0					18.4	10.7			21.2	17.5
Incremental Delay (d_2), s/veh		2.7					7.0	1.2			4.3	0.2
Initial Queue Delay (d_3), s/veh		0.0					0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh		25.7					25.3	11.9			25.5	17.7
Level of Service (LOS)		C					C	B			C	B
Approach Delay, s/veh / LOS	25.7	C		0.0			18.6	B		25.0	C	
Intersection Delay, s/veh / LOS	22.0						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS7 Signalized Intersection Results Summary

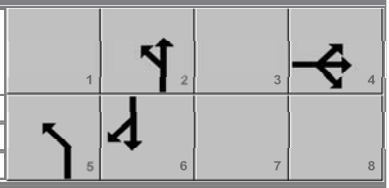
General Information				Intersection Information	
Agency	TMS Engineers, Inc.			Duration, h	0.25
Analyst	MWS	Analysis Date	6/23/2018	Area Type	Other
Jurisdiction	City of Strasburg, Ohio	Time Period	PM Peak	PHF	0.92
Urban Street	SR 21	Analysis Year	2039	Analysis Period	1> 7:00
Intersection	SR 21 & USR 250 / SR 21	File Name	2039 Build PM 21 250 w Improve.xus		
Project Description	Build w Improvements				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	40	0	434				370	353			385	40

Signal Information			
Cycle, s	90.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	17.8	22.8	28.4	0.0	0.0	0.0
Yellow	5.0	5.0	5.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		12.0			1.0	4.0		7.3
Phase Duration, s		35.4			24.8	54.6		29.8
Change Period, ($Y+R_c$), s		7.0			7.0	7.0		7.0
Max Allow Headway (*MAH*), s		4.2			4.0	0.0		0.0
Queue Clearance Time (g_s), s		30.4			19.8			
Green Extension Time (g_e), s		0.0			0.0	0.0		0.0
Phase Call Probability		1.00			1.00			
Max Out Probability		1.00			1.00			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h		515					402	384			418	43
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1625					1570	1648			1693	1434
Queue Service Time (g_s), s		28.4					17.8	12.9			22.1	2.1
Cycle Queue Clearance Time (g_c), s		28.4					17.8	12.9			22.1	2.1
Green Ratio (*g/C*)		0.32					0.47	0.53			0.25	0.25
Capacity (*c*), veh/h		513					397	872			429	363
Volume-to-Capacity Ratio (*X*)		1.005					1.012	0.440			0.976	0.120
Back of Queue (*Q*), ft/ln (85 th percentile)		500.5					414.8	186.1			459.3	36.8
Back of Queue (*Q*), veh/ln (85 th percentile)		20.0					14.6	6.6			16.5	1.3
Queue Storage Ratio (*RQ*) (85 th percentile)		0.00					0.92	0.00			0.00	0.37
Uniform Delay (d_1), s/veh		30.8					23.8	13.0			33.3	25.9
Incremental Delay (d_2), s/veh		40.9					48.3	1.6			37.9	0.7
Initial Queue Delay (d_3), s/veh		0.0					0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh		71.7					72.0	14.6			71.2	26.5
Level of Service (LOS)		F					F	B			E	C
Approach Delay, s/veh / LOS	71.7	E		0.0			44.0	D		67.0	E	
Intersection Delay, s/veh / LOS	58.1						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS7 Roundabouts Report

General Information

Analyst	MWS
Agency or Co.	TMS Engineers, Inc.
Date Performed	6/24/2018
Analysis Year	2039
Time Analyzed	AM Peak
Project Description	Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
E/W Street Name	USR 250
N/S Street Name	SR 21
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.92
Jurisdiction	City of Strasburg, Ohio

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0
Lane Assignment			LR								LT				TR	
Volume (V), veh/h	0	20		257					0	287	292		0		286	20
Percent Heavy Vehicles, %	3	17		17					3	17	17		3		13	13
Flow Rate (v_{PCE}), pc/h	0	25		327					0	365	371		0		351	25
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1								1				1			
Pedestrians Crossing, p/h	0								0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763						4.9763			4.9763	
Follow-Up Headway (s)		2.6087						2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		352						736			376	
Entry Volume veh/h		301						629			333	
Circulating Flow (v_c), pc/h	351			761			25			365		
Exiting Flow (v_{ex}), pc/h	0			390			396			678		
Capacity (c_{pce}), pc/h		965						1345			951	
Capacity (c), veh/h		825						1150			842	
v/c Ratio (x)		0.36						0.55			0.40	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		8.7						9.6			9.0	
Lane LOS		A						A			A	
95% Queue, veh		1.7						3.4			1.9	
Approach Delay, s/veh	8.7						9.6			9.0		
Approach LOS	A						A			A		
Intersection Delay, s/veh | LOS	9.2						A					

HCS7 Roundabouts Report

General Information

Analyst	MWS
Agency or Co.	TMS Engineers, Inc.
Date Performed	6/24/2018
Analysis Year	2039
Time Analyzed	PM Peak
Project Description	Build

Site Information

Intersection	SR 21 & USR 250 / SR 21
E/W Street Name	USR 250
N/S Street Name	SR 21
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.92
Jurisdiction	City of Strasburg, Ohio

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0
Lane Assignment			LR								LT				TR	
Volume (V), veh/h	0	40		434					0	370	353		0		385	40
Percent Heavy Vehicles, %	3	17		17					3	17	17		3		13	13
Flow Rate (v_{PCE}), pc/h	0	51		552					0	471	449		0		473	49
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1								1				1			
Pedestrians Crossing, p/h	0								0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763						4.9763			4.9763	
Follow-Up Headway (s)		2.6087						2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		603						920			522	
Entry Volume veh/h		515						786			462	
Circulating Flow (v_c), pc/h	473			971			51			471		
Exiting Flow (v_{ex}), pc/h	0			520			500			1025		
Capacity (c_{pce}), pc/h		852						1310			854	
Capacity (c), veh/h		728						1120			755	
v/c Ratio (x)		0.71						0.70			0.61	

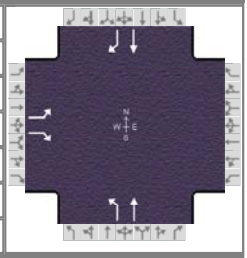
Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		19.5						13.9			15.0	
Lane LOS		C						B			C	
95% Queue, veh		5.9						6.2			4.2	
Approach Delay, s/veh	19.5						13.9			15.0		
Approach LOS	C						B			C		
Intersection Delay, s/veh | LOS	15.9						C					

Appendix N
Build Capacity Analysis Worksheets - 2039
Signal Control w EB Right Turn Lane

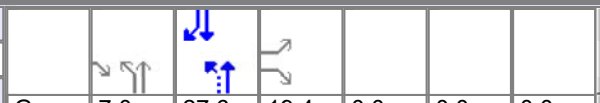
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	TMS Engineers, Inc.			Duration, h	0.25
Analyst	MWS	Analysis Date	6/23/2018	Area Type	Other
Jurisdiction	City of Strasburg, Ohio	Time Period	AM Peak	PHF	0.92
Urban Street	SR 21	Analysis Year	2039	Analysis Period	1> 7:00
Intersection	SR 21 & USR 250 / SR 21	File Name	2039 Build AM 21 250 w Improve EB RT.xus		
Project Description	Build w Improvements				

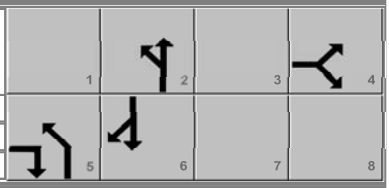


Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	20		257				287	292			286	20

Signal Information			
Cycle, s	75.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	7.0	27.6	19.4	0.0	0.0	0.0
Yellow	5.0	5.0	5.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0



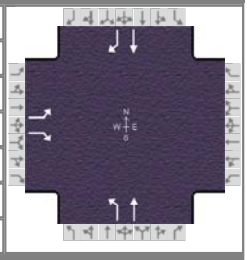
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		9.0			1.0	4.0		7.3
Phase Duration, s		26.4			14.0	48.6		34.6
Change Period, ($Y+R_c$), s		7.0			7.0	7.0		7.0
Max Allow Headway (*MAH*), s		4.2			4.0	0.0		0.0
Queue Clearance Time (g_s), s		14.2			9.0			
Green Extension Time (g_e), s		0.5			0.0	0.0		0.0
Phase Call Probability		1.00			1.00			
Max Out Probability		0.57			1.00			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7		14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h	22		279				312	317			311	22
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1570		1397				1570	1648			1693	1434
Queue Service Time (g_s), s	0.8		12.2				7.0	8.0			10.7	0.7
Cycle Queue Clearance Time (g_c), s	0.8		12.2				7.0	8.0			10.7	0.7
Green Ratio (*g/C*)	0.26		0.35				0.49	0.55			0.37	0.37
Capacity (*c*), veh/h	406		492				455	914			623	528
Volume-to-Capacity Ratio (*X*)	0.054		0.568				0.685	0.347			0.499	0.041
Back of Queue (*Q*), ft/ln (85 th percentile)	13.5		158.3				143.9	114.5			171.1	11.4
Back of Queue (*Q*), veh/ln (85 th percentile)	0.5		5.6				5.1	4.0			6.2	0.4
Queue Storage Ratio (*RQ*) (85 th percentile)	0.04		0.45				0.58	0.00			0.00	0.11
Uniform Delay (d_1), s/veh	20.9		19.7				16.6	9.2			18.3	15.2
Incremental Delay (d_2), s/veh	0.1		1.5				4.2	1.0			2.8	0.1
Initial Queue Delay (d_3), s/veh	0.0		0.0				0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh	21.0		21.2				20.9	10.3			21.2	15.4
Level of Service (LOS)	C		C				C	B			C	B
Approach Delay, s/veh / LOS	21.2		C	0.0			15.5		B	20.8		C
Intersection Delay, s/veh / LOS	18.3						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

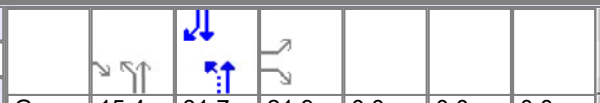
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	TMS Engineers, Inc.			Duration, h	0.25
Analyst	MWS	Analysis Date	6/23/2018	Area Type	Other
Jurisdiction	City of Strasburg, Ohio	Time Period	PM Peak	PHF	0.92
Urban Street	SR 21	Analysis Year	2039	Analysis Period	1> 7:00
Intersection	SR 21 & USR 250 / SR 21	File Name	2039 Build PM 21 250 w Improve EB RT.xus		
Project Description	Build w Improvements				

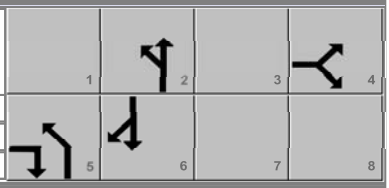


Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	40		434				370	353			385	40

Signal Information			
Cycle, s	90.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	15.4	31.7	21.9	0.0	0.0	0.0
Yellow	5.0	5.0	5.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		9.0			1.0	4.0		7.3
Phase Duration, s		28.9			22.4	61.1		38.7
Change Period, ($Y+R_c$), s		7.0			7.0	7.0		7.0
Max Allow Headway (*MAH*), s		4.2			4.0	0.0		0.0
Queue Clearance Time (g_s), s		23.9			16.1			
Green Extension Time (g_e), s		0.0			0.0	0.0		0.0
Phase Call Probability		1.00			1.00			
Max Out Probability		1.00			1.00			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7		14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h	43		472				402	384			418	43
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1570		1397				1570	1648			1693	1434
Queue Service Time (g_s), s	1.9		21.9				14.1	10.9			19.1	1.8
Cycle Queue Clearance Time (g_c), s	1.9		21.9				14.1	10.9			19.1	1.8
Green Ratio (*g/C*)	0.24		0.41				0.55	0.60			0.35	0.35
Capacity (*c*), veh/h	382		579				468	991			596	505
Volume-to-Capacity Ratio (*X*)	0.114		0.815				0.860	0.387			0.702	0.086
Back of Queue (*Q*), ft/ln (85 th percentile)	35.3		349				243.4	150.8			305.4	30.3
Back of Queue (*Q*), veh/ln (85 th percentile)	1.2		12.3				8.6	5.3			11.0	1.1
Queue Storage Ratio (*RQ*) (85 th percentile)	0.10		1.00				0.97	0.00			0.00	0.30
Uniform Delay (d_1), s/veh	26.5		23.3				16.9	9.3			25.1	19.5
Incremental Delay (d_2), s/veh	0.1		8.8				14.9	1.1			6.8	0.3
Initial Queue Delay (d_3), s/veh	0.0		0.0				0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh	26.6		32.1				31.9	10.5			31.9	19.8
Level of Service (LOS)	C		C				C	B			C	B
Approach Delay, s/veh / LOS	31.6		C	0.0			21.4		C	30.7		C
Intersection Delay, s/veh / LOS	26.8						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

Appendix O
Access Capacity Analysis Worksheets - 2019

HCS7 Two-Way Stop-Control Report

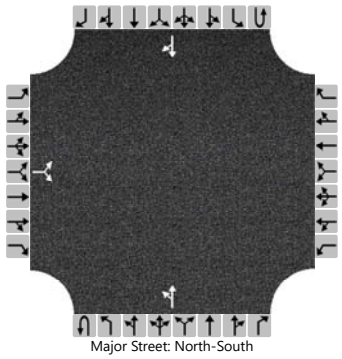
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2019
Time Analyzed	AM Peak
Intersection Orientation	North-South
Project Description	Build

Site Information

Intersection	SR 21 & Dev Access Drive
Jurisdiction	Strasburg, Ohio
East/West Street	Development Access Drive
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	0	1	0	0	0	1	0
Configuration			LR							LT						TR
Volume (veh/h)		16		16						62	230				270	47
Percent Heavy Vehicles (%)		0		0						0						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized																
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.40		6.20						4.10						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.50		3.30						2.20						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			35							67						
Capacity, c (veh/h)			502							1226						
v/c Ratio			0.07							0.05						
95% Queue Length, Q_{95} (veh)			0.2							0.2						
Control Delay (s/veh)			12.7							8.1						
Level of Service (LOS)			B							A						
Approach Delay (s/veh)		12.7								2.1						
Approach LOS		B														

HCS7 Two-Way Stop-Control Report

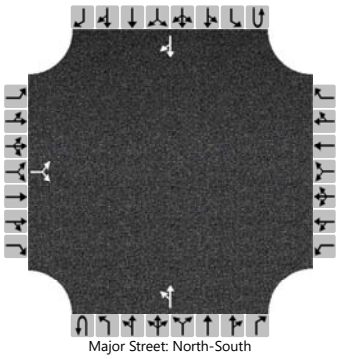
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2019
Time Analyzed	PM Peak
Intersection Orientation	North-South
Project Description	Build

Site Information

Intersection	SR 21 & Dev Access Drive
Jurisdiction	Strasburg, Ohio
East/West Street	Development Access Drive
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	0	1	0	0	0	1	0
Configuration			LR							LT						TR
Volume (veh/h)		32		35						33	330				360	25
Percent Heavy Vehicles (%)		0		0						0						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized																
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.40		6.20						4.10						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.50		3.30						2.20						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			73							36						
Capacity, c (veh/h)			444							1151						
v/c Ratio			0.16							0.03						
95% Queue Length, Q_{95} (veh)			0.6							0.1						
Control Delay (s/veh)			14.7							8.2						
Level of Service (LOS)			B							A						
Approach Delay (s/veh)		14.7								1.0						
Approach LOS		B														

HCS7 Two-Way Stop-Control Report

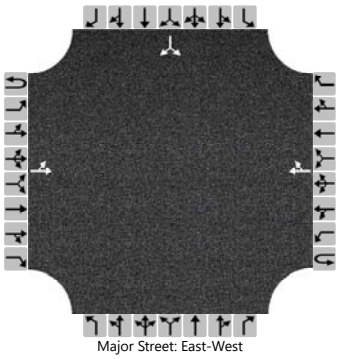
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2019
Time Analyzed	AM Peak
Intersection Orientation	East-West
Project Description	Build

Site Information

Intersection	SR 250 & Dev Access Drive
Jurisdiction	Strasburg, Ohio
East/West Street	USR 250
North/South Street	Development Access Drive
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	1	0
Configuration		LT						TR							LR	
Volume (veh/h)		47	240				260	17						17		17
Percent Heavy Vehicles (%)		0												0		0
Proportion Time Blocked																
Percent Grade (%)														0		
Right Turn Channelized																
Median Type | Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.10												6.40		6.20
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.20												3.50		3.30

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		51													37	
Capacity, c (veh/h)		1271													536	
v/c Ratio		0.04													0.07	
95% Queue Length, Q_{95} (veh)		0.1													0.2	
Control Delay (s/veh)		7.9													12.2	
Level of Service (LOS)		A													B	
Approach Delay (s/veh)	1.6												12.2			
Approach LOS	B												B			

HCS7 Two-Way Stop-Control Report

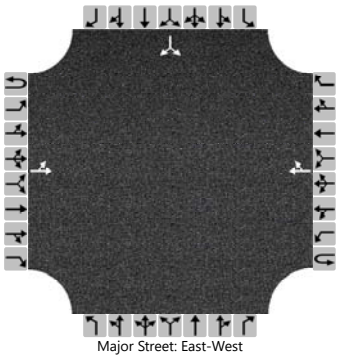
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2019
Time Analyzed	PM Peak
Intersection Orientation	East-West
Project Description	Build

Site Information

Intersection	SR 250 & Dev Access Drive
Jurisdiction	Strasburg, Ohio
East/West Street	USR 250
North/South Street	Development Access Drive
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	1	0
Configuration		LT						TR							LR	
Volume (veh/h)		33	400				370	10						34		35
Percent Heavy Vehicles (%)		0												0		0
Proportion Time Blocked																
Percent Grade (%)														0		
Right Turn Channelized																
Median Type | Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.10												6.40		6.20
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.20												3.50		3.30

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		36													75	
Capacity, c (veh/h)		1157													409	
v/c Ratio		0.03													0.18	
95% Queue Length, Q_{95} (veh)		0.1													0.7	
Control Delay (s/veh)		8.2													15.8	
Level of Service (LOS)		A													C	
Approach Delay (s/veh)	0.9												15.8			
Approach LOS	B												C			

Appendix P
Access Capacity Analysis Worksheets - 2039

HCS7 Two-Way Stop-Control Report

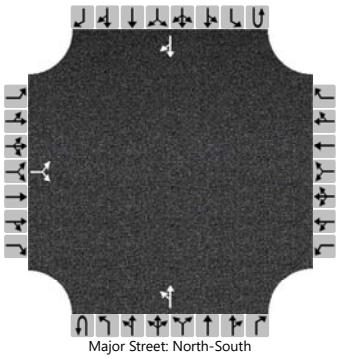
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2039
Time Analyzed	AM Peak
Intersection Orientation	North-South
Project Description	Build

Site Information

Intersection	SR 21 & Dev Access Drive
Jurisdiction	Strasburg, Ohio
East/West Street	Development Access Drive
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	0	1	0	0	0	1	0
Configuration			LR							LT						TR
Volume (veh/h)		16		16						62	250				290	47
Percent Heavy Vehicles (%)		0		0						0						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized																
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.40		6.20						4.10						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.50		3.30						2.20						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			35							67						
Capacity, c (veh/h)			479							1203						
v/c Ratio			0.07							0.06						
95% Queue Length, Q_{95} (veh)			0.2							0.2						
Control Delay (s/veh)			13.1							8.2						
Level of Service (LOS)			B							A						
Approach Delay (s/veh)		13.1								2.1						
Approach LOS		B														

HCS7 Two-Way Stop-Control Report

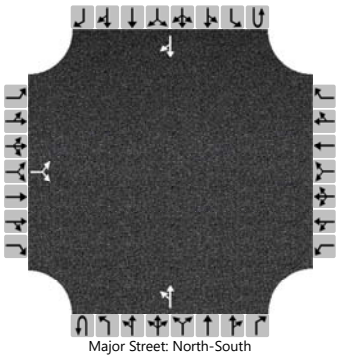
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2039
Time Analyzed	PM Peak
Intersection Orientation	North-South
Project Description	Build

Site Information

Intersection	SR 21 & Dev Access Drive
Jurisdiction	Strasburg, Ohio
East/West Street	Development Access Drive
North/South Street	SR 21
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	0	1	0	0	0	1	0
Configuration			LR							LT						TR
Volume (veh/h)		32		35						33	360				390	25
Percent Heavy Vehicles (%)		0		0						0						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized																
Median Type | Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.40		6.20						4.10						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.50		3.30						2.20						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			73							36						
Capacity, c (veh/h)			413							1120						
v/c Ratio			0.18							0.03						
95% Queue Length, Q_{95} (veh)			0.6							0.1						
Control Delay (s/veh)			15.6							8.3						
Level of Service (LOS)			C							A						
Approach Delay (s/veh)		15.6								1.0						
Approach LOS		C														

HCS7 Two-Way Stop-Control Report

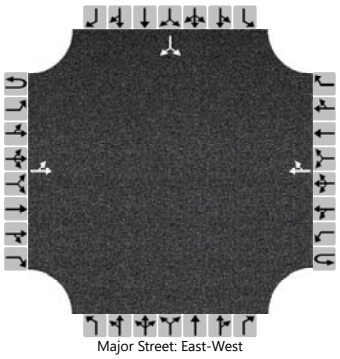
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2039
Time Analyzed	AM Peak
Intersection Orientation	East-West
Project Description	Build

Site Information

Intersection	SR 250 & Dev Access Drive
Jurisdiction	Strasburg, Ohio
East/West Street	USR 250
North/South Street	Development Access Drive
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	1	0
Configuration		LT						TR							LR	
Volume (veh/h)		47	260				290	17						17		17
Percent Heavy Vehicles (%)		0												0		0
Proportion Time Blocked																
Percent Grade (%)														0		
Right Turn Channelized																
Median Type | Storage																
	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.10												6.40		6.20
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.20												3.50		3.30

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		51													37	
Capacity, c (veh/h)		1237													504	
v/c Ratio		0.04													0.07	
95% Queue Length, Q_{95} (veh)		0.1													0.2	
Control Delay (s/veh)		8.0													12.7	
Level of Service (LOS)		A													B	
Approach Delay (s/veh)		1.6												12.7		
Approach LOS		B												B		

HCS7 Two-Way Stop-Control Report

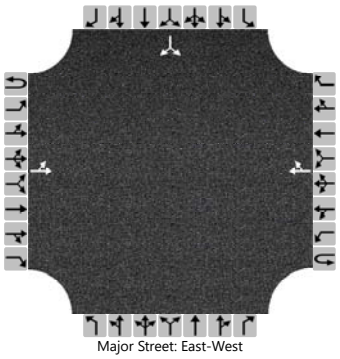
General Information

Analyst	MWS
Agency/Co.	TMS Engineers, Inc.
Date Performed	6/23/2018
Analysis Year	2039
Time Analyzed	PM Peak
Intersection Orientation	East-West
Project Description	Build

Site Information

Intersection	SR 250 & Dev Access Drive
Jurisdiction	Strasburg, Ohio
East/West Street	USR 250
North/South Street	Development Access Drive
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes


Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	1	0
Configuration		LT						TR							LR	
Volume (veh/h)		33	440				400	10						34		35
Percent Heavy Vehicles (%)		0												0		0
Proportion Time Blocked																
Percent Grade (%)														0		
Right Turn Channelized																
Median Type | Storage																

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.10												6.40		6.20
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.20												3.50		3.30

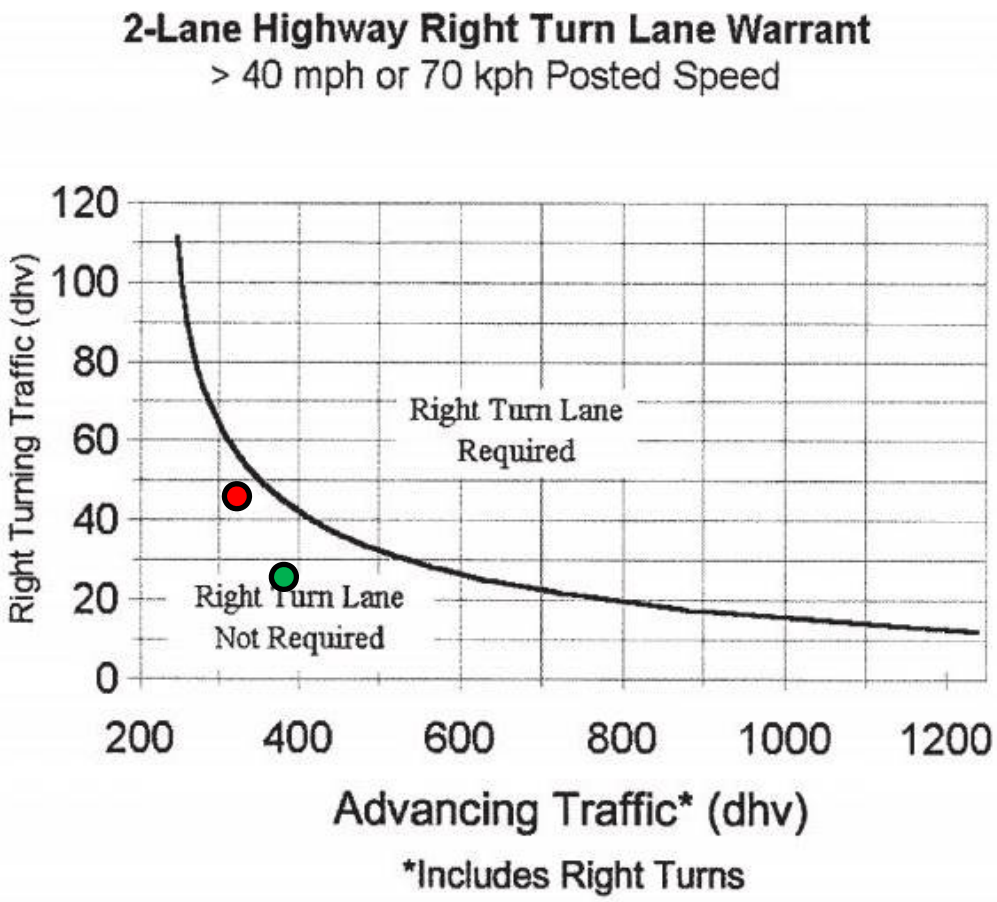
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		36													75	
Capacity, c (veh/h)		1125													375	
v/c Ratio		0.03													0.20	
95% Queue Length, Q_{95} (veh)		0.1													0.7	
Control Delay (s/veh)		8.3													17.0	
Level of Service (LOS)		A													C	
Approach Delay (s/veh)	0.9												17.0			
Approach LOS	B												C			

Appendix Q
Turn Lane Warrant Analysis
SR 21 Un-Signalized Access Driveway

SR 21 & PROVIA WINDOW PLANT ENTRANCE

2019 Build – WARRANT IS NOT MET



2-LANE RIGHT TURN LANE WARRANT (HIGH SPEED)

401-6bE

REFERENCE SECTION 401.6.3

AM Advancing Volume = 317 vph	PM Advancing Volume = 385 vph
AM Right Turn Volume = 47 vph	PM Right Turn Volume = 25 vph
WARRANT IS NOT MET	WARRANT IS NOT MET

SR 21 & PROVIA WINDOW PLANT ENTRANCE

2039 Build – WARRANT IS NOT MET

2-LANE RIGHT TURN LANE WARRANT (HIGH SPEED)

401-6bE

REFERENCE SECTION 401.6.3

AM Advancing Volume = 337 vph	PM Advancing Volume = 415 vph
AM Right Turn Volume = 47 vph	PM Right Turn Volume = 25 vph
WARRANT IS NOT MET	WARRANT IS NOT MET

SR 21 & PROVIA WINDOW PLANT ENTRANCE

2019 Build – WARRANT IS MET

2-LANE LEFT TURN LANE WARRANT (HIGH SPEED)

401-5bE

REFERENCE SECTION 401.6.1

AM Opposing Volume = 317 vph	PM Opposing Volume = 385 vph
AM Left Turn Volume = 62 vph (21.2%)	PM Left Turn Volume = 33 vph (9.1%)
AM Advancing Volume = 292 vph	PM Advancing Volume = 363 vph
WARRANT IS MET	WARRANT IS MET

SR 21 & PROVIA WINDOW PLANT ENTRANCE

2039 Build – WARRANT IS MET

2-LANE LEFT TURN LANE WARRANT (HIGH SPEED)

401-5bE

REFERENCE SECTION 401.6.1

AM Opposing Volume = 337 vph	PM Opposing Volume = 415 vph
AM Left Turn Volume = 62 vph (21.2%)	PM Left Turn Volume = 33 vph (8.4%)
AM Advancing Volume = 312 vph	PM Advancing Volume = 393 vph
WARRANT IS MET	WARRANT IS MET

Appendix R
Turn Lane Warrant Analysis
USR 250 Un-Signalized Access Driveway

USR 250 & PROVIA WINDOW PLANT ENTRANCE

2019 Build – WARRANT IS NOT MET

2-LANE RIGHT TURN LANE WARRANT (HIGH SPEED)

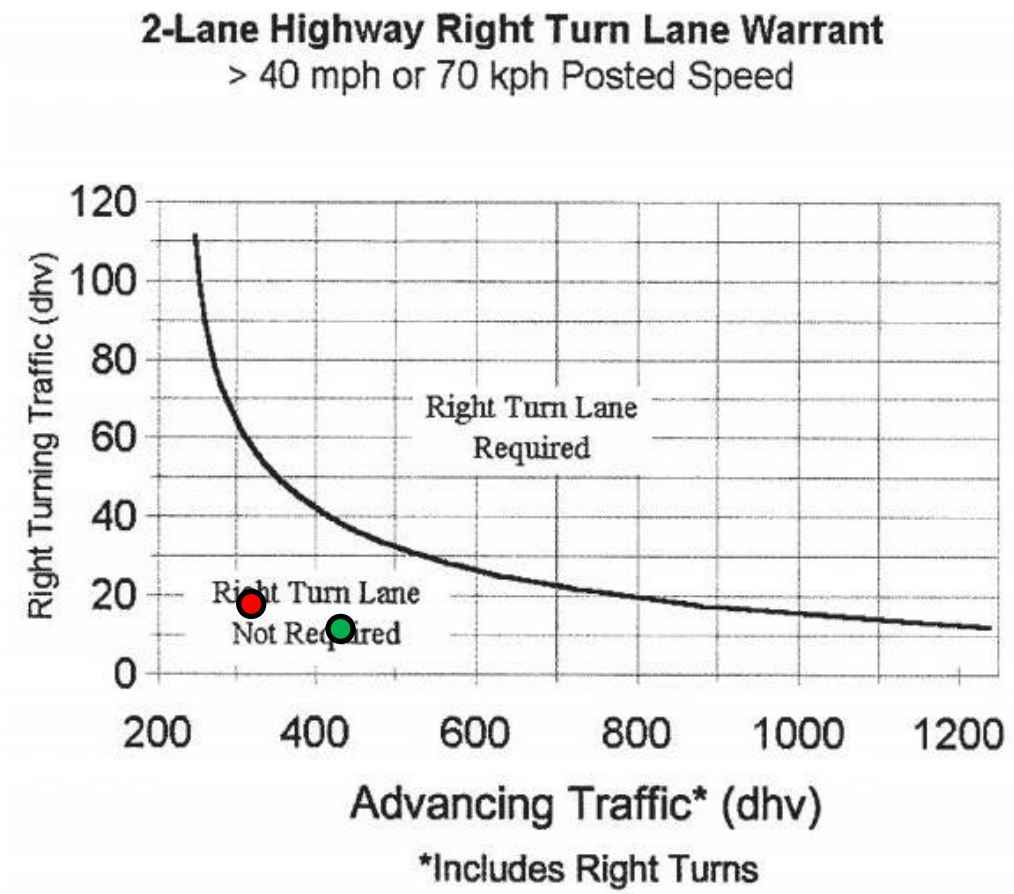
401-6bE

REFERENCE SECTION 401.6.3

AM Advancing Volume = 277 vph	PM Advancing Volume = 380 vph
AM Right Turn Volume = 17 vph	PM Right Turn Volume = 10 vph
WARRANT IS NOT MET	WARRANT IS NOT MET

USR 250 & PROVIA WINDOW PLANT ENTRANCE

2039 Build – WARRANT IS NOT MET



2-LANE RIGHT TURN LANE WARRANT (HIGH SPEED)

401-6bE

REFERENCE SECTION 401.6.3

AM Advancing Volume = 307 vph	PM Advancing Volume = 410 vph
AM Right Turn Volume = 17 vph	PM Right Turn Volume = 10 vph
WARRANT IS NOT MET	WARRANT IS NOT MET

USR 250 & PROVIA WINDOW PLANT ENTRANCE

2019 Build – WARRANT IS MET

2-LANE LEFT TURN LANE WARRANT (HIGH SPEED)

401-5bE

REFERENCE SECTION 401.6.1

AM Opposing Volume = 277 vph	PM Opposing Volume = 380 vph
AM Left Turn Volume = 47 vph (16.4%)	PM Left Turn Volume = 33 vph (7.6%)
AM Advancing Volume = 287 vph	PM Advancing Volume = 433 vph
WARRANT IS MET	WARRANT IS MET

USR 250 & PROVIA WINDOW PLANT ENTRANCE

2039 Build – WARRANT IS MET

2-LANE LEFT TURN LANE WARRANT (HIGH SPEED)

401-5bE

REFERENCE SECTION 401.6.1

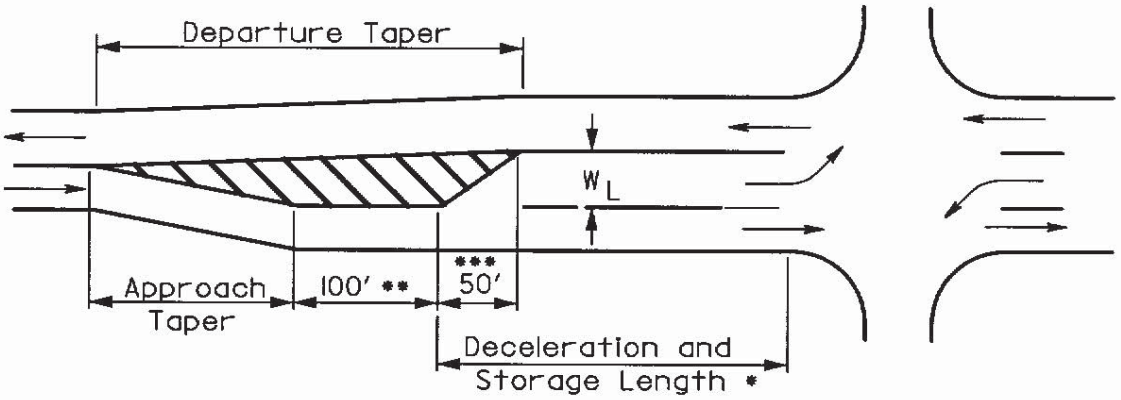
AM Opposing Volume = 307 vph	PM Opposing Volume = 410 vph
AM Left Turn Volume = 47 vph (15.3%)	PM Left Turn Volume = 33 vph (7.0%)
AM Advancing Volume = 307 vph	PM Advancing Volume = 473 vph
WARRANT IS MET	WARRANT IS MET

Appendix S
ODOT Turn Lane Design Criteria

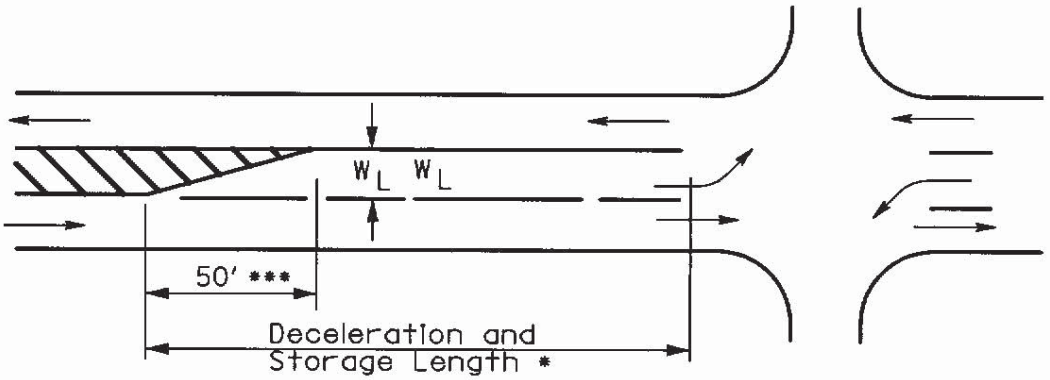
TURNING LANE DESIGN

401-7E

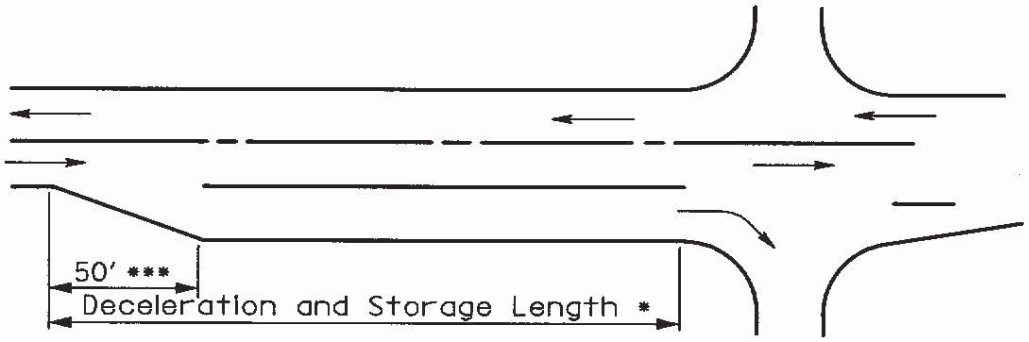
REFERENCE SECTIONS
401.6.1, 401.6.3



LEFT TURN LANE - NO MEDIAN OR MEDIAN WIDTH < W_L



LEFT TURN LANE - MEDIAN WIDTH >= W_L



RIGHT TURN LANE

- * See **Figures 401-9 and 401-10** to copmpute length.
- ** May be reduced or elliminated in urban areas if intersection spacing or storage is constraining
- *** Diverging taper

W_L = Turn Lane Width

BASIS FOR COMPUTING LENGTH OF TURN LANES

401-9E

REFERENCE SECTIONS
401.6.1, 401.6.3

TYPE OF TRAFFIC CONTROL	DESIGN SPEED (mph)					
	30 - 35		40 - 45		50 - 60	
	TURN DEMAND VOLUME					
	HIGH	LOW*	HIGH	LOW*	HIGH	LOW*
SIGNALIZED	Ⓐ	Ⓐ	Ⓑ** or Ⓒ**	Ⓑ** or Ⓒ**	Ⓑ** or Ⓒ**	Ⓑ** or Ⓒ**
UNSIGNALIZED STOPPED CROSSROAD	Ⓐ	Ⓐ	Ⓐ	Ⓐ	Ⓐ	Ⓐ
UNSIGNALIZED THROUGH ROAD	Ⓐ	Ⓐ	Ⓒ	Ⓑ	Ⓑ** or Ⓒ**	Ⓑ

* LOW is considered 10% or less of approach traffic volume.
** Whichever is greater

CONDITION Ⓐ STORAGE ONLY

Length = 50' (diverging taper) + Storage Length **(Figure 401-10)**

CONDITION Ⓑ HIGH SPEED DECELERATION ONLY

Design Speed	Length (Including 50' Diverging Taper)
40	125
45	175
50	225
55	285
60	345

CONDITION Ⓒ MODERATE SPEED DECELERATION AND STORAGE

Design Speed	Length (Including 50' Diverging Taper)
40	115 + Storage Length **(Figure 401-10)**
45	125 "
50	145' "
55	165' "
60	185' "

For Explanation, See Turn Lane Design Example

July 2017

STORAGE LENGTH AT INTERSECTIONS

401-10E

REFERENCE SECTIONS
401.6.1, 401.6.3

* AVERAGE No. OF VEHICLES/CYCLE	REQUIRED LENGTH
1	50 ft
2	100 ft
3	150 ft
4	175 ft
5	200 ft
6	250 ft
7	275 ft
8	325 ft
9	350 ft
10	375 ft
11	400 ft
12	450 ft
13	475 ft
14	500 ft
15	525 ft
16	550 ft

* AVERAGE No. OF VEHICLES/CYCLE	REQUIRED LENGTH
17	600 ft
18	625 ft
19	650 ft
20	675 ft
21	725 ft
22	750 ft
23	775 ft
24	800 ft
25	825 ft
30	975 ft
35	1125 ft
40	1250 ft
45	1400 ft
50	1550 ft
55	1700 ft
60	1850 ft

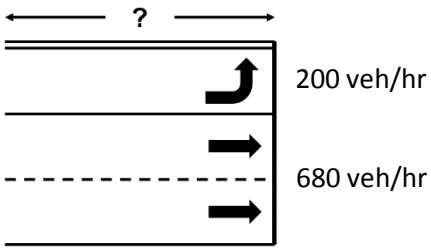
* Average Vehicles per Cycle = $\frac{\text{DHV (TURNING LANE)}}{\text{CYCLES/HOUR}}$

If Cycles are unknown, assume:
UNSIGNALIZED OR 2 PHASE - 60 CYCLES/HR
3 PHASE - 40 CYCLES/HR
4 PHASE - 30 CYCLES/HR

Example - Turn Lane Design Using Figures 401-9 and 401-10

Problem
Calculate the length of an exclusive left turn lane.

Traffic Control: **Signalized**
Design Speed: **55 mph**
Cycle Length: **90 sec**



Determine Storage and Turn Lane Lengths

Turn Lane Demand (High/Low) $= \frac{200 \text{ veh/hr}}{200 \text{ veh/hr} + 680 \text{ veh/hr}} = 23\% =$ **High Demand**

Refer to the matrix in **Figure 401-9**.

For Signalized, 55 mph, High Demand, use Method B or C, whichever is greater.

Method B – For 55 mph, a **285'** turn lane length is required (235' storage + 50' taper).

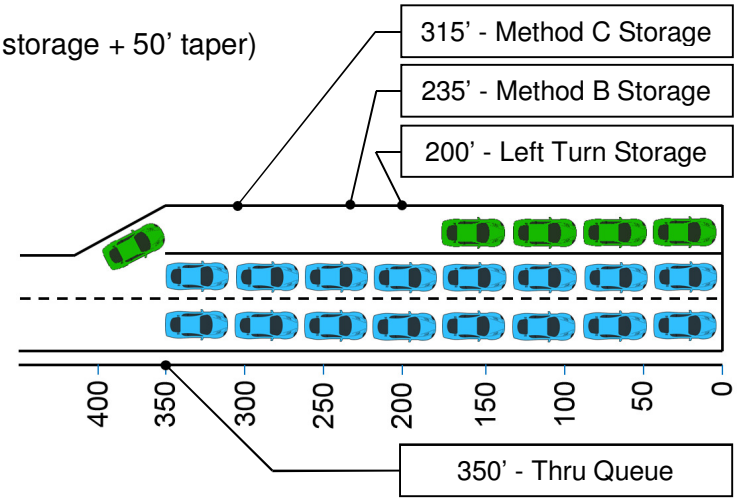
Method C – For 55 mph, 165' + calculated storage length in **Figure 401-10**.

Average Vehicles per Cycle $= \frac{(200 \text{ veh/hr}) * (90 \text{ sec/cyc})}{3600 \text{ sec/hr}} =$ 5 veh/cyc → 200'

Total Length = 165' + 200' = **365'** (315' storage + 50' taper)

Method C = **365'** > Method B = **285'**

Use Method C



Check Length for Thru-Block

Refer to **Figure 401-10** to calculate thru lane(s) queue distance.

680 veh/hr / 2 lanes = 340 veh/hr/ln

Average Vehicles per Cycle $= \frac{(340 \text{ veh/hr/ln}) * (90 \text{ sec/cyc})}{3600 \text{ sec/hr}} =$ 9 veh/cyc/ln → **350 ft/ln**

Thru Block = **350'** > Method C Storage = **315'** → **Turn Lane Blocked**

Use **350'** storage + **50'** taper = **400' Turn Lane Length**