MD 355 [FREDERICK ROAD] OVER LITTLE BENNETT CREEK

MAINTENANCE OF TRAFFIC ALTERNATIVE ANALYSIS

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

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INTRODUCTION

The purpose of this report is to present the results of traffic analyses performed for the replacement of Bridge No. 150053001 on MD 355 (Frederick Road) over Little Bennett Creek in Montgomery County. The bridge is located between Hyattstown and Clarksburg. Running parallel to I-270, MD 355 is a two-lane, undivided rural collector with 11 foot lanes (with no shoulder at the bridge) in each direction. For the purposes of this analysis, it was assumed the bridge would be reconstructed in year 2019. The bridge location is shown in **Figure 1**.

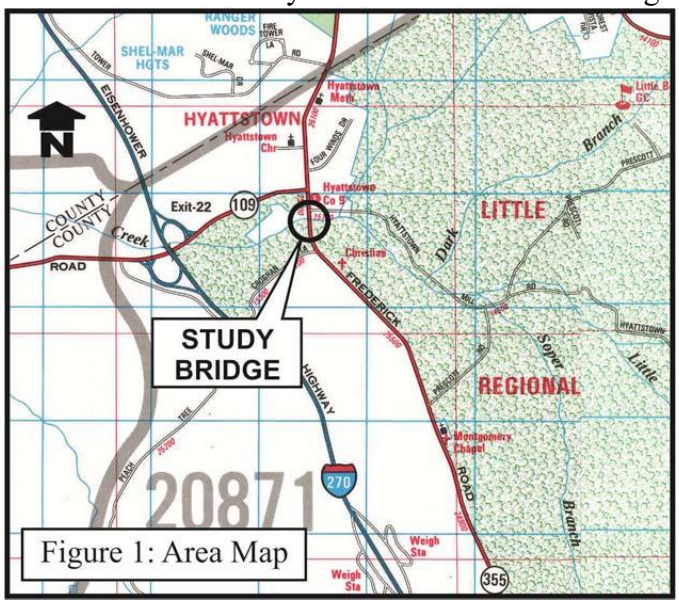


Figure 1: Area Map

Under this project, the bridge will be reconstructed and will feature 12 foot travel lanes and 6 foot shoulders. The design speed for the ultimate roadway within the project limits will be 30 mph.

SUMMARY OF ALTERNATIVES

The Maryland Department of Transportation State Highway Administration (MDOT SHA) requested three major Maintenance of Traffic (MOT) alternatives be evaluated for this study: (1) Full Detour, (2) Maintain One Travel Lane, and (3) Maintain All Travel Lanes. The following is a description of each of the alternatives.

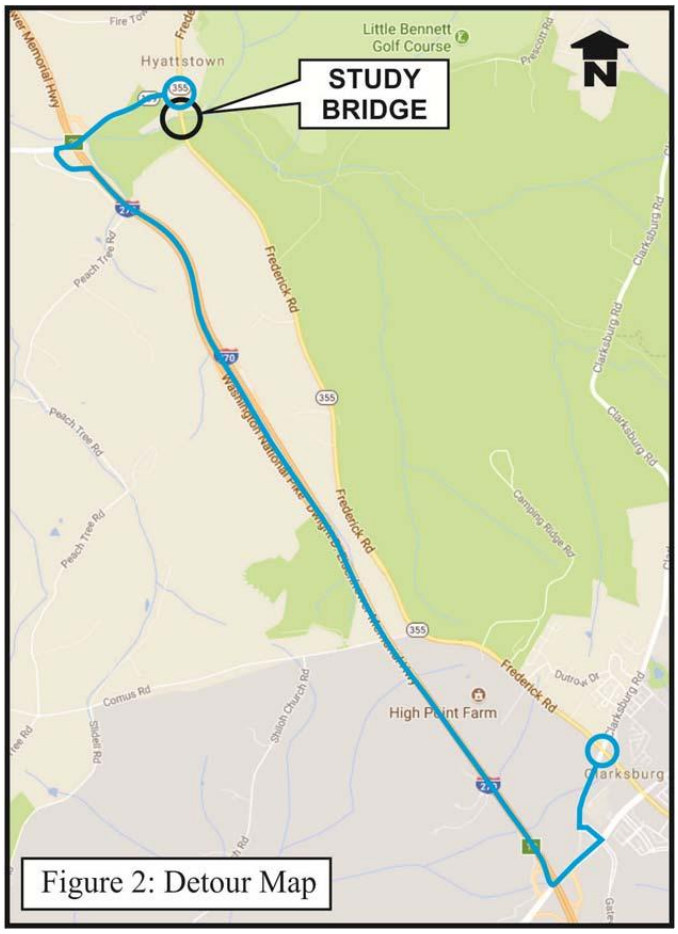


Figure 2: Detour Map

Alternative 1 (Full Detour): This alternative would consist of one construction phase. MD 355, in the vicinity of the bridge, would be closed to traffic and a detour would be instituted for all traffic for the duration of the construction project. The detour route would include MD 109 (Old Hundred Road) from MD 355 to I-270, I-270 from MD 109 to MD 121 (Clarksburg Road), and MD 121 from I-270 to MD 355. A map of the detour route can be seen in **Figure 2**. The existing route along MD 355 between MD 109 and MD 121 is approximately 3.5 miles long. The proposed detour route is approximately 5.9 miles in length. All roadways along the proposed detour route

are governed by MDOT SHA. MD 109 is a two-lane undivided collector, I-270 is a four-lane divided freeway, MD 121 (Clarksburg/Stringtown Road) is a four-lane divided arterial to Gateway Center Drive, which is also a four-lane divided roadway to MD 121 (Clarksburg Road), which is a two-lane local road to its intersection with MD 355.

The speed limit along MD 355 is 30 mph approaching the study bridge. Within the limits of the detour, speed limits on MD 355 transition from 40 mph up to 50 mph and then back down to 30 mph just prior to the bridge. Also, the speed limits along I-270, MD 109, and MD 121 are 65 mph, 30 mph, and 40 mph lessening to 30 mph, respectively.

Alternative 2 (Maintain One Travel Lane): Under this option, one travel lane will be maintained at all times and the bridge will be constructed in stages while alternating traffic across the bridge through the use of a temporary signal at each end of the work zone. During the first stage of construction, the existing northbound travel lane will be maintained while the western portion of the new bridge and roadway alignment is constructed. During the second stage of construction, the single lane of traffic will be shifted to the newly constructed western portion of the roadway while the remaining portion of the roadway and bridge work is performed. Analysis for this alternative will include signal optimization for the installation of temporary traffic signals to regulate the direction of travel throughout the work zone.

Alternative 3 (Maintain All Travel Lanes): Under this alternative, all existing travel lanes will be maintained through the work area. During the first stage of construction, a temporary roadway alignment will be constructed around the majority of the project limits. The temporary roadway will include temporary drainage structures at the location of the existing creek crossing. During the second stage of construction, all travel lanes will be shifted to the temporary roadway alignment, the existing bridge will be removed, and the new bridge will be constructed. During the final stage of construction, all travel lanes will be shifted to the ultimate alignment and the temporary roadway and bridge will be removed. It should be noted that under this alternative, construction of the tie-in areas between the ultimate and temporary alignments must be constructed, which would not be require under either a full detour (such as under Alternative 1) or while maintaining a single travel lane through the project limits (such as under Alternative 2).

TRAFFIC VOLUMES

Traffic count data obtained from MDOT SHA's Data Services Engineering Division (DSED) was used for this study. The data included the following:

- 48-hour classification count on MD 355 over Little Bennett Creek (October 2013)
- MD 355 at MD 109 (13-hour turning movement count - September 2016)
- MD 355 at Hyattstown Mill Road (13-hour turning movement count - October 2013)
- MD 355 at Comus Road (13-hour turning movement count - September 2013)
- MD 109 at NB I-270 Ramps (13-hour turning movement count - September 2013)
- MD 109 at SB I-270 Ramps (13-hour turning movement count - September 2013)
- MD 121 at SB I-270 Ramps (13-hour turning movement count - September 2013)
- MD 121 at NB I-270 Ramps (13-hour turning movement count - September 2013)

- MD 121 (Stringtown Road) at Gateway Center Drive (13-hour turning movement count - September 2012)
- MD 121A (Clarksburg Road) at Gateway Center Drive (13-hour turning movement count - January 2011)
- MD 121A at MD 355 (13-hour turning movement count – November 2016)

It should be noted, except for the count data at the intersection of MD 121A and MD 355, no traffic counts from the recently constructed Clarksburg Premium Outlets has been considered in this analysis.

The detailed count data is included in Appendix A.

According to AADT data on MD 355 south of MD 109, the average annual growth rate in the vicinity of the study bridge between 2012 and 2016 was 0.84%. Therefore, an annual growth rate factor of 0.9% was applied when developing the construction year (2019) traffic volumes.

The traffic volumes were factored to adjust for the highest traffic volume month and day of the week for the year during AM and PM peak periods. The MDOT SHA's Traffic Trends data was used to determine the applicable adjustment factor. The highest 2013 peak AADT flow occurs on Fridays in May (118.16%). Based on these factors, the hourly volumes at each intersection were adjusted to Friday peak hour volumes in May in order to reflect the highest traffic volumes of the year. The Traffic Trends data is included in Appendix B.

The adjustment factor for the peak day of the year was applied to the traffic volumes and the 0.9% annual growth rate was used to calculate Year 2019 analysis volumes. Table 1 summarizes the adjusted weekday peak hour volumes by direction on MD 355 over Little Bennett Creek from 2013 to the proposed construction year of 2019. **Figure 3** shows the adjusted weekday peak hour volumes for Year 2019 along the detour route. It should be noted that only Year 2019 traffic volumes were used for the analysis in this study.

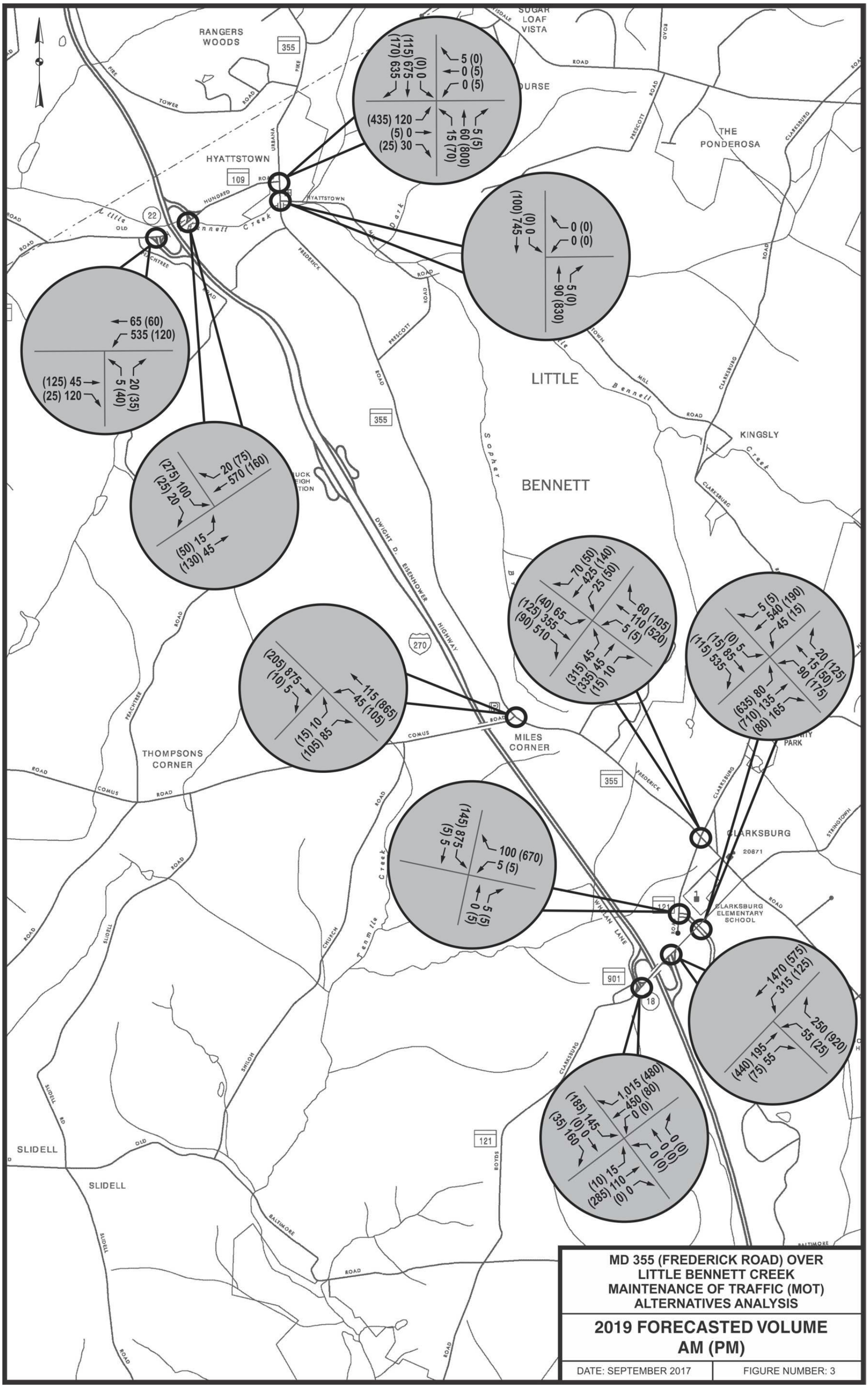
Table 1. Traffic Volumes on MD 355 over Little Bennett Creek

Peak Hour	Existing Weekday Peak Hour Volume (Veh/hr)		2019 Adjusted Weekday Peak Hour Volume (Veh/hr)	
	NB	SB	NB	SB
AM	167	690	200	800
PM	884	132	1030	150

EXISTING CONDITIONS

Existing Roadway Profile

The 25-year storm overtops the existing MD 355 bridge over Little Bennett Creek resulting in erosion of the roadway north of the bridge. Therefore, as part of this project, the roadway profile will be increased by approximately 2.0 feet at the bridge to prevent the 25-year storm from overtopping the structure. In order to tie in the new bridge profile, adjustments to the approach roadway profile will be required over a distance of approximately 700' (400' north of the bridge and 250 south of the bridge).



MD 355 (FREDERICK ROAD) OVER LITTLE BENNETT CREEK MAINTENANCE OF TRAFFIC (MOT) ALTERNATIVES ANALYSIS

2019 FORECASTED VOLUME AM (PM)

DATE: SEPTEMBER 2017 | FIGURE NUMBER: 3

Existing Environmental Features

A preliminary investigation has been performed to identify environmental and cultural features within the project limits. This investigation indicated the following resources in the area of the bridge 1) floodplain 2) the MD 355 bridge (15053) and Hyattstown Historic District, both listed in the Maryland Inventory of Historical Properties (MIHP) 3) wetlands 4) Green Infrastructure elements 5) Little Bennett Regional Park 6) Potential rare, threatened and endangered species, and 7) Forest Interior Dwelling Birds (FIDs) habitat. Therefore, potential impacts to environmental and cultural resources should be considered in the evaluation of the available alternatives.

Evaluation of Study Network Geometrics

Available sight distances were evaluated at each intersection and road along the detour routes. Based on the field observation, it appears the sight distances at all locations along the detour routes are adequate.

The intersections within the roadway network were also evaluated for adequate turning radii. Based on the evaluation of a WB-50 vehicle, turning radii for movements are adequate at all of the intersections along the detour route.

Travel Time Study

Field travel times were collected during off-peak hours traveling along the proposed detour route. Based on the field study, the detour is expected to add approximately 7-8 minutes in travel time over the full length of the detour in each direction during off-peak hours.

School Bus Routes

There are four public schools located in the vicinity of the detour route. This includes one high school (Clarksburg High School), one middle school (Rocky Hill Middle School), and two elementary schools (Little Bennett and Clarksburg Elementary schools), located in Clarksburg. School bus routes for all of these schools likely utilize portions of MD 355 or the detour route under existing conditions and will therefore be impacted by any proposed roadway (full or partial) closure. According to Montgomery County Public Schools' (MCPS) Transportation Department, MD 355 is a heavily traveled school bus route providing access to the schools located in Clarksburg. A closure of MD 355 in the vicinity of the study bridge would result in an increase in school bus travel times between 10 and 15 minutes and if a detour option is selected, MCPS needs to be notified by at least the Spring before the planned closure so that the detour can be incorporated into the planned school bus routes for the school year when construction is to be completed. As this project continues through the planning and design stages, it is recommended that MCPS be involved.

MDOT SHA MOBILITY THRESHOLDS

The MDOT SHA has developed mobility thresholds for work zone operations and they are shown in Table 2.

Table 2. MDOT SHA Mobility Thresholds

Signalized Intersections	
Existing Level of Service	Mobility Threshold
A, B or C	Maximum LOS D Control delay ≤ 45 seconds
D	Maximum increase in Control delay of 30%
E	Maximum increase in Control delay of 30%, or Control delay ≤ 80 seconds
F	No increase in control delay
Unsignalized Intersections	
Existing Level of Service	Mobility Threshold
A, B or C	Maximum LOS D Control delay ≤ 30 seconds
D	Maximum increase in Control delay of 30%
E	Maximum increase in Control delay of 30%, or Control delay ≤ 50 seconds
F	No increase in control delay
Arterials	
Existing Travel Time	Mobility Threshold
T	Travel time cannot increase more than 15 minutes (Maximum of T+15)

ALTERNATIVES ANALYSIS

Alternative 1: Full Detour

Under this alternate, the bridge will be closed to all traffic for the duration of the construction project. Through traffic on MD 355 will be detoured along MD 109 (between MD 355 and I-270), I-270 (between MD 109 and MD 121), and MD 121 (between I-270 and MD 355).

Geometric Analysis

Under this alternative, the new bridge will be constructed along roughly the same alignment as the existing bridge, with a slight offset to accommodate the widened bridge section.

Volume Redistribution

Traffic volumes for movements prohibited by the proposed bridge closure were redistributed throughout the study network based on several assumptions. These assumptions were based on the existing traffic count data in the study network and assumed driver behavior. The following are some assumptions that were used to redistribute network volumes:

- Motorists are familiar with the area and will utilize the shortest path in order to get to their destination.
- All volumes were redistributed based on the downstream or upstream intersection's current volume proportions of turns for each turning movement.

- Travel demand on MD 355 north of MD 109 will not be affected by the detour.

Based on these assumptions, the Year 2019 factored traffic volumes were redistributed throughout the study network. **Figure 4** shows the redistributed traffic volumes that were used for the analysis of this alternative.

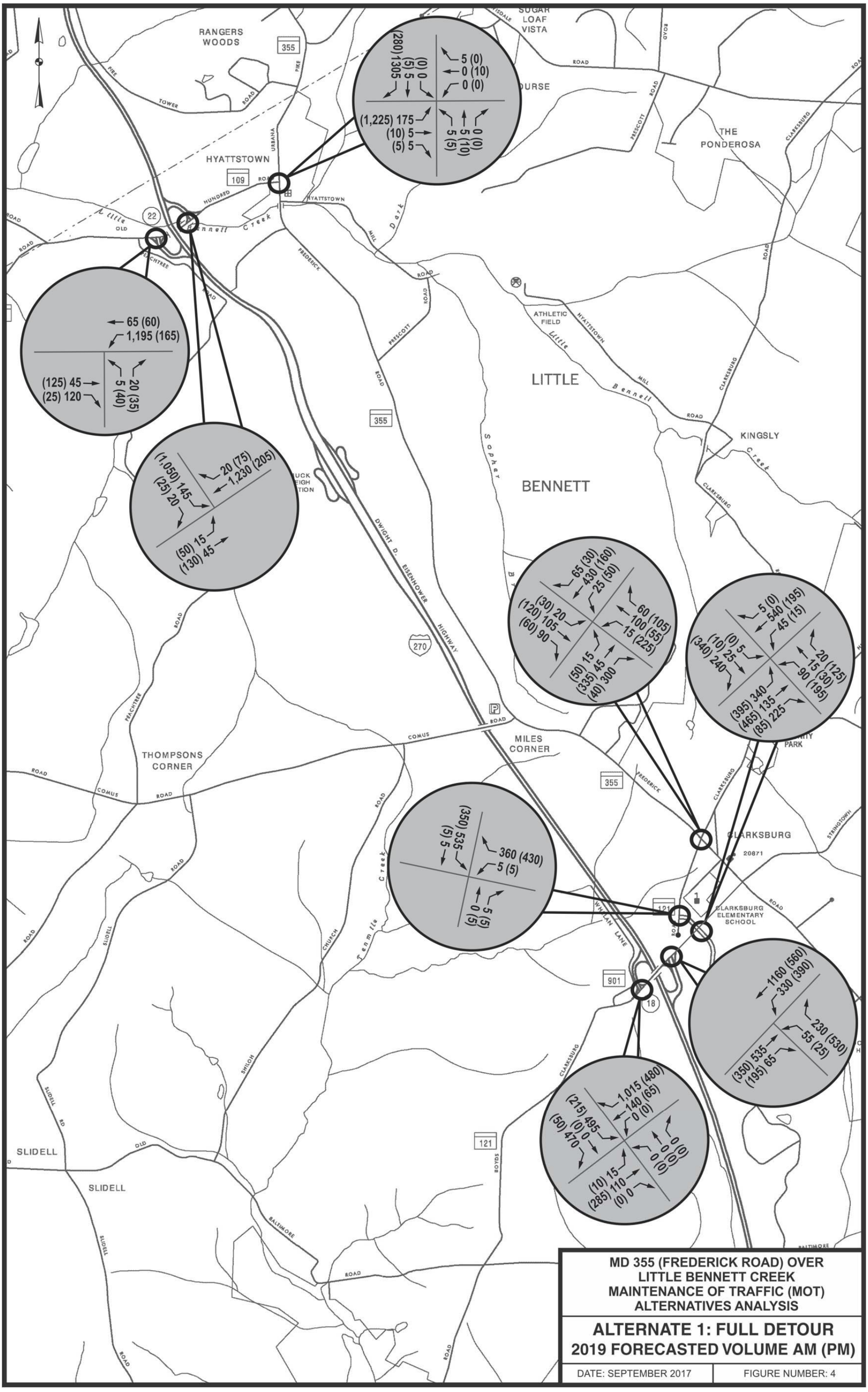
Analysis Results

Synchro and Highway Capacity Software (HCS) analyses were performed on the study network under existing and full detour conditions to determine the impact of the proposed detour. Synchro was used specifically for the evaluation of intersections along the detour route. HCS was utilized to analyze freeway and ramp operations along the detour route, since Synchro does not adequately evaluate freeway operations.

Tables 3 and 4 summarize the results of the Synchro and HCS analyses, respectively, under existing conditions. Tables 5 and 6 summarize the results of the Synchro and HCS analyses, respectively, under Full Detour conditions. It should be noted that signal timings at signalized intersections were optimized under Full Detour conditions to mitigate the impacts of the volume redistribution. Values shown in bold red italics exceed MDOT SHA's allowable mobility thresholds. The Synchro and HCS worksheets for existing conditions can be found in Appendix C, and worksheets for Full Detour conditions can be found in Appendix D.

Table 3. Peak Hour Synchro Analysis – Existing Conditions – AM (PM)

Intersection Approach	Delay / Vehicle (sec)	V/C Ratio	Level of Service
MD 355 at MD 109			
SB MD 355	39.3 (13.4)	1.01 (0.29)	D (B)
NB MD 355	3.0 (49.5)	0.10 (0.99)	A (D)
EB MD 109	97.4 (78.6)	0.89 (1.01)	F (E)
WB Driveway	52.9 (22.1)	0.00 (0.02)	D (C)
TOTAL INTERSECTION	43.1 (51.4)	1.02 (1.04)	D (D)
MD 109 at NB I-270 Ramps			
WB MD 109	0.0 (0.0)	0.38 (0.15)	N/A (N/A)
EB MD 109	2.3 (2.4)	0.02 (0.04)	N/A (N/A)
I-270 NB Ramps	18.1 (20.6)	0.32 (0.59)	C (C)
MD 109 at SB I-270 Ramps			
WB MD 109	8.1 (5.4)	0.37 (0.09)	N/A (N/A)
EB MD 109	0.0 (0.0)	0.11 (0.10)	N/A (N/A)
I-270 SB Ramps	15.3 (11.5)	0.07 (0.13)	C (B)



MD 355 (FREDERICK ROAD) OVER LITTLE BENNETT CREEK
MAINTENANCE OF TRAFFIC (MOT) ALTERNATIVES ANALYSIS

ALTERNATE 1: FULL DETOUR
2019 FORECASTED VOLUME AM (PM)

DATE: SEPTEMBER 2017 | FIGURE NUMBER: 4

Table 3 (cont.). Peak Hour Synchro Analysis – Existing Conditions – AM (PM)

Intersection Approach	Delay / Vehicle (sec)	V/C Ratio	Level of Service
MD 121 at SB I-270 Ramps			
EB MD 121	4.8 (5.3)	0.05 (0.13)	A (A)
WB MD 121	8.8 (6.0)	0.70 (0.33)	A (A)
I-270 SB Ramps	24.7 (16.8)	0.70 (0.58)	C (B)
TOTAL INTERSECTION	11.1 (8.0)	0.70 (0.41)	B (A)
MD 121 at NB 1-270 Ramps			
EB MD 121	2.5 (26.7)	0.08 (0.52)	A (C)
WB MD 121	5.4 (35.2)	0.63 (0.78)	A (D)
I-270 NB Ramps	23.6 (35.5)	0.17 (0.97)	C (D)
TOTAL INTERSECTION	7.4 (33.3)	0.56 (0.92)	A (C)
MD 121/Stringtown Road at Gateway Center Drive			
EB MD 121	10.5 (19.9)	0.23 (0.93)	B (B)
WB Stringtown Rd	15.4 (24.2)	0.52 (0.30)	B (C)
NB Gateway Center Dr	13.8 (19.4)	0.23 (0.43)	B (B)
SB Gateway Center Dr	13.8 (6.8)	0.64 (0.07)	B (A)
TOTAL INTERSECTION	13.6 (19.4)	0.65 (0.79)	B (B)
Gateway Center Drive at MD 121A			
NB Gateway Center Dr	14.6 (15.0)	0.16 (0.68)	B (C)
EB MD 121A	0.0 (0.0)	0.0 (0.01)	N/A (N/A)
WB MD 121A	10.3 (7.3)	0.59 (0.10)	N/A (N/A)
MD 121A at MD 355			
EB MD 121A	34.4 (79.0)	0.53 (1.01)	C (E)
WB Clarksburg Rd	30.5 (89.7)	0.82 (0.92)	C (F)
SB MD 355	25.3 (47.4)	0.82 (0.79)	C (D)
NB MD 355	15.2 (59.7)	0.23 (0.93)	B (E)
TOTAL INTERSECTION	26.4 (69.2)	0.78 (1.00)	C (E)

Table 4. Peak Hour HCS Analysis – Existing Conditions – AM (PM)

Section	Density (pc/mi/ln)	Speed (mph)	Level of Service
Southbound I-270			
Merge from MD 109	44.1 (30.4)	41.5 (55.2)	F (D)
Freeway Section Between MD 109 & MD 121	56.0 (24.6)	46.5 (69.5)	F (C)
Diverge to MD 121	27.2 (21.0)	56.4 (56.5)	C (C)
Northbound I-270			
Merge from MD 121	20.6 (27.4)	58.9 (57.2)	C (C)
Freeway Section Between MD 121 & MD 109	22.5 (50.7)	71.0 (49.6)	C (F)
Diverge to MD 109	29.7 (45.5)	51.9 (51.5)	D (F)

Table 5. Peak Hour Synchro Analysis –Full Detour Conditions – AM (PM)

Intersection Approach	Delay / Vehicle (sec)	V/C Ratio	Level of Service
MD 355 at MD 109			
SB MD 355	30.8 (59.1)	0.97 (0.23)	C (E)
NB MD 355	3.7 (66.7)	0.01 (0.43)	A (E)
EB MD 109	49.0 (92.6)	0.78 (1.16)	D (F)
WB Driveway	27.4 (1.3)	0.00 (0.01)	C (A)
TOTAL INTERSECTION	32.9 (85.6)	0.98 (1.15)	C (F)
MD 109 at NB I-270 Ramps			
WB MD 109	0.0 (0.0)	0.80 (0.18)	N/A (N/A)
EB MD 109	3.3 (2.4)	0.03 (0.04)	N/A (N/A)
I-270 NB Ramps	203.6 (616.4)	1.22 (2.32)	F (F)
MD 109 at SB I-270 Ramps			
WB MD 109	17.4 (6.0)	0.83 (0.12)	N/A (N/A)
EB MD 109	0.0 (0.0)	0.11 (0.10)	N/A (N/A)
I-270 SB Ramps	680.7 (12.5)	1.47 (0.14)	F (B)
MD 121 at SB I-270 Ramps			
EB MD 121	27.5 (5.9)	0.10 (0.13)	C (A)
WB MD 121	37.6 (6.6)	0.71 (0.33)	D (A)
I-270 SB Ramps	96.8 (17.5)	1.14 (0.65)	F (B)
TOTAL INTERSECTION	62.5 (9.1)	1.00 (0.45)	E (A)
MD 121 at NB 1-270 Ramps			
EB MD 121	2.9 (4.4)	0.23 (0.17)	A (A)
WB MD 121	3.8 (6.4)	0.62 (0.67)	A (A)
I-270 NB Ramps	23.6 (27.2)	0.16 (0.68)	C (C)
TOTAL INTERSECTION	6.0 (11.5)	0.55 (0.67)	A (B)
MD 121/Stringtown Road at Gateway Center Drive			
EB MD 121	15.6 (15.8)	0.77 (0.79)	B (B)
WB Stringtown RD	18.7 (19.3)	0.58 (0.27)	B (B)
NB Gateway Center Dr	15.9 (13.7)	0.23 (0.39)	B (B)
SB Gateway Center Dr	9.7 (7.0)	0.25 (0.21)	A (A)
TOTAL INTERSECTION	15.8 (14.2)	0.62 (0.65)	B (B)
Gateway Center Drive at MD 121A			
NB Gateway Center Dr	10.5 (11.0)	0.04 (0.02)	B (B)
EB MD 121A	0.0 (0.0)	0.00 (0.01)	N/A (N/A)
WB MD 121A	8.4 (7.8)	0.36 (0.24)	N/A (N/A)
MD 121A at MD 355			
EB MD 121A	22.3 (30.9)	0.24 (0.81)	C (C)
WB Clarksburg Rd	18.9 (27.5)	0.73 (0.63)	B (C)
SB MD 355	21.9 (26.4)	0.47 (0.55)	C (C)
NB MD 355	17.7 (22.2)	0.32 (0.72)	B (C)
TOTAL INTERSECTION	20.2 (26.9)	0.57 (0.78)	C (C)

Table 6. Peak Hour HCS Analysis –Full Detour Conditions – AM (PM)

Section	Density (pc/mi/ln)	Speed (mph)	Level of Service
Southbound I-270			
Merge from MD 109	49.6 (30.7)	23.0 (55.1)	F (D)
Freeway Section Between MD 109 & MD 121	94.6 (50.7)	31.5 (49.6)	F (F)
Diverge to MD 121	31.8 (21.4)	54.8 (56.4)	D (C)
Northbound I-270			
Merge from MD 121	20.9 (32.9)	58.8 (55.1)	C (D)
Freeway Section Between MD 121 & MD 109	23.0 (89.9)	70.7 (32.8)	C (F)
Diverge to MD 109	30.2 (53.0)	51.8 (49.7)	D (F)

As shown in these tables, this alternative is expected to result in increases in delay at the intersections of MD 109 with MD 355 and the I-270 Ramps at MD 109 and with the SB I-270 Ramps at MD 121 due to the proposed roadway closure and subsequent detour. These increases in delay are expected to result in conditions that will fail MDOT SHA's mobility thresholds. The HCS analyses along I-270 indicated increases in density and reductions in speeds throughout the study network, with increases in density of up to over 100% in the southbound direction during the PM Peak hour.

Alternative 2: Maintain One Travel Lane

Under this alternative, MD 355 will be reduced to one travel lane during construction. The bridge will be constructed in stages while alternating traffic across the bridge through the use of a temporary signal. As with Alternative 1, the roadway profile within the project limits will be raised to reduce existing flooding issues.

Signal Control

This alternative involves regulating the direction of traffic in the one open lane on the bridge through the use of a temporary traffic signal. Due to the presence of an existing driveway and intersection at the northern limits of the project, this alternative will require the installation of signalization for the driveway leg and intersection of Hyattstown Mill Road. Appendix E contains concept plans of this alternative.

For the development of traffic signal timings, the length of the clearance interval is a function of the effective width of the intersection. In this instance the effective width of the intersection is the length of the tapers, work zone, and buffer area, and the clearance interval should allow a vehicle to travel the distance from stop-line to stop-line before the opposing direction of traffic receives the green indication. Clearance intervals were developed using MDOT SHA's Policy for Determining Yellow Timings at Intersections, and the Institute of Transportation Engineers (ITE's) Traffic Signal Design Handbook. Based on these guidelines, Table 7 presents the yellow and all-red timings for these signals, where t is the perception-reaction time (assumed to be 1 sec.), V_{posted} is the posted speed limit (30 mph), $V_{operating}$ is the operating speed (assumed to be 25 mph), a is the acceleration (10 ft/s^2), W is the total effective intersection width (535 ft), and L is the average vehicle length (assumed to be 25 ft). It should be noted that the operating

speed was assumed to be 25 mph because it is expected that vehicles will be traveling at lower speeds through the work zone.

Table 7. Clearance Interval Calculations

Interval	Equation	Duration (sec)
Yellow (Y)	$t + 1.47*V_{posted}/(2a)$	4
All-Red (AR)	$(W + L) / 1.47*V_{operating}$	16
Total Clearance (CL)	Y + AR	20

Five seconds were added to the AR interval to account for the 10% trucks in the vehicle flow resulting in a computed CL duration of 25 seconds.

Analysis Results for Signal Control Option

Synchro and SimTraffic analyses were performed for the signal control option. Table 8 summarizes the analysis results of existing conditions at the unsignalized intersection of MD 355 at Hyattstown Mill Road. Table 9 summarizes the analysis results for Alternative 2. Values shown in bold red italics exceed MDOT SHA's allowable mobility thresholds. The Synchro and SimTraffic worksheets for the One-Lane Signal operations can be found in Appendix F.

Table 8. Peak Hour Synchro Analysis – MD 355 at Hyattstown Mill Road
Existing Conditions – AM (PM)

Intersection Approach	Delay / Vehicle (sec)	V/C Ratio	Level of Service
MD 355 at Hyattstown Mill Road			
NB MD 355	0.0 (0.0)	0.0 (0.0)	A (A)
SB MD 355	0.0 (0.0)	0.0 (0.0)	A (A)
EB Driveway	17.3 (16.0)	0.03 (0.03)	C (C)
WB Hyattstown Mill Rd	14.4 (19.8)	0.03 (0.04)	B (C)

Table 9. Peak Hour Synchro/SimTraffic Analysis – One-Lane Signal Option – AM(PM)

Intersection Approach	Delay / Vehicle (sec)	V/C Ratio	Level of Service	95th Percentile Queue Length (ft)
NB MD 355	76.8 (1147.1)	0.70 (3.39)	E (F)	164 (1,874)
SB MD 355	796.9 (65.6)	2.62 (0.48)	F (E)	1,680 (171)
EB Driveway	78.0 (81.3)	0.38 (0.40)	E (F)	31 (31)
WB Hyattstown Mill Rd	69.1(71.3)	0.01 (0.01)	E (E)	0 (0)

As shown in the table, this alternative is expected to result in queues up to 0.35 miles that will extend through the upstream intersections of MD 355 and Croghan Lane and MD 355 at the Hyattsville Volunteer Fire Department access and MD 109. It should be noted that this alternative will result in poor traffic operations and the impact to traffic operations will be confined to the vicinity of the bridge (as opposed to being distributed throughout a network of other roadways) and the impact to local businesses as a result of vehicles being detoured away from the area will be reduced when compared with the detour options.

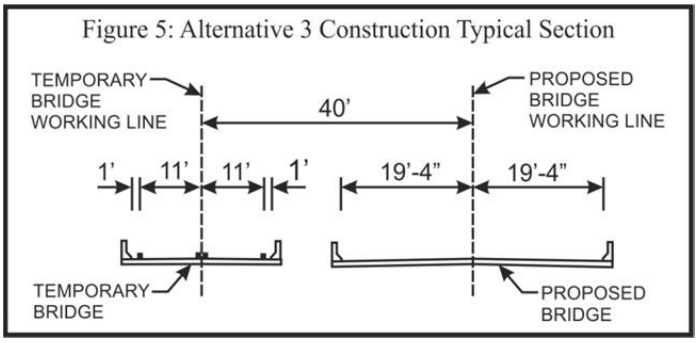
Alternative 3: Maintain All Travel Lanes

Under this alternative, all travel lanes will be maintained throughout construction through the use of a temporary roadway alignment. Pavement reconstruction within the limits of the tie-in between the temporary and ultimate roadway alignments will be performed over a short duration through the use of a full or one-way detour.

Geometric Analysis

During the first stage of construction under this alternative a temporary roadway (with a temporary bridge structure) will be constructed west of the existing roadway alignment. During the second stage of construction, both travel lanes will be shifted onto the temporary roadway alignment, the existing bridge will be demolished and the new bridge will be constructed, along with new approach roadways within the limits of the temporary alignment. During the final stage of construction, traffic will be shifted to the ultimate roadway alignment and the temporary roadway will be demolished. For the purposes of developing conceptual temporary roadway alignments, it was assumed that the temporary roadway would bypass the construction activities at the existing and proposed bridge and that profile adjustments on the approaches outside of the limits of the bridges would be performed during short term full or one-way detours. Figure 5 shows the typical section of the temporary roadway alignment relative to the proposed bridge under this alternative.

Figure 5: Alternative 3 Construction Typical Section



Appendix G contains the concept plan of the proposed roadway alignment under this alternative. As shown in the concept plan, this alternative is expected to have impacts to existing utility poles located along the west side of MD 355 and a larger footprint than Alternatives 1 and 2. It should be noted that the impacts due to the proposed alignment are expected to require additional right-of-way and have additional impacts to wetlands and parkland resources.

Analysis Results

This alternative is not expected to result in any changes to lane configurations or reductions in travel lanes throughout the limit of work, with the exception of the construction of pavement in tie-in areas. It is expected that the primary impact to traffic operations under this alternative would be the potential reduction in capacity as a result of motorists' perception of the work zone. The impacts to roadway capacity as a result of work zone activities were estimated using the Lane Closure Analysis Program (LCAP) and the following assumptions:

- Truck percentage = 10%
- Work zone grade = 0.5%
- 12" lateral clearance to channelization devices
- Work zone length = ¼ mile
- Work zone intensity = medium

Based on those assumptions and the University of Maryland equation that is included within

LCAP, it was estimated that the work zone capacity will be approximately 1,839 vehicles per hour. This estimated work zone capacity will exceed the peak hour traffic volumes through the work zone during both peak periods. Therefore, it is not anticipated that the work zone activities will result in any additional queuing.

EVALUATION OF MOBILITY THRESHOLDS

Table 10 summarizes the evaluation of the mobility thresholds for each alternative.

Table 10. Evaluation of Applicable Mobility Thresholds

	Alternative 1	Alternative 2	Alternative 3
Applicable Mobility Thresholds Met?	NO	NO	Yes

COST ANALYSIS

Cost analyses were performed on the three proposed alternatives using estimated maintenance of traffic quantities, construction cost estimates, and the MDOT SHA's 2066 Highway Construction Cost Estimating Manual. Table 11 summarizes the results of the cost analyses. As shown in the table, the full detour alternative is expected to have the lowest total project cost.

Table 11. Cost Analyses

	Alternative 1	Alternative 2	Alternative 3
MOT Costs	$14,000	$247,000	$152,000
Temporary Signs	$12,000	$9,000	$5,000
Channelization Devices (Drums, Barrier, etc.)	$2,000	$13,000	$12,000
Temporary Traffic Signal	N/A	$225,000	N/A
Temporary Pavement	N/A	N/A	$135,000
Construction Costs	$1,544,000	$1,914,000	$1,849,000
Total Cost	$1,558,000	$2,161,000	$2,001,000

SUMMARY OF ALTERNATIVES

Appendix H contains the Work Zone Constraints Form, which compares the three alternatives based on cost, safety, constructability, and other attributes. The following is a more detailed description of the work zone constraints.

Impact to Traffic Operations

The analyses performed for this study indicate that Alternative 1 (Full Detour) will have the greatest impact on traffic operations, as it will result in increases in delay throughout the study network. Alternative 2 (Maintain One Travel Lane) with the One-Lane Signal option is expected to result in queues along MD 355; however, impacts to traffic operations will be

confined to the vicinity of the bridge and will not impact operations along MD 121, MD 109, or I-270. Alternative 3 (Maintain All Travel Lanes) is expected to have minimal impacts on traffic operations since it does not result in the reduction of any travel lanes through the work area.

Impacts to Local Businesses

Alternative 1 is expected to have some impacts to local businesses along MD 355, as it requires that traffic be rerouted onto alternate roadways. It should be noted that all businesses within the detoured portion of MD 355 are destination businesses where patrons would still travel along the detour route to access the business.

Impacts to Emergency Response

The Hyattstown Volunteer Fire Department is located just 300 feet north of the subject bridge. It is expected that Alternative 1 will result in significant increases in response times, as emergency vehicles will be required to utilize the detour route to access MD 355 and the surrounding areas south of the bridge. Alternative 2 (with One-Lane Signal Option) is expected to have substantial impact to emergency services as access will be maintained but emergency vehicles may be required to contend with opposing traffic in the single travel lane and queues that affect access to MD 355. Alternative 3 is not expected to have any impact on emergency response.

Impacts to School Bus Routes

Alternative 3 is expected to have no impact on existing school bus routes. Alternative 2 (with One-Lane Signal Option) is expected to have some impacts to school buses as buses would be subject to delays and queuing at the signals. Alternative 1 is expected to have significant impacts to this very busy school bus corridor; however, consideration should be given to scheduling construction so that most of the detour occurs during the Summer time when school is not in session.

Estimated Costs

Alternative 2 is expected to have the highest MOT cost, requiring a temporary signal. Alternative 1 is expected to have the lowest MOT and construction cost as it will not require any temporary structure or signal to maintain traffic flow during construction.

Safety

Alternative 1 is expected to increase congestion at intersections impacted by the detours. As a result of this congestion, there is a possibility of an increase in congestion-related collision types (such as rear ends). Alternative 2 (with One-Lane Signal Option) may result in an increase in rear end collisions due to the introduction of new traffic signals with queuing. Alternative 3 is expected to have minimal impact to motorist safety, compared with the other available alternatives.

Construction Duration

Alternative 2 is expected to have the longest construction duration, as it requires the construction of the new bridge in two stages. Alternative 1 is expected to have the shortest duration, as it only consists of one construction stage.

Worker Safety/Constructability

Alternative 1 provides a safer environment for workers because there would be no active traffic near the work zone. Alternative 1 would also provide an unconstrained work area, allowing for improved constructability and quality and would provide a staging area for construction access. On the contrary, Alternatives 2 and 3 would have traffic passing within close proximity of the workers and construction traffic coming to and going from the work area, increasing the possibility of conflicts. The constrained buffer between the existing and proposed bridges under Alternatives 2 and 3 will result in more constraints on the work area and construction access and could potentially have an impact on the quality of the final product.

RECOMMENDATIONS AND CONCLUSIONS

Alternative 1 (Full Detour) has the greatest impact on traffic operations and local businesses, and increases travel times throughout the study network. However, it provides the shortest construction time and safest work zone for workers. Alternative 3 (Maintain All Travel Lanes) has the least impact on traffic operations and local businesses, but requires the most temporary roadway work. Alternative 2 provides improved traffic operations over Alternative 1, has the longest construction duration, yet does not require temporary pavement of Alternative 3.

Table 12 summarizes the advantages and disadvantages of each construction alternative that should be considered by the project stakeholders (i.e., road users, affected communities, MDOT SHA).

Based upon the anticipated traffic impacts from Alternative 1, and the potential for Alternative 2 queues to block the Hyattstown Volunteer Fire Department access onto MD 355, along with neither of these alternatives meeting the MDOT SHA mobility thresholds for work zones, Alternative 3 is recommended for this project.

Table 12. Summary of Alternatives Advantages and Disadvantages

Alternative	Advantages	Disadvantages
Alternative 1 – Full Detour	· Lowest MOT/construction cost · Provides best construction access, constructability, and worker safety · Shortest construction duration	· Greatest impact on traffic operations throughout the network · Greatest impact to school bus routes if detour in effect during the school year · Greatest impact to emergency services and local businesses · Does not meet mobility thresholds at several intersections throughout the study network
Alternative 2 – Maintain One Travel Lane (with One-Lane Signal Option)	· Fewer impacts to local traffic and school bus routes	· Expected to result in delays and queues on both sides of the bridge that will impact access to MD 355 from the Hyattsville Volunteer Fire Department · Highest MOT cost · Bridge must be constructed in two stages resulting in longest construction duration · Increased safety risk due to traffic flowing through the work zone · Highest overall project cost
Alternative 3 – Maintain All Travel Lanes	· Least impact to traffic operations · No impact to school bus routes · Meets mobility thresholds · No impact to emergency services · No impact to local businesses	· Requires temporary paving and temporary structures · Greatest environmental impacts / limit of disturbance · ROW/utility impacts