



ROS-23-21.17

Ros-23 & Blackwater Rd Safety Study

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I. Executive Summary

A. Purpose and Need

The purpose of this study is to analyze existing conditions and identify potential countermeasures to reduce crash frequency and severity at the intersection of US 23 and Blackwater Rd. The study limits include the intersection of US 23 and Blackwater Rd and approximately 250 feet on each intersection approach.

ODOT District 9 maintains a list of all the 4-lane, divided highway intersections in District 9 and ranks each intersection based on various criteria with safety being a key focus. This intersection is ranked #3 on the list. Increased attention has been given to this intersection due to an increase in severe crashes.

B. Overview of Safety Issues

Crash data was pulled from 2017 through 2021 from ODOT's crash database inside TIMS. There were 22 crashes within that 5-year period.

Of the 22 crashes that occurred at the intersection, there were 3 serious injury crashes (13.6%) and 9 injury crashes (36.4%). The primary crash type was angle crashes with 10 crashes (45.5%). Crashes numbers have remained steady over the last 5 years, except for 2018 where there was 1 crash that occurred. It is unknown why there was a drop-off of crashes in just this one year. After investigating the crashes, a crash pattern involving angle crashes was identified.

C. Recommended Countermeasures

Based on the crash report investigation resulting in an angle/left turn crash pattern being identified, a Turbo Lane configuration is being proposed at this intersection. The Turbo Lane configuration is expected to mitigate the primary crash pattern identified at the intersection. The estimated cost of the Turbo Lane is \$2,180,728. ECAT analysis shows a benefit-cost ratio of 1.26. It is expected ECAT is underrepresenting the safety benefit of the Turbo Lane. It is recommended the Turbo Lane be considered for future implementation.

II. Purpose and Need

The purpose of this study is to analyze existing conditions and identify potential countermeasures to reduce crash frequency and severity at the intersection of US 23 and Blackwater Rd. The study limits include the intersection of US 23 and Blackwater Rd and approximately 250 feet on each intersection approach.

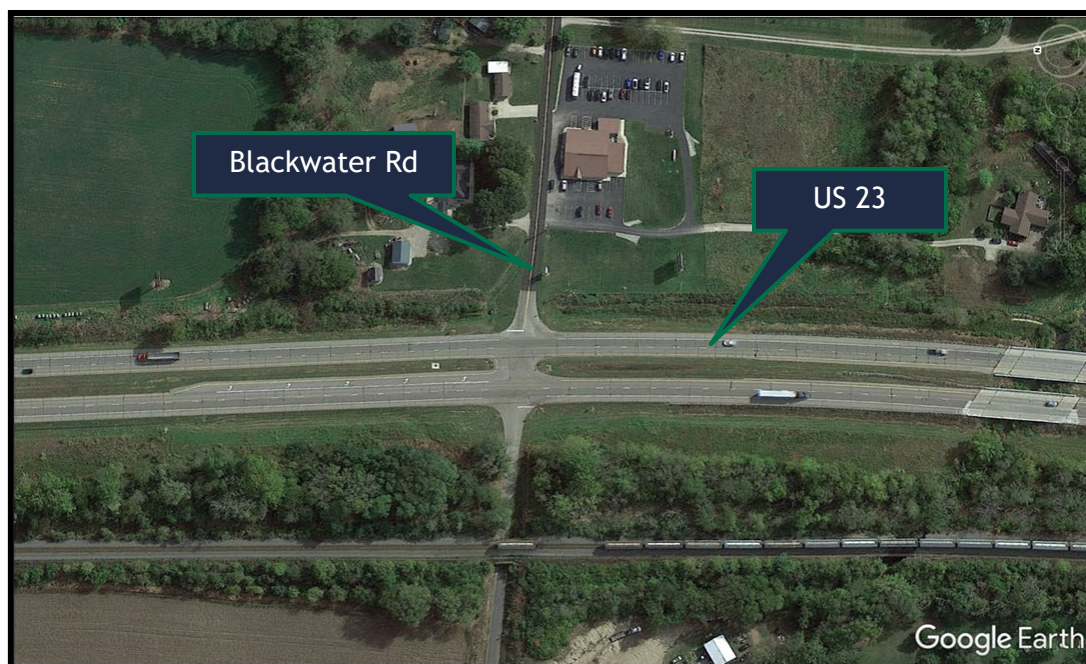
ODOT District 9 generated a list of rural, four-lane divided highway, at-grade intersections within District 9. The intersections were ranked based on frequency/severity of crashes, major/minor average daily traffic (ADT), and speed limit. The study intersection was ranked #3 on the list, initiating the need for further study. Note, some intersections ranked higher on the same list have already been selected for safety funding. The intersection is not ranked on the 2020 HSIP list. However, it is understood Highway Safety Manual (HSM) methodology utilized to generate the HSIP list oftentimes underrepresents these types of intersections. Therefore, ODOT District 9 generated a separate list to focus on improving these intersections. A project location map is provided in **Figure 1**. A study area aerial is provided in **Figure 2**.



Figure 1: Project Location Map (Ross County outlined in red)



Figure 2: Study Area Aerial





III. Existing Conditions

A. Land Use

The study area is approximately 9 miles north of the city of Chillicothe. The surrounding area of the study area includes undeveloped wooded and grassy space. A commercial property exists north of the intersection on Blackwater Rd. A residential drive exists on Blackwater Rd close to the intersection.

B. Roadway Conditions

US 23 acts as a north-south connector throughout Ohio and is one of the higher AADT routes in District 9 with an AADT of 24,313. US 23 is classified as a Principal Arterial Other and has a posted speed limit of 60 MPH. This segment of US 23 is a four-lane, divided highway with 10-foot shoulders. A dedicated left turn lane exists on US 23 for southbound traffic. Rumble strips are present at the outside edge lines in both directions.

Blackwater Rd is designated as TR-279 and is classified as a Local road. The roadway is a two-lane rural roadway with a 1-foot paved shoulder. A centerline exists on the roadway; however, edge lines are not present.

C. Intersection Conditions

The intersection of US 23 and Blackwater Rd (TR-279) is a 4-leg, divided highway, intersection. Blackwater Rd's approach is a single lane, stop-controlled approach. US 23 has no stop control. A dedicated left turn lane exists on US 23 southbound. A slight horizontal curve exists south of the intersection, approximately 750' from the center of the intersection.

D. Data Collection

Existing data for the routes and the intersection was obtained through TIMS.

IV. Existing Conditions Analysis

A previous study had been conducted at the intersection to investigate signal warrants. No warrants were met as part of the study. This study was performed following 3 serious injury crashes at the intersection. It was believed that high traffic volumes on US 23 resulting in long minor street queues were causing the observed crash patterns. Traffic analysis was conducted and showed concerning delay times for vehicles and levels of service for both approaches of Blackwater Rd. **Table 1** shows TransModeler results for a no-build scenario. It is believed that the queue lengths of the side streets are causing drivers to find unsafe gaps and exhibit dangerous driver behaviors. Improving the levels of service on the intersection legs of Blackwater Rd will result in safer driver behaviors.



Table 1: TransModeler No-Build Scenario

No-Build 2044 AM/PM HCS Results					
2042 AM No-Build (PHF=0.91)					
US23 & Blackwater Rd.	LOS	Delay (sec/veh)	v/c	95% QSR	95% Queue Length (ft)
Blackwater Rd. (Stop)					
EB L/T/R	E	42.8	0.26	1.00	25
EB Approach	E	42.8			
WB L/T/R	F	61.0	0.56	2.80	70
WB Approach	F	61.0			
Route 23					
NB L/T	B	11.3	0.02	0.10	3
NB T/R	A	0.4			
NB Approach	A	0.5			
SB L	B	14.9	0.03	0.10	3
SB T	A	0.4			
SB T/R	A	0.4			
SB Approach	A	0.6			
Overall					
2042 PM No-Build (PHF=0.91)					
US23 & Blackwater Rd.	LOS	Delay (sec/veh)	v/c	95% QSR	95% Queue Length (ft)
Blackwater Rd. (Stop)					
EB L/T/R	F	138.4	0.59	2.40	60
EB Approach	F	138.4			
WB L/T/R	F	140.4	0.81	4.10	103
WB Approach	F	140.4			
Route 23					
NB L/T	C	20.7	0.05	0.10	3
NB T/R	A	1.6			
NB Approach	A	1.7			
SB L	B	14.8	0.11	0.40	10
SB T	A	1.5			
SB T/R	A	1.5			
SB Approach	A	1.8			
Overall					

V. Crash Data

Crash data was pulled from 2017 through 2021 from ODOT's crash database inside TIMS. There were 22 crashes within that 5-year period.

Of the 22 crashes that occurred at the intersection, there were 3 serious injury crashes (13.6%) and 9 injury crashes (36.4%). The primary crash type was angle crashes with 10 crashes (45.5%). The statewide average for angle crashes at an intersection of this site type is 28%. Crashes numbers have remained steady over the last 5 years, except for 2018 where there was 1 crash that occurred. It is unknown why there was a drop-off of crashes in just this one year. After investigating the crashes, a crash pattern involving angle crashes was identified.

Table 2: Crash Statistics

TRAFFIC_CRASH_YEAR	Number	%
2017	4	18.2%
2018	1	4.5%
2019	8	36.4%
2020	4	18.2%
2021	5	22.7%
Grand Total	22	100.0%

TYPE_OF_CRASH	Number	%
Angle	10	45.5%
Fixed Object	5	22.7%
Rear End	5	22.7%
Sideswipe - Passing	1	4.5%
Right Turn	1	4.5%
Grand Total	22	100.0%

Crash Severity	Crashes	%
(2) Serious Injury Suspected	3	13.64%
(3) Minor Injury Suspected	8	36.36%
(4) Injury Possible	1	4.55%
(5) PDO/No Injury	10	45.45%
Grand Total	22	100.00%



HOUR_OF_DAY		Number	%
	1	1	4.5%
	5	2	9.1%
	10	1	4.5%
	11	1	4.5%
	13	4	18.2%
	14	2	9.1%
	15	4	18.2%
	16	1	4.5%
	17	2	9.1%
	18	3	13.6%
	20	1	4.5%
Grand Total		22	100.0%

CONTRIBUTING_FACTOR1		Number	%
Failure to Yield		7	31.8%
Following Too Closely/ACDA		7	31.8%
Drove off Road		2	9.1%
None		2	9.1%
Unsafe Speed		1	4.5%
Not Discernible		1	4.5%
Other Improper Action		1	4.5%
Ran Stop Sign		1	4.5%
Grand Total		22	100.0%

VI. Recommended Countermeasures

A. Recommended Alternative

Based on the crash report investigation resulting in an angle crash pattern being identified, a Turbo Lane configuration is being proposed at this intersection. The Turbo Lane configuration consists of creating a median island, with striping and delineation, to provide guided entrance into a median acceleration lane for left turning traffic out of the east leg of Blackwater Rd. The left turn lane on US 23 southbound would be separated with delineation and striping from the mainline. The west leg of Blackwater Rd's access would be reduced to right-in, right-out only. Right turn lanes would be added to US 23 in both directions. A bridge structure south of the intersection would need to be widened to accommodate the median acceleration lane.

A traditional 4-lane, divided highway intersection has 42 total conflict points, including 24 crossing points, 10 merge points, and 8 diverge points. The Turbo Lane configuration proposed reduces those conflict points down to 12. Those 12 conflict points include 5 crossing points, 4 merge points, and 3 diverge points. It is important to note that 1 of the 5 crossing points involves traffic turning left out of the east leg of Blackwater Rd and traffic turning left from US 23 southbound. These movements are relatively low speed. Should an accident occur, the accident is not expected to be severe. **Figure 3** shows the proposed layout of the Turbo Lane configuration. **Figure 4** shows the conflict points of a traditional 4-lane, divided highway intersection. **Figure 5** shows the conflict points of the proposed Turbo Lane configuration. **Table 3** shows the TransModeler results of the proposed Turbo Lane configuration.

With the Turbo Lane configuration would come access restrictions to the intersection. The west leg of Blackwater Rd would have its access restricted to right-in, right-out only. The through movement for vehicles on the east leg of Blackwater Rd would now be prohibited. The left turn movement on US 23 northbound onto the west leg of Blackwater Rd would now be prohibited. These newly restricted accesses would impact approximately 86 vehicles daily. However, these impacted vehicles would have several alternative routes nearby to reach their desired destinations. Orr Rd (CR-526) is a county route that runs parallel to US 23 along this corridor. Orr Rd provides 3 additional access points to US 23 in proximity to the intersection of US 23 and Blackwater Rd, one to the north and two to the south. In addition, Orr Rd provides access to an overpass over US 23 on Kingston Adelphi Rd approximately 1 mile north of the intersection of US 23 and Blackwater Rd. The overpass alternative route on Kingston Adelphi Rd provides the removed through movement for Blackwater Rd traffic since a township route, Immel Rd, connects Blackwater Rd and Kingston Adelphi Rd approximately 1 mile east of the intersection of US 23 and Blackwater Rd. This alternative route using the overpass adds approximately 2 miles of trip distance. Other restricted



movements are accommodated through other access points of Orr Rd to US 23 with little displacement. **Figure 6** shows the corridor of US 23 of which Orr Rd is running parallel.

First results of traffic analysis showed the Turbo Lane configuration performing similarly to the No Build condition, with the eastbound Blackwater approach performing worse than the No Build condition. District 9 staff questions the results due to delays increasing significantly by simply making the west Blackwater Rd approach a right-in, right-out. Further analysis is being investigated due to the positive results of all Turbo Lanes analyzed before.



Figure 3: Proposed Turbo Lane Layout

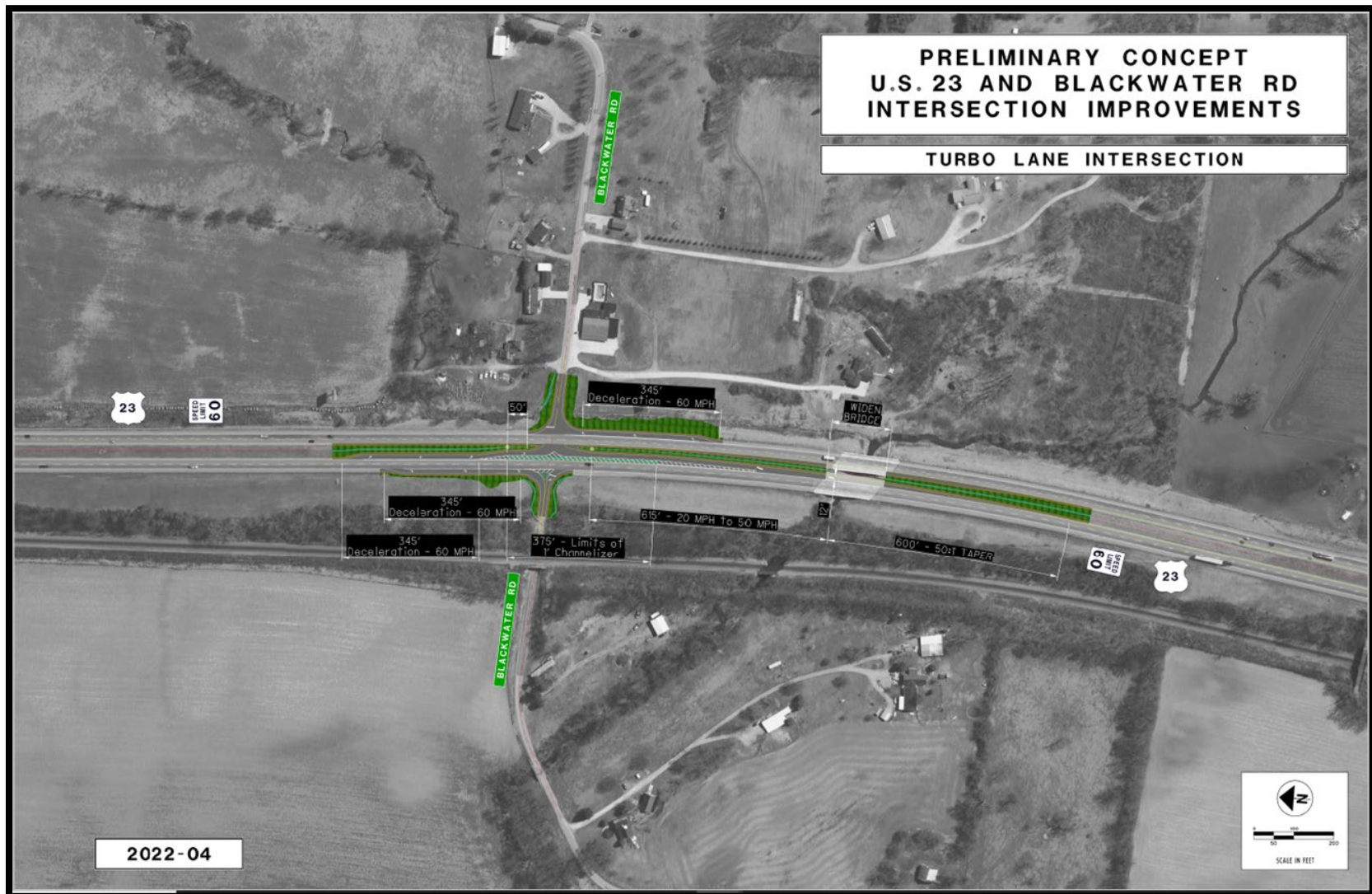




Figure 4: Traditional 4-Lane, Divided Highway Conflict Points

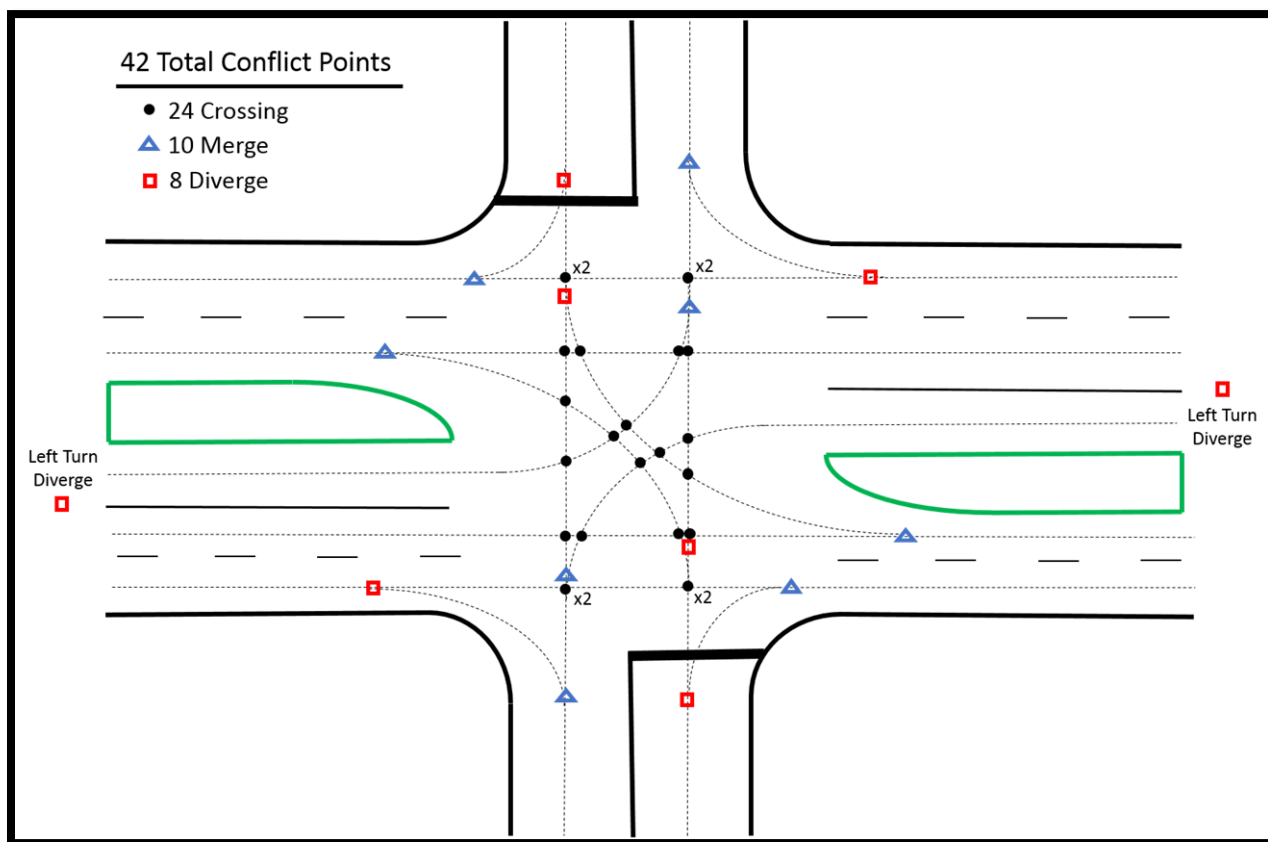


Figure 5: Proposed Turbo Lane Conflict Points

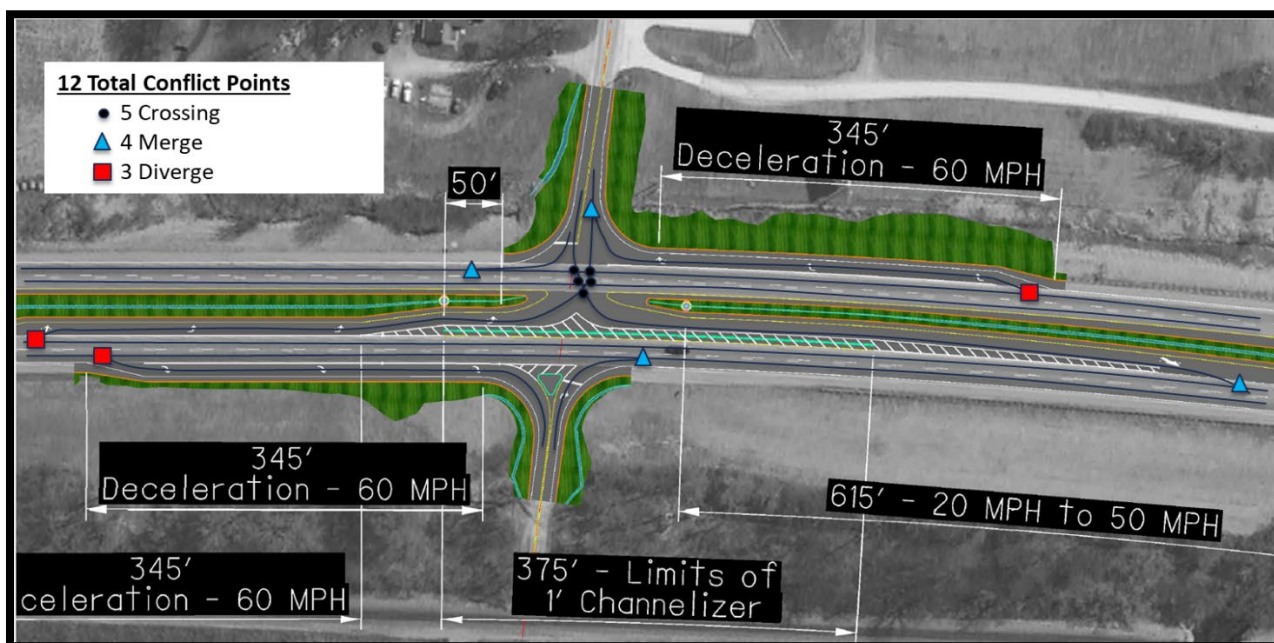




Table 3: Turbo Lane TransModeler Results

2044 AM Analysis - HCS & TransModeler Analysis

HCS - 2044 AM No-Build (PHF=0.91)						TransModeler - 2044 AM No-Build (PHF=0.91)				TransModeler - 2044 AM Build (PHF=0.91)			
US23 & Blackwater Rd.	LOS	Delay (sec/veh)	v/c	95% QSR	95% Queue Length (ft)	US23 & Blackwater Rd.	LOS	Delay (sec/veh)	95% Queue Length (ft)	US23 & Blackwater Rd.	LOS	Delay (sec/veh)	95% Queue Length (ft)
Blackwater Rd. (Stop)						Blackwater Rd. (Stop)				Blackwater Rd. (Stop)			
EB L/T/R	E	42.8	0.26	1.00	25	EB L/T/R	F	95.8	86	EB L/T/R	C	19.5	10
EB Approach	E	42.8				EB Approach	F	95.8		EB Approach	C	19.5	
WB L/T/R	F	61.0	0.56	2.80	70	WB L/T/R	F	111.6	153	WB L/T/R	F	110.3	110
WB Approach	F	61.0				WB Approach	F	111.6		WB Approach	F	110.3	
Route 23						Route 23				Route 23			
NB L/T	B	11.3	0.02	0.10	3	NB L/T	A	0.3	0	NB T (2 lanes)	A	0.0	0
NB T/R	A	0.4				NB T/R	A	0.1	0	NB R	A	0.0	0
NB Approach	A	0.5				NB Approach	A	0.2		NB Approach	A	0.0	
SB L	B	14.9	0.03	0.10	3	SB L	C	16.8	0	SB L	B	11.2	0
SB T	A	0.4				SB T	A	0.0	0	SB T (2 lanes)	A	0.0	0
SB T/R	A	0.4				SB T/R	A	0.0	0	SB R	A	0.0	0
SB Approach	A	0.6				SB Approach	A	0.2		SB Approach	A	0.1	
Overall						Overall	A	4.2		Overall	A	3.1	

2044 PM Analysis - HCS & TransModeler Analysis

HCS - 2044 PM No-Build (PHF=0.91)						TransModeler - 2044 PM No-Build (PHF=0.91)				TransModeler - 2044 PM Build (PHF=0.91)			
US23 & Blackwater Rd.	LOS	Delay (sec/veh)	v/c	95% QSR	95% Queue Length (ft)	US23 & Blackwater Rd.	LOS	Delay (sec/veh)	95% Queue Length (ft)	US23 & Blackwater Rd.	LOS	Delay (sec/veh)	95% Queue Length (ft)
Blackwater Rd. (Stop)						Blackwater Rd. (Stop)				Blackwater Rd. (Stop)			
EB L/T/R	F	138.4	0.59	2.40	60	EB L/T/R	F	197.7	113	EB L/T/R	F	300.9	154
EB Approach	F	138.4				EB Approach	F	197.7		EB Approach	F	300.9	
WB L/T/R	F	140.4	0.81	4.10	103	WB L/T/R	F	312.5	281	WB L/T/R	F	122.8	134
WB Approach	F	140.4				WB Approach	F	312.5		WB Approach	F	122.8	
Route 23						Route 23				Route 23			
NB L/T	C	20.7	0.05	0.10	3	NB L/T	A	0.6	3	NB T (2 lanes)	A	0.0	0
NB T/R	A	1.6				NB T/R	A	0.4	0	NB R	A	0.0	0
NB Approach	A	1.7				NB Approach	A	0.5		NB Approach	A	0.0	
SB L	B	14.8	0.11	0.40	10	SB L	C	16.5	1	SB L	D	25.3	62
SB T	A	1.5				SB T	A	0.1	0	SB T (2 lanes)	A	0.0	0
SB T/R	A	1.5				SB T/R	A	0.0	0	SB R	A	0.0	0
SB Approach	A	1.8				SB Approach	A	0.4		SB Approach	A	0.6	
Overall						Overall	A	7.4		Overall	A	4.8	



Figure 6: US 23 Corridor Orr Rd Access





The estimated cost of the Turbo Lane is \$2,180,728. ECAT analysis shows a benefit-cost ratio of 1.26. It is expected ECAT is underrepresenting the safety benefit of the Turbo Lane. It is recommended the Turbo Lane be considered for future implementation.

B. Alternatives Considered

Given the angle crash pattern observed at the intersection, an RCUT alternative was considered. Traffic data submitted to the ODOT Office of Roadway Engineering showed that loons would be needed in the RCUT. There were safety concerns with the RCUT involving the loons and the high traffic volumes on US 23. A traditional RCUT has 24 total conflict points including 4 crossing points, 10 merge points, and 10 diverge points. When loons are added to an RCUT the total conflict points remain the same, but the types of points and their severity possibilities change. The 24 total conflict points of an RCUT with loons include 8 crossing points, 8 merge points, and 8 diverge points because the traditional U-turn merge point becomes 2 crossing points and the U-turn diverge point is removed. This results in more probable high severity conflict points than the Turbo Lane configuration. **Figure 7** shows the conflict points of an RCUT.

When comparing the conflict points of the problematic movement of left turning traffic out of east leg of Blackwater Rd in both alternatives, the Turbo Lane showed to have less conflict points total and a lower number of high severity conflict points. The left turning traffic out of the east leg of Blackwater Rd experiences 4 conflict points in the Turbo Lane compared to 7 in the RCUT with loons. The 4 Turbo Lane conflict points include 3 crossing points and a merge point. The RCUT, with loons, conflict points include 2 crossing points, 3 merge points, and 2 diverge points. It is important to note that one of the crossing points in the Turbo Lane is the slow speed crossing conflict point described in section VI.A. It is also important to note that the merge conflict point of the RCUT, with loons, involves a slow speed movement of vehicles entering US 23 with high-speed through vehicles and should be considered a probable high severity conflict point.

The RCUT was estimated to have a higher cost, due to more widening of the bridge structure, and had a lower benefit-cost ratio than the Turbo Lane configuration. Due to the positive traffic analysis results of the Turbo Lane and the favorable comparison of a Turbo Lane configuration to an RCUT, in this scenario, an RCUT is not being pursued at the intersection.



Figure 7: RCUT Conflict Points

