MEMO

Date: March 2024

To: Aaron Conley, PE

From: Abby Cueva, PE

Subject: SUM-18-1.43 & SUM-18-2.18-2.26 - Traffic Investigation Summary of Results

ODOT District 4 commissioned EMH&T to perform traffic investigations for the SR 18 corridor between South Hametown Road and Cleveland Massillon Road, which contains the I-77 interchange in the middle of the study segment. The tasks were assigned in two parts: SUM-18-1.43 which focused on the west side of the interchange; and SUM-18-2.18-2.26 was focused on the area from the northbound I-77 exit ramp to Cleveland Massillon Road. A previous safety study dated July 2, 2020 completed by TranSystems (PID 110958), identified several countermeasures to reduce crashes within the corridor. District 4 determined that further analysis was needed to verify the proposed safety countermeasures would not adversely impact queueing and delay. Burgess & Niple (B&N), as a subconsultant of EMH&T, completed the capacity analysis using TransModeler simulation software and developed an O-D matrix utilizing StreetLight data to balance inbound and outbound volumes in the network.

SUM-18-1.43 (S. Hametown Road to I-77)

The specific scope items for the memo are as follows:

1) Does the 2020 Safety Study recommendation of protected left-turns for the eastbound and westbound approaches at South Hametown Road, Heritage Woods Drive, and Crystal Lake Road/Montrose West Avenue intersection have a negative impact on delay and queueing?
2) Are there benefits to coordinating S. Hametown Road with Heritage Woods and Crystal Lake?
3) Is the EB right turn at Crystal Lake needed?
4) The eastbound left at Crystal Lake/Montrose is proposed to be protected in the 2020 study. Is the eastbound storage sufficient for protected only? And does a protected eastbound left cause more problems than benefits considering the crash history.
5) Review additional considerations shown on page 11 of the 2020 Study.

Scope item #1: Does the 2020 Safety Study recommendation of protected left-turns for the eastbound and westbound approaches at South Hametown Road, Heritage Woods Drive, and Crystal Lake Road/Montrose West Avenue intersection have a negative impact on delay and queueing?

B&N analyzed the intersections in Transmodeler under three conditions: existing conditions, a scenario where (most) left turns were protected, and one where left turn phasing followed the traffic signal phasing guidance in Table 497-10 of the Traffic Engineering Manual (TEM). The three conditions analyzed are summarized in the table. The findings for Scope Item #1 are summarized below the table, with supporting documentation summarized. Detailed summarizes of the TransModeler analysis results, compiled by B&N, can be found in **Appendix 6 & 7**.

SR 18 & Hametown Rd			
	Existing Condition	**Protected Only Condition**	**TEM Recommendation**
Eastbound	Permitted	Permitted	Permitted
Westbound	Prot-Perm	Protected	Protected
SR 18 & Heritage Woods Dr			
	Existing Condition	**Protected Only Condition**	**TEM Recommendation**
Eastbound	Prot-Perm	Protected	Permitted
Westbound	Prot-Perm	Protected	Protected
SR 18 & Crystal Lake Rd/Montrose W Ave			
	Existing Condition	**Protected Only Condition**	**TEM Recommendation**
Eastbound	Prot-Perm	Protected	Protected
Westbound	Prot-Perm	Protected	Protected

Findings for Scope Item #1: In summary, the Protected Only Condition and the TEM Recommended Condition perform similar to the Existing Condition. There is a slight increase in the overall intersection delays and increases in the eastbound and westbound left turn delays but nothing that would be expected to significantly increase congestion and queuing along the corridor. *Given the lack of crash history for the eastbound lefts at Heritage Woods, we'd recommend the* ***TEM recommended condition*** *be applied as shown in the table above. In addition, consideration should be given to lengthening the westbound left at Heritage Woods by reducing the eastbound left at Crystal Lake/Montrose West. This could be done by simply restriping the back-to-back left turn lanes.*

Existing Condition Results

Under the existing left turn phasing and signal timing all three signals are expected to operate with an overall intersection LOS of D or better. There is one approach and four movements that operate at LOS F. These locations explained below, with side by tables that follow.

South Hametown Road

This intersection operates with an overall LOS of B in both the AM and PM peak hours. In addition, all movements and approaches are expected to operate at an acceptable LOS D or better.

Heritage Woods Drive

During the AM peak, the southbound left turn is operating at LOS F. However, this movement only has 10 vehicles, so the signal timing is favoring the high-volume movements at the expense of this movement. The 95% queue length is 33 feet. In the PM peak hour, the entire southbound approach is expected to operate at LOS F with delays approaching 200 seconds per vehicle. This is still a fairly low volume approach, but with delays this long, a couple of additional seconds of green time should be added to the southbound approach to reduce the delays.

Crystal Lake/Montrose West

This intersection is expected to operate at LOS B in the AM peak hour and LOS D in the PM peak hour. The eastbound left is expected to operate at LOS F in the AM peak and the westbound left is expected to operate at LOS F in the PM peak.

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Protected Only Results

Under the protected only left turn phasing and optimized signal timings, all three signals are expected to operate with an overall intersection LOS of C or better. There is one approach and three movements that operate at LOS F. These locations will be discussed below.

South Hametown Road

The addition of the protected only left turn movement has caused the overall delay in the PM peak to increase by 3 seconds per vehicle. The increased green time needed for the protected westbound left movement has reduced the green time available for the eastbound through movement, resulting in the delay increase for the intersection. To minimize the impact to the eastbound through movement, the available green time for the low volume streets was reduced by a couple seconds causing the movements on these approaches to decline from LOS D to LOS E conditions. Overall, the operation at the intersection is very similar to the Existing Condition and all LOS criteria has been met.

Heritage Woods Drive

During the AM and PM peaks, the removal of the permitted left turn phase has caused the LOS for the eastbound and westbound left turn movements to decline to LOS E and F. The delay for the eastbound left turn in the PM peak has just crossed the threshold between LOS E and LOS F, and it is for a low volume. The effect of this LOS F movement on the signal operation will be minimal. For the northbound and southbound approaches, a little additional green time was added compared to the Existing Condition. While there are still LOS E and F conditions, the delay for these approaches was improved compared to the Existing Condition. The operation of this intersection will be similar to the Existing Condition.

Crystal Lake/Montrose West

The optimization of the signal timings has improved the two LOS F movements from the Existing Condition to LOS E. However, the eastbound left turn movement has declined from LOS E to LOS F during the PM peak with the removal of the permitted left turn phase. This movement only has 50 vehicles and the 95% queue length is 74 feet. This LOS F condition will not have a significant impact on the operation of the signal. The operation of this intersection will be similar to the Existing Condition.

TEM Recommended Results

Under the left turn phasing recommended by the TEM and optimized signal timings, all three signals are expected to operate with an overall intersection LOS of C or better. There are two approaches and three movements that operate at LOS F. These locations will be discussed below.

South Hametown Road

This intersection is expected to operate nearly identical to the Protected Only Condition with an overall LOS of B in both the AM and PM peak hours. The only change is that the southbound approach during the PM peak has declined from LOS E to LOS F. This approach has fewer than 30 total vehicles, so it is a case of the actuated green time during the TransModeler runs being just a second shorter during a few cycles between the two conditions. The 95% queue length for the approach is expected to be just 48 feet.

Heritage Woods Drive

The Heritage Woods Drive intersection is expected to operate nearly identical to the Protected Only Condition. *The conversion of the eastbound left protected only movement to permitted, did improve the LOS for this movement.* All other movements at the intersection are very similar to the Protected Only Condition.

Crystal Lake/Montrose West

This intersection is expected to have nearly identical delays compared to the Protected Only Condition. The LOS and delay for each movement and approach is almost identical between the two conditions.

The tables on the following pages show the side-by-side comparison of the results at each intersection for the existing, protected only, and TEM recommended option for easy comparison. Please note the existing turn lengths for SR 18 are denoted on the left side with the needed length noted and coded red or green.

South Hametown Road

SR 18 & S. Hametown Road	2021 AM Peak Existing Timings			2021 PM Peak Existing Timings			2021 AM Peak Protected Lefts			2021 PM Peak Protected Lefts			2021 AM Peak TEM Recommended Lefts			2021 PM Peak TEM Recommended Lefts		
	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)
EB LTR	B	18.7	222	B	15.5	226	B	12.7	197	C	20.9	320	B	12.5	186	C	20.6	309
EB Approach	**B**	**18.7**		**B**	**15.5**		**B**	**12.7**		**C**	**20.9**		**B**	**12.5**		**C**	**20.6**	
WB L (380')	B	19.2	61	D	45.5	281	D	48.6	88	D	42.5	245	D	45.5	77	D	43.7	240
WB T	A	7.5	85	A	6.5	80	A	7.7	23	A	6.5	17	A	7.4	49	A	6.2	19
WB R	A	0	0	A	5.1	0	A	0	0	A	7.3	0	A	0	0	A	6.5	0
WB Approach	**A**	**8.2**		**B**	**12.7**		**B**	**10.3**		**B**	**12.5**		**A**	**9.9**		**B**	**12.3**	
NB LT	C	30.6	28	D	42.5	49	D	54.9	49	E	60.8	79	D	54.4	48	E	59.2	74
NB R	B	17.8	84	C	23.4	91	C	29.3	150	C	27.9	120	C	30.8	159	C	28.8	131
NB Approach	**C**	**20.1**		**C**	**28.7**		**C**	**34**		D	36.9		**D**	**35.1**		**D**	**37.1**	
SB LTR	A	0	0	D	52.5	30	A	0	0	E	74	41	A	0	0	F	84.1	48
SB Approach	**A**	**0**		**D**	**52.5**		**A**	**0**		**E**	**74**		**A**	**0**		**F**	**84.1**	
Intersection	**B**	**14.5**	--	**B**	**15.5**		**B**	**14.2**		**B**	**18.3**		**B**	**14.1**		**B**	**18.1**	

Heritage Woods Drive

SR 18 & Heritage Woods Drive	2021 AM Peak Existing Timings			2021 PM Peak Existing Timings			2021 AM Peak Protected Lefts			2021 PM Peak Protected Lefts			2021 AM Peak TEM Recommended Lefts			2021 PM Peak TEM Recommended Lefts		
	LOS	Delay (sec/veh)	95th %tile Queue (ft)	LOS	Delay (sec/veh)	95th %tile Queue (ft)	LOS	Delay (sec/veh)	95th %tile Queue (ft)	LOS	Delay (sec/veh)	95th %tile Queue (ft)	LOS	Delay (sec/veh)	95th %tile Queue (ft)	LOS	Delay (sec/veh)	95th %tile Queue (ft)
EB L (430')	A	6.6	23	A	9.3	18	E	77.6	81	F	86.6	57	B	10.6	26	C	32.8	37
EB TR	A	6	130	A	9	169	A	5.4	60	A	8.9	102	A	4.4	85	A	9.6	102
EB Approach	**A**	**6.4**		**A**	**9**		**A**	**7.9**		**B**	**10.6**		**A**	**4.6**		**B**	**10.1**	
WB L (150')	A	7.3	97	C	32.6	256	E	72.4	164	E	73.7	333	E	57.2	137	E	78.1	352
WB TR	A	1	14	A	1.6	23	A	0.7	3	A	3.5	64	A	21	57	A	2.4	19
WB Approach	**A**	**1.5**		**A**	**5**		**A**	**7**		**B**	**10.8**		**A**	**6.9**		**B**	**10.4**	
NB LT	E	72.4	70	E	79.8	93	E	56.3	48	E	57.7	64	D	54.8	46	E	61.7	61
NB R	C	31	131	C	30.8	92	C	28.4	131	C	29.2	119	C	29	138	C	28.5	110
NB Approach	**D**	**38**		**D**	**42.1**		**C**	**33**		**D**	**35.8**		**C**	**33.3**		**D**	**36**	
SB LT	F	80.5	33	F	249.2	319	E	56	23	F	102	210	E	67.8	34	F	106.3	206
SB R	C	22.7	14	F	177.2	7	B	14.2	11	E	59.4	17	B	14.7	3	E	65	18
SB Approach	**D**	**50.6**		**F**	**225.6**		**C**	**34.8**		**F**	**88**		**D**	**41.2**		**F**	**92.4**	
Intersection	**A**	**7.4**		**B**	**14.8**		**A**	**9.7**		**B**	**14.4**		**A**	**8.2**		**B**	**14.1**	

Crystal Lake/Montrose West

SR 18 & Crystal Lake Road/ Montrose West	2021 AM Peak Existing Timings			2021 PM Peak Existing Timings			2021 AM Peak Protected Lefts			2021 PM Peak Protected Lefts			2021 AM Peak TEM Recommended Lefts			2021 PM Peak TEM Recommended Lefts		
	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)
EB L (330')	F	123.7	276	E	62	57	E	72.3	170	F	83	74	E	66.9	157	F	81.1	65
EB TR	B	15.3	198	C	34.2	391	B	15.3	175	D	35.5	363	B	15	186	D	35.1	344
EB Approach	**C**	**24.6**		**C**	**35**		**B**	**19.9**		**D**	**36.8**		**B**	**19.5**		**D**	**36.3**	
WB L (880')	C	28.8	112	F	128.9	514	E	56.4	141	E	68.8	335	E	56.9	133	E	73.2	357
WB T	B	15	206	C	22.5	295	C	22.1	247	C	25.3	339	C	22	246	C	25.4	333
WB R	A	5	22	A	7.6	3	A	6.6	46	A	8.6	17	A	6.7	39	A	8.1	11
WB Approach	**B**	**13.4**		**C**	**33.7**		**C**	**20.5**		**C**	**28.7**		**C**	**20.4**		**C**	**29.3**	
NB LT	E	70.4	48	E	66	61	E	59.1	35	E	57.1	54	E	59.9	35	E	60	63
NB R	C	25.5	70	C	29.9	119	C	24.4	62	C	26.7	120	C	25.4	64	C	25.7	123
NB Approach	**C**	**34.1**		**D**	**36.3**		**C**	**31.1**		**C**	**32**		**C**	**32**		**C**	**31.6**	
SB L	E	61	178	D	53.5	219	D	51.8	165	E	60.2	236	D	53.7	168	E	59.8	230
SB TR	C	24.8	39	D	36.5	126	C	22.6	37	D	38.6	132	C	24.1	47	D	41	129
SB Approach	**D**	**53.8**		**D**	**48.3**		**D**	**46**		**D**	**53.5**		**D**	**47.7**		**D**	**54.1**	
Intersection	**B**	**19.2**		**D**	**36**		**C**	**22.8**		**C**	**34.6**		**C**	**22.8**		**C**	**34.8**	

Scope Item #2: Are there benefits to coordinating S. Hametown Road with Heritage Woods and Crystal Lake?
In the existing condition, the Crystal Lake Drive and Heritage Woods Drive signals are coordinated, while the S. Hametown Road signal is not coordinated. B&N analyzed the S. Hametown Road signal as coordinated in the Protected Only and TEM Recommended Conditions, and it does not appear to substantially impact queue lengths or delay.

Findings for Scope Item #2: *It does not appear that adding S. Hametown to the signal coordination had a large impact on the delay and queues between S. Hametown and Heritage Woods.* Coordination couldn't hurt, but it does not appear that it is necessary and could potentially come at a cost if the existing coordination system uses cable.

Scope Item #3: Is the EB right turn at Crystal Lake needed?
The 2020 Safety Study identified the SR 18 and Crystal Lake Road intersection as a location for a dedicated eastbound right turn lane due to the 29 rear end crashes based on the 2015-2019 data, with a review of the crash reports revealing "multiple" right lane rear end crashes the study stated. Of the five years of crash data, 2015 and 2016 had only two eastbound lanes and 2017-2019 had three eastbound lanes. For both conditions, the average rear ends per year was six. From an operational perspective, the existing eastbound approach operates at LOS C in the AM Peak and PM Peak. The eastbound approach is predicted to operate at LOS B in the AM and LOS D in the PM for both the Protected Only and TEM Recommended conditions.
Findings for Scope Item #3: Given the right turn volumes at this intersection are fairly low volumes (15/30/57 for AM/Midday/PM) and the operations are favorable under both conditions, *we recommend not moving forward with an eastbound right turn lane at this intersection and continuing to monitor the situation.*

Scope Item #4: The eastbound left at Crystal Lake/Montrose is proposed to be protected in the 2020 study. Is the eastbound storage sufficient for protected only? And does a protected eastbound left cause more problems than benefits considering the crash history.
EMH&T has verified the storage at the eastbound left turn lane at Crystal Lake Drive is more than sufficient when the signal phasing is protected only for that movement. The existing turn lane has approximately 330' of storage. The TransModeler simulation results show the longest queue length being in the existing condition at 276' in the AM Peak Hour, but the AM queue length reduces to 170' when the signal phasing is updated to protected only and there is a substantial decrease in delay. The delay and queue lengths slightly increase in the PM Peak Hour, decreasing the eastbound left turn LOS from E to F, but still only show an approximate 65'-75' 95th percentile queue length.

Findings for Scope Item #4: The collision diagrams contained in the TranSystems safety study show 32 angle crashes occurring at this location between 2015 and 2019, 18 of which are coded as injury crashes. *The very minor increase in delay in the PM Peak Hour does not negate the benefit of the protected phase.* In addition, the storage capacity of the eastbound left does not get exceeded with the protected only phasing, and can likely be reduced to better accommodate the westbound left at Heritage Woods, as discussed above.

Scope Item #5: Review additional considerations shown on page 11 of the 2020 Study.
District 4 tasked EMH&T with reviewing the "Additional Considerations" contained in the original TranSystems safety study. EMH&T concurs that it will be beneficial to analyze the interchange in a separate study so the District may understand if there are operational deficiencies present, especially if further growth and development is anticipated. TranSystems recommended changes to the westbound lane assignments at the S Hametown Road intersection, however it does not appear these movements experience significant safety or capacity issues. Therefore, efforts to improve capacity or safety will be better focused elsewhere in the corridor. EMH&T agrees with TranSystems' recommendation that new traffic counts be collected and projected to a horizon year when considering any improvements that could affect capacity.

SUM-18-2.18-2.26 (I-77 to Cleveland-Massillon Road)

Three conditions were evaluated for this segment of the corridor. Each condition focused on different treatments for the eastbound and westbound left turn movements at the signalized intersections. The conditions include Existing Timings, Protected Lefts, and TEM Recommended Lefts and are described below.

Scope item #1: Does the 2020 Safety Study recommendation of protected left-turns for the eastbound and westbound approaches at Springside Drive, Montrose Ford/ACME, and Cleveland-Massillon Road intersections have a negative impact on delay and queueing?

	Existing Condition	Protected Only Condition	TEM Recommendation
SR 18 & Springside			
Eastbound	Prot-Perm	Protected	Prot-Perm
Westbound	Prot-Perm	Protected	Prot-Perm
SR 18 & Ford/ACME			
Eastbound	Prot-Perm	Protected	Protected
Westbound	Permitted	Protected	Permitted
SR 18 & Cleveland Massillon			
Eastbound	Prot-Perm	Protected	Prot-Perm
Westbound	Prot-Perm	Protected	Protected

Findings for Scope Item #1: The Protected Only Condition and the TEM Recommended Condition perform similar to the Existing Condition. There is a slight increase in the overall intersection delays and increases in the eastbound and westbound left turn delays but nothing that would be expected to significantly increase congestion and queuing along the corridor.

Existing Condition Results

Springside Drive
This intersection operates with an overall LOS of B in the AM peak hour and LOS E in the PM peak hour. The available storage of 130' for the eastbound left is deficient in the PM peak and would need extended a minimum of 130' to provide adequate storage. During the PM peak, the single northbound left turn lane has a volume of 400 vehicles and is well over capacity with a delay of nearly 400 seconds. Due to the high eastbound and westbound through volumes, there is not enough remaining green time to adequately service the northbound and southbound movements, resulting in LOS E and F conditions for all northbound and southbound movements.

ACME/Montrose Ford
This intersection is expected to operate with an overall LOS A in the AM peak hour and LOS B in the PM peak hour. All movements will operate with an acceptable LOS D or better. This intersection meets the operational goals for this study. There is room to extend the eastbound left, deficient in the PM peak, with minor restriping.

Cleveland Massillon Road
This intersection is expected to operate with an overall LOS C in both the AM and PM peak hours. All movements are expected to operate with an acceptable LOS E or better. This intersection meets the operational goals for this study.

Protected Only Results

Under the protected only left turn phasing and optimized signal timings, all three signals are expected to operate with an overall intersection LOS of D or better. The Springside Drive and ACME/Montrose Ford intersections are expected to have movements that operate at LOS F. These locations will be discussed below.

Springside Drive
The overall intersection LOS is expected to improve from LOS E to LOS D for the PM peak hour compared to the Existing Condition. This improvement is primarily related to the dual northbound left turn lanes. The second lane reduces the amount of green time needed to serve the left turn which allows more green time to be distributed to the other movements at the intersection. The northbound approach has improved from LOS F to LOS D. However, the southbound approach is still at LOS F, the same as the Existing Condition.

ACME/Montrose Ford
This intersection is expected to operate with an overall LOS A in the AM peak hour and LOS B in the PM peak hour, which is comparable to the Existing Condition. However, the addition of the protected eastbound and westbound left turn phases has created LOS E for these movements. In addition, the northbound approach in the PM peak will operate at LOS F. The northbound approach has a low volume, and the 95% queues are expected to be 114 feet so the LOS F conditions will not significantly impact the intersection operation.

Cleveland Massillon Road
This intersection is expected to operate with an overall LOS C in both the AM and PM peak hours and all movements are expected to operate with an acceptable LOS E or better. While the LOS and delay for the eastbound and westbound left turn movements will have a slight decline, the LOS and delay for the remaining movements will be very similar to the Existing Condition. This intersection meets the operational goals for this study.

TEM Recommended Results

Under the left turn phasing recommended by the TEM and optimized signal timings, all three signals are expected to operate with an overall intersection LOS of D or better. The Springside Drive and ACME/Montrose Ford intersections are expected to have movements that operate at LOS F. These locations will be discussed below.

Springside Drive
The overall intersection LOS is expected to improve slightly in the AM peak hour and be very similar in the PM peak hour compared to the Protected Only Condition. This improvement is related to changing the eastbound and westbound left turn phasing from protected only to protected-permitted. This change reduces the protected only green time which allows for more eastbound/westbound through green and side street green. The southbound approach will still operate at LOS F, but the delays will be a little lower than the Protected Only Condition.

ACME/Montrose Ford
This intersection is expected to operate nearly identical to the Protected Only Condition. The conversion of the westbound left protected only movement to permitted did improve the LOS for this movement. All other movements at the intersection are very similar to the Protected Only Condition.

Cleveland Massillon Road
This intersection is expected to operate with an overall LOS C in both the AM and PM peak hours and all movements are expected to operate with an acceptable LOS E or better. The LOS and delay for the movements and approaches will be very similar to the Protected Only Condition. This intersection meets the operational goals for this study.

The tables on the following pages show the side-by-side comparison of the results at each intersection for the existing, protected only, and TEM recommended option for easy comparison. Please note the existing turn lengths for SR 18 turns are denoted on the left side with the needed length noted and coded red or green.

Springside Drive

SR 18 & Springside	2021 AM Peak Existing Timings			2021 PM Peak Existing Timings			2021 AM Peak Protected Lefts			2021 PM Peak Protected Lefts			2021 AM Peak TEM Recommended Lefts			2021 PM Peak TEM Recommended Lefts		
	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)
EB L (130')	C	20.5	117	F	133.1	255	D	44.7	196	E	79.9	244	B	18.3	100	F	91.4	247
EB TR	B	12.9	142	C	22	246	B	16.3	172	C	20.1	240	B	15	142	C	22	244
EB Approach	**B**	**14.6**		**C**	**34.1**		**C**	**21.8**		**C**	**26.7**		**B**	**15.6**		**C**	**29.6**	
WB L (140')	B	18.5	41	F	80.1	167	E	56.8	80	F	80.5	202	C	20.1	34	E	66	5
WB TR	B	10.1	101	C	26.8	310	C	20.4	191	C	31.6	314	B	15.7	166	C	33.5	313
WB Approach	**B**	**10.8**		**C**	**31.3**		C	22.6		**C**	**34.4**		**B**	**16**		**D**	**35.7**	
NB L (390')	D	39.2	149	F	394.7	951	D	41.5	89	E	63.6	238	D	41.7	86	E	62.6	238
NB TR	C	22.6	55	E	61.8	228	B	16.5	39	C	29.9	120	B	19.1	44	C	29	114
NB Approach	**C**	**34.2**		**F**	**279.7**		**C**	**33.9**		**D**	**54.3**		**C**	**34.9**		**D**	**53.3**	
SB L (200')	C	33.7	45	F	126.8	142	C	26	37	F	138.3	194	C	25.9	35	F	115.3	154
SB TR	C	23	100	F	141.9	574	B	18.4	69	F	131.4	571	B	18.8	70	F	114.3	570
SB Approach	**C**	**25.6**		**F**	**138.8**		**C**	**20.2**		**F**	**132.8**		**C**	**20.5**		**F**	**114.5**	
Intersection	**B**	**19.2**		**E**	**65.3**		**C**	**23.2**		**D**	**43.9**		**B**	**18.1**		**D**	**44.5**	

Montrose Ford/ACME

SR 18 & Montrose Ford/ACME	2021 AM Peak Existing Timings			2021 PM Peak Existing Timings			2021 AM Peak Protected Lefts			2021 PM Peak Protected Lefts			2021 AM Peak TEM Recommended Lefts			2021 PM Peak TEM Recommended Lefts		
	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)
EB Left (120')	A	3.7	14	C	33.6	228	C	33.1	53	E	62.1	244	C	33.6	62	D	45.1	231
EB Th/Right	A	2.2	20	A	7.4	157	A	5.4	63	A	5	65	A	3.9	38	A	6.8	154
EB Approach	**A**	**2.3**		**B**	**10.5**		**A**	**6.8**		**B**	**11.5**		**A**	**5.6**		**B**	**11.3**	
WB Left (100')	A	6.5	3	C	30.3	13	E	71.4	17	E	78.4	20	B	11.1	2	C	23.8	6
WB T/R	A	5.6	73	B	13	172	B	11.6	116	B	13.5	159	B	12.9	121	B	18.5	172
WB Approach	**A**	**5.6**		**B**	**13.1**		**B**	**11.9**		**B**	**14**		**B**	**12.9**		**B**	**18.5**	
NB L/T/R	C	33.5	21	D	49.7	77	C	27.1	23	F	108.3	114	C	28.5	29	F	114	111
NB Approach	**C**	**33.5**		**D**	**49.7**		**C**	**27.1**		**F**	**108.3**		**C**	**28.5**		**F**	**114**	
SB L/T	D	45.4	21	D	47.2	**77**	D	36.1	18	D	48.8	82	D	36.7	17	D	48.6	77
SB R	A	8.6	14	C	30.8	161	A	7	8	C	31.4	163	A	7.1	9	C	33.9	164
SB Approach	**C**	20.5		**D**	**35**		**B**	**16.3**		**D**	**35.8**		**B**	**16.5**		**D**	**37.6**	
Intersection	**A**	**4.6**		**B**	**14.5**		**A**	**9.6**		**B**	**16.3**		**A**	**9.3**		**B**	**18.5**	

Cleveland/Massillon Road

SR 18 & Cleveland-Massillon Rd	2021 AM Peak Existing Timings			2021 PM Peak Existing Timings			2021 AM Peak Protected Lefts			2021 PM Peak Protected Lefts			2021 AM Peak TEM Recommended Lefts			2021 PM Peak TEM Recommended Lefts		
	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)	LOS	Delay (sec/veh)	95th % tile Queue (ft)
EB Left (280')	B	13	41	D	38.4	105	D	50.2	91	D	45.8	116	A	9.9	27	D	38.6	107
EB Through	C	22.4	162	C	32.9	243	B	13.6	95	C	30.7	274	B	13.5	106	B	18.2	211
EB Right	A	9.6	28	B	11.6	69	A	6	20	C	21.7	136	A	9.1	39	B	11.6	98
EB Approach	**B**	**19.5**		**C**	**29.8**		**B**	**16.2**		**C**	**30.5**		**B**	**12.5**		**B**	**18.8**	
WB Left (200')	B	10.1	22	C	32.4	149	D	44.8	76	E	56	200	D	44.8	78	E	57.5	212
WB T/R	B	10.8	84	C	21.6	264	B	12.4	84	C	21.6	254	B	12.6	89	C	23.1	262
WB Approach	**B**	**10.8**		**C**	**23.4**		**B**	**16.7**		**C**	**26.9**		**B**	**17**		**C**	**28.2**	
NB Left	D	47.8	79	E	56.7	152	D	44.5	73	D	52.3	146	D	44	75	D	53.1	150
NB Through	D	42.9	60	D	49.3	84	D	37.7	54	D	48	79	D	38.5	57	D	47.3	78
NB Right	A	9	16	B	14.9	55	B	10.9	17	B	14.1	51	B	10.3	16	B	15.2	57
NB Approach	**D**	**37.8**		**D**	**41.8**		**D**	**35**		**D**	**39.3**		**C**	**34.9**		**D**	**39.9**	
SB Left	D	48.2	49	E	59.8	146	D	43.4	48	E	55.1	130	D	44.5	50	E	55.1	134
SB Through	D	43.5	45	E	56.1	140	D	39.8	45	D	54.8	138	D	40.4	42	D	54.6	137
SB Right	B	10.8	19	C	29	118	B	10.7	24	C	25.5	101	B	11.3	18	C	29.2	119
SB Approach	**D**	**36**		**D**	**51.3**		**C**	**32.9**		**D**	**48.2**		**C**	**33.6**		**D**	**48.9**	
Intersection	**C**	**22**		**C**	**33.3**		**C**	**21.8**		**C**	**33.8**		**C**	**20.5**		**C**	**31.2**	

Scope Item #2: The eastbound left at Springside Drive; 1) does the left turn lane need extended? 2) Check both AM and PM peak for the storage length needed for the eastbound protected left turn.

Findings for Scope Item #2: The results of B&N's TransModeler analysis shows the eastbound left turn lane should be extended to provide enough storage for peak hour left turn volumes. Left turn volumes are higher during the AM Peak Hour, however, TransModeler analysis shows the longest queue lengths occurring in the PM Peak Hour. Eastbound left turn queue lengths extend 247' in the TEM Recommended scenario during the PM Peak Hour, while the existing turn lane only provides 125' of storage. On top of restriping, extending the existing turn lane will also require a portion of the concrete median barrier on SR 18 to be removed. The turn lane can be extended to approximately 385' before it would impact the existing truss on SR 18 westbound, which is more than needed.

Scope Item #3: What does the conversion of Flight Memorial to a RIRO do to the Springside Drive intersection, particularly NB lefts and WB lefts? Also, analyze dual NB lefts at Springside Drive.

Findings for Scope Item #3: The NB lefts at Springside Drive operate at a LOS F in the existing condition, showing nearly 400 seconds of delay and a 950' queue in the PM Peak. **The following results tables reflect a proposed configuration** that introduces dual NB left, a RIRO at Flight Memorial, and a signalized NB off-ramp at the interchange. It should be noted that the EB Left at Montrose Ford/ACME should be extended (with re-striping) when Flight Memorial is converted to a RIRO based on the results summarized on Page 7. The results of the proposed condition describe here are summarized below:

SR 18 & Springside Drive

SR 18 & Springside	2021 AM Peak TEM Recommended Lefts			2021 PM Peak TEM Recommended Lefts		
	LOS	Delay (sec/veh)	95th %tile Queue (ft)	LOS	Delay (sec/veh)	95th %tile Queue (ft)
EB L (modified to 300')	D	42.7	84.7	E	73.9	212.3
EB TR	B	12.1	124.6	C	23.5	213.7
EB Approach	**B**	**10.6**		**C**	**21.3**	
WB L (140')	D	36.4	17.6	F	86.3	110.2
WB TR	B	16.3	119.7	B	17.5	179
WB Approach	**B**	**10.3**		**B**	**14.2**	
NB L (390')	D	43.5	21.6	E	56.9	58
NB TR	D	36.7	0	D	47.8	1.5
NB Approach	**D**	**42.6**		**E**	**56.6**	
SB L (200')	D	43.2	43.8	E	66.7	114.9
SB TR	B	16.7	28	D	44.6	341.1
SB Approach	**B**	**15.4**		**D**	**52**	
Intersection	**B**	**16.9**		**C**	**29.1**	

SR 18 & I-77 NB Exit

SR 18 & I-77 NB Exit Ramp	2021 AM Peak			2021 PM Peak		
	LOS	Delay (sec/veh)	95th %tile Queue (ft)	LOS	Delay (sec/veh)	95th %tile Queue (ft)
EB TR (400')	A	6.6	95.2	A	8	135.9
EB Approach	**A**	**6.6**		**A**	**8**	
NB R	C	23.3	166.6	C	34.1	269.7
NB Approach	**C**	**23.3**		**C**	**34.1**	
Intersection	**B**	**10.6**		**A**	**8.1**	

Scope Item #4: Analyze the WB to NB drop lane and how it effects the WB direction on SR 18. Also, if the NB exit is signalized, does the EB queue extend back to the NB entrance ramp and cause operational issues?

Findings for Scope Item #4: A review of B&N's simulation does not indicate the westbound to northbound drop lane at the I-77 northbound entrance ramp negatively impacts operations on westbound SR 18 or northbound Springside Drive.

EMH&T analyzed volume-based signal warrants at the I-77 northbound exit ramp and SR 18 eastbound intersection using count data provided by ODOT. The signal warrants were analyzed under the criteria contained in OMUTCD §4C using the ODOT Traffic Signal Warrant Spreadsheet. The intersection satisfies Warrants 1, 2 and 3 when right turn reduction is not applied. No warrants are satisfied when the right turn reduction is applied.

Preliminary analysis of the I-77 northbound exit ramp to SR-18 eastbound signalized intersection was completed using Highway Capacity Software 2023 (HCS) and traffic volumes provided by ODOT. The goal of this analysis was to determine if signalizing this intersection would cause operational issues on SR-18 eastbound; in particular if queues would extend back to the I-77 northbound entrance ramp. The preliminary HCS analysis shows the longest 95th percentile queue lengths for the SR-18 eastbound occur in the PM Peak Hour and are 127.3'. There is approximately 400' between the I-77 northbound entrance ramp and where a stop bar would if the northbound exit ramp intersection were to be signalized. This indicates the signalized intersection will not affect the I-77 northbound entrance ramp, however, an interchange study with horizon year volumes is needed to fully analyze the impacts on the study area.

Appendices included with the memo include:

1. Traffic Count for Signal Warrants
2. US 77 and SR-18 Signal Warrant with no Right Turn Reduction
3. US 77 and SR-18 Signal Warrant with Right Turn Reduction applied
4. NB Ramp Signalized HCS
5. East Side Traffic Analysis Memo + Attachments (B&N)
6. West Side Traffic Analysis Memo + Attachments (B&N)
7. Updated TransModeler Reports_Proposed Condition (EMH&T)