Shady Grove Minor Master Plan Amendment
Transportation Appendix

Contents

Introduction
1. Existing Conditions
    A. Existing Walking & Bicycling Conditions in the Plan Area
        i. Qualitative Analysis – Walkshop Results
        ii. Pedestrian Level of Comfort Analysis
        iii. Pedestrian Intersection Counts & Delay Analysis
        iv. Existing and Planned Bicycling Conditions
        v. Existing Transit Use
    B. Vision Zero Analysis
        i. Speed Analysis
        ii. Crash Analysis
        iii. Prioritized List of Vision Zero Improvements
        iv. Synchro Modeling Results for Vision Zero Improvements
2. Consolidated Information on Corridor Cities Transitway and MD 355 BRT
    A. Corridor Cities Transitway
    B. MD 355 BRT
3. Vehicle Modeling
    A. Summary Table of 15 Scenarios and Assumptions
    B. Outputs by Study Intersection, Scenarios A-O
    C. Discussion of Findings and Trade-Offs
4. Interchange Feasibility Analysis
    A. Interchange Feasibility Memo
5. Non-Auto Driver Mode Share (NADMS) Goals
6. Infrastructure Priority Plan to Achieve (NADMS) Goals
7. Complete Streets Guide Typologies
8. Addendum: Updated Pedestrian Level of Comfort Map & Connectivity Analysis

Introduction

This “Transportation Appendix” provides a comprehensive resource related to the transportation element of the Shady Grove Minor Master Plan Amendment (Plan). The appendix is divided into seven sections based on topic; however, due to the nature of the content there is some overlap across sections. Where possible, content is intentionally not repeated to avoid redundancy.

The first section centers on existing conditions and includes information about walking and biking conditions, plan area speeds and crashes, the Department’s beta-testing of the Pedestrian Level of Comfort, and an analysis of pedestrian delay (also called “pedestrian area holding time”). This work culminated in a list of prioritized Vision Zero improvements, which is provided in a tabular format. Many of the listed Vision Zero improvements that impact vehicle capacity were modeled in Synchro using existing volumes to understand the magnitude of likely vehicular capacity impacts should the given safety improvements be implemented today.

The second section focuses on the Corridor Cities Transitway and the Maryland 355 Bus Rapid Transit Line. This section provides information about the projects’ histories through the time of this writing. The Plan document proposes sections for streets that—at the time of this writing—are anticipated to provide BRT service.

The third section functions as a resource detailing the fifteen different vehicle capacity modeling runs completed to support the Plan. The Plan’s extensive modeling effort included Synchro and VISSIM analyses. The VISSIM analyses were completed for intersections along streets assumed to provide BRT service and include various alignments, including curb running, median running, and peak-hour median running scenarios.

The 2006 Shady Grove Sector Plan added three interchanges to the Master Plan of Highways and Transitways, including a grade-separated interchange at MD 355 and Gude Drive, a partial interchange at Crabbs Branch Way and Metro Access Road, and an interchange at I-370 and Metro Access Road to support access to the Intercounty Connector (MD 200). The latter of these interchanges was constructed as a component of the Intercounty Connector project. Section four discusses the former two interchange recommendations, focusing on why the Plan amendment has moved away from these previous recommendations. This section includes a memo documenting the work of a project consultant that studied various interchange options at MD 355 and Gude Drive. This memo assesses operational improvements and impacts and ultimately concludes that an interchange may not be the best solution to support mobility along the MD 355 corridor due to upstream and downstream impacts.

Section five and six of the appendix focus on the Plan’s Non-Auto Driver Mode Share (NADMS) Goals, including the modeling done to support the Plan’s goals as well as an infrastructure prioritization scheme to achieve such goals.

The last section suggests classification for street types within the Plan area, employing the draft Complete Streets Guidelines typologies. Beginning in 2018, The Planning Department began working with the Montgomery County Department of Transportation on new street classifications. The purpose of the Design Guide is to 1) articulate a consistent, countywide vision for street design; 2) consolidate street design standards and policies into one document; 3) address best practices in fire access, stormwater management, and the use of alternative materials; and 4) increase flexibility for street design while maintaining standard and continuity of facilities. The proposed street typologies are for future consideration following the approval and adoption of the new anticipated Guidelines.

1. Existing Conditions

Analysis of the existing bicycling and pedestrian conditions in the Plan area were taken through the lens of Vision Zero. Vision Zero is a strategy to eliminate all travel-related fatalities and severe injuries on roadways while increasing safe, healthy, equitable mobility for all roadway users. First implemented in Sweden in the 1990s, Vision Zero has been adopted by jurisdictions across the country including the Washington DC Metropolitan Region. In 2016, Montgomery County committed to eliminate all traffic fatalities and severe injuries by 2030. In 2017, the County Executive released an initial two-year action plan of activities to advance the County toward Vision Zero. Upon completion of the two-year action plan, the County will advance a ten-year action plan to achieve Vision Zero by 2030. The main principles of Vision Zero follow below:

- All transportation-related deaths and injuries are preventable;
- Street designers must assume that all users—drivers, pedestrians and bicyclists—make imperfect choices;
- Street designers must emphasize the prevention of severe and fatal crashes, which includes an acknowledgement of user vulnerability; and
- Reducing crash severity is more important than reducing crash frequency.

The principles of Vision Zero are relevant to all roadway users, but because non-motorists are the most vulnerable users of a roadway network, this planning effort specifically examined what improvements could be made to improve safety for pedestrians and bicyclists. Because the County has adopted a Vision Zero policy and 2030 commitment, the recommendations in Commission plans should advance the principles of the policy; however, the Commission is also required to adhere to the County's Subdivision Staging Policy (SSP), whose transportation policy components largely focus on automobile capacity. Meeting the delay thresholds set by the current SSP and subsequent Local Area Transportation Review Guidelines (LATR Guidelines, 2017) can result in large-footprint multilane intersections that are unsafe for pedestrians to cross. In cases where two Council-approved policies conflict, it is the responsibility of the project team to offer solutions to County decision makers that balance policy requirements and merits. For this effort, the Planning Department privileges the safety of pedestrians, bicyclists, and drivers over vehicular capacity and convenience.

A. Existing Walking & Bicycling Conditions in the Plan Area

The Plan Area includes several major pedestrian and micromobility generators, including the Washington Metropolitan Area Transportation Authority's (WMATA) Metrorail Station, local bus service stops, a school, and a daycare center. There are additional retail options along Frederick Road (MD 355 Corridor), within the Grove Shopping Center, and within the newly constructed Daley building. From a leisure perspective, the area also encompasses and borders multiple parks, including Blueberry Hill Local Park, Crabbs Branch Stream Valley Park, Mill Creek Stream Valley Park, Derwood Station Neighborhood Park, at the City of Rockville's Mattie J.T. Stepanek Park.

Consistent with mid-century suburban design, roads in the Plan Area were designed to facilitate automobile traffic and many pedestrian facilities lack safe and comfortable conditions. To assess accessibility for pedestrians, the Master Plan team employed qualitative field studies, including a "Walkshop," and a mixed-method GIS application referred to as the "Pedestrian Level of Comfort."

i. Qualitative Analysis – "Walkshop"

A “walkshop” was conducted on June 3, 2019. This combined workshop-walk audit was attended by 25 individuals from the City of Gaithersburg, the City of Rockville, the Montgomery County Department of Transportation, the State Highway Administration, and the Montgomery County Planning Department. This purpose of the event was to generate discussion about the planning area’s transportation conditions, primarily from the perspective of a non-motorist.

Attendees were separated into groups based on topical and geographical relevance and driven from the walkshop’s home-base location at 16700 Crabbs Branch Way to the starting location of the three respective walking routes. These routes—and a fourth route along Shady Grove, which was not completed by the group based on interest—are shown in subsequent pages (Figures 1 through 4).

Comments about conditions in the plan area were recorded and are shown in Table 1 following the walking route maps. Some comments included in the table extend beyond the realm of pedestrian and bicycle conditions, but are included nonetheless. Table 1 indicates where each comment is addressed, either in the Plan or the Appendix.

Figure 1 – Walkshop Route 1

Figure 2 – Walkshop Route 2

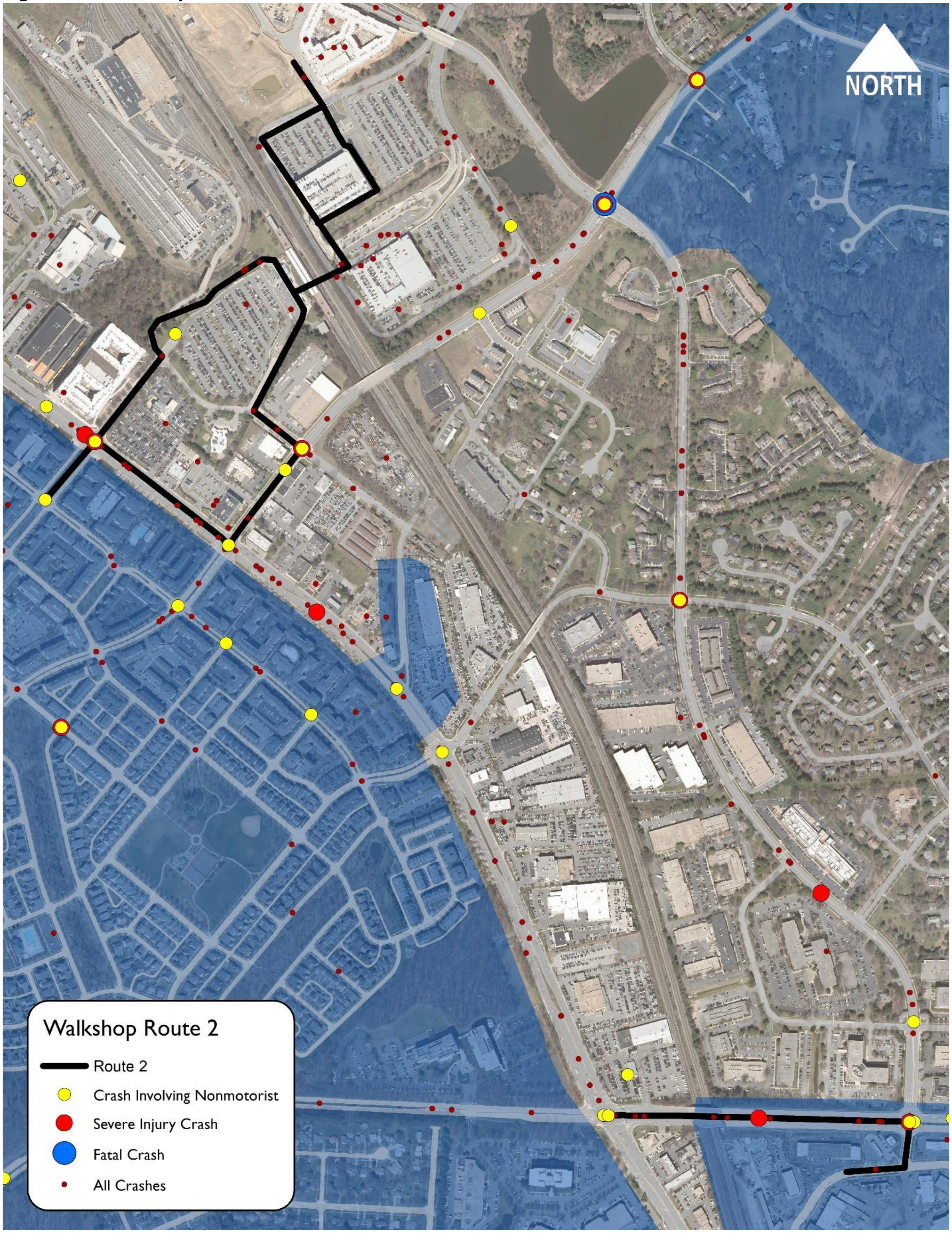

Figure 3 – Walkshop Route 3

Figure 4 – Walkshop Route 4

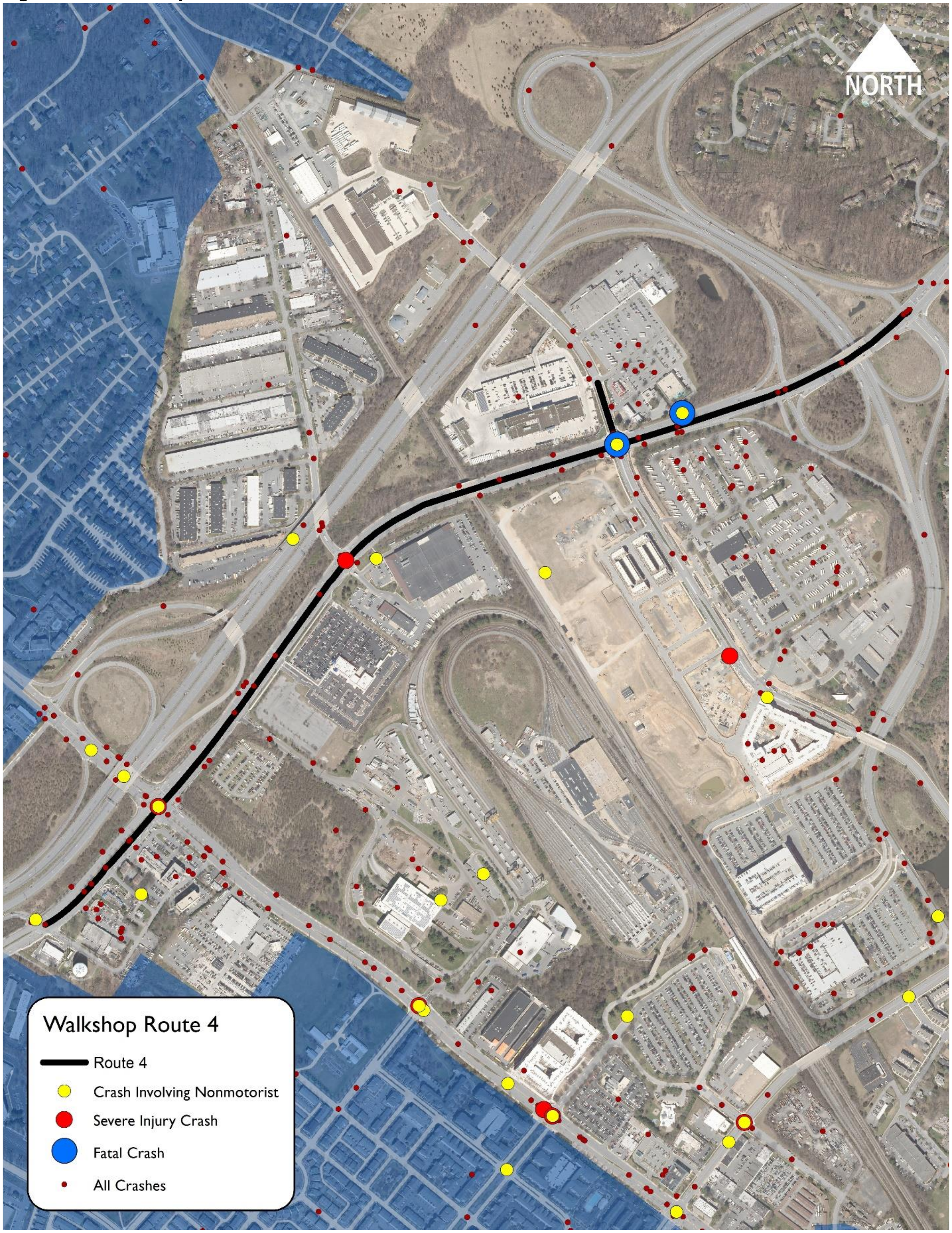

Table 1 – Consolidated Walkshop Comments

Walking Route	Location	Comment	Response/ How Comment Could or Should Be Addressed
1	Crabbs Branch Way (within EYA & Bus Depot Area)	Despite the 10-foot lanes, the cartway still feels wide. Is this because the gutter pans are excluded from the measurement? Could the presence of unused parking or turn lanes also make the lanes feel wider?	Speed studies done in this location do confirm high speeds; the Vision Zero table in this Appendix recommends camera enforcement.
1	Crabbs Branch Way (between Gramercy and Redland)	Vehicles appear to be speeding—particularly those moving down grade extending from Shady Grove Road down to Redland Road.	Speed studies done in this location do confirm high speeds; the Vision Zero table in this Appendix recommends camera enforcement.
1	Crabbs Branch Way Bridges	Sidewalks are relatively narrow (with the vertical enclosures) and there's no buffer from traffic; Consider expanding the pedestrian/bicycle facilities with a cantilevered trail on both sides of the bridge; Consider making more direct access to the trails below the bridges.	
1	Crabbs Branch Way	North of Redland Road, but south of Grammercy and the bridge, there is an unprotected crossing where the trail on the east side intersects with the sidewalk. People are likely crossing mid-block and they should be protected to make that crossing more predictable for motorists.	Improvements should be implemented through adjacent development on the eastern side of Crabbs Branch Way.
1	Crabbs Branch Way	South of Redland Road, consider a road diet and/or replacing the center turn lane (CTL) with a concrete median.	The Plan proposes a four-lane section with a vegetated median.
1	Redland Road & Crabbs Branch Way	Pedestrian wait time and crossing distances are not ideal.	Planning Department staff concur and recommend a Leading Pedestrian Interval (LPI) in the Vision Zero table. Time is not addressed directly, but could be considered by MCDOT.

Walking Route	Location	Comment	Response/ How Comment Could or Should Be Addressed
1	Redland Road & Crabbs Branch Way	People appear to make rolling "right-turn on red," from the south leg of Crabbs Branch Way onto EB Redland Road, and EB Redland onto SB Crabbs Branch Way.	The Vision Zero table in this appendix recommends additional right turn on red restrictions at this intersection.
1	Crabbs Branch Way (between Redland Road and Indianola Drive)	Because of the speeds on the roadway, cars do not appear to comply with the "stop for pedestrian" signage at designated mid-block crossings.	The cone of vision increases when speeds are reduced. The Vision Zero Table in this Appendix recommends camera enforcement. Additionally, a new section is recommended in the Plan.
1	Crabbs Branch Way (between Redland Road and Indianola Drive)	Crosswalks are missing over intersections at locations where there are townhomes.	Missing markings should be addressed through ongoing street maintenance programs by MCDOT.
1	Crabbs Branch Way & Indianola Drive	Existing curb ramps are diagonal/apex ramps. Separate curb ramps should be provided for each direction of crossing.	ADA capital improvements should be addressed through ongoing street maintenance programs by MCDOT.
1	Crabbs Branch Way & Indianola Drive	The pedestrian pushbuttons are not accessible because they are not audible. Additionally, there is only one button for each corner (i.e. buttons are not separated by the direction of crossing).	ADA capital improvements should be addressed through ongoing street maintenance programs by MCDOT.
1	Indianola (between Crabbs Branch Way and MD 355)	ROW is too wide for vehicular needs; a bicycle facility could be added to reduce speeds and provide additional connectivity.	The Plan recommends a new sidepath facility on the north side of the roadway.
1	Indianola (between Crabbs Branch Way and MD 355)	The deceleration/right turn lane into the Nissan dealership is not necessary and the space could be used to provide a bicycle facility, were one to be recommended.	The Plan recommends a new sidepath facility on the north side of the roadway.
1	Indianola (between Crabbs Branch Way and MD 355)	The sidewalk on the south side of the roadway terminates into nowhere at the bridge. No logical crossing location is provided or noted through signage.	Capital improvements should be addressed through ongoing street maintenance programs by MCDOT.

Walking Route	Location	Comment	Response/ How Comment Could or Should Be Addressed
1	Indianola Drive & MD 355	There is no marked pedestrian crossing, nor pedestrian ramps, along the south leg of the intersection.	Additional crossing could be assessed and added by MDOT SHA, and such improvements would impact the area's pedestrian level of comfort.
1	MD 355 (between Indianola Drive & Redland Road)	The sidewalks are wide, but they are not adequately buffered from the fast moving traffic. Additionally, the sidewalk breaks for foliage provide little aesthetic benefit—many of the trees are dead—and should be removed.	The Plan and Vision Zero advocate for better buffers. A section of MD 355 is provided in the Plan. Note that the County only controls the eastern side of MD 355. The western side is within the jurisdiction of Rockville.
1	MD 355 (between Indianola Drive & Redland Road)	There are too many curb cuts on the east side of MD 355. Additionally, the sidewalks ramp down to the grade of the roadway; they should be held flush across the driveways.	The Plan advocates for potential parallel roads which would facilitate better access management. The Vision Zero table in this Appendix recommends the improved reconstruction of existing curb cuts.
1	Redland Road & MD 355	On the northeast corner of the intersection near the 7-11, the placement of an existing light pole obstructs an accessible path (it is in the middle of the sidewalk).	ADA improvements should be addressed by MCDOT. If MD 355 were to be widened for transit or bicycle facilities, the pole would need to be relocated. See Plan section.
1	Redland Road & MD 355	Crossing times for pedestrians over MD 355 appear to be excessive. It took over a minute for the phase to change. This is not ideal given the proximity to the Metro Station.	The Plan recommends minimizing pedestrian delay over MD 355 to improve access to the Shady Grove station.
1	Redland Road (between MD 355 & Somerville Drive)	Is the peak hour parking adjacent to the retail on the south side of roadway necessary? Could it be repurposed to create a landscape buffer? Or, could the sidewalk be adjusted in some manner to provide legible separation between non-motorists and traffic?	The Vision Zero table in this Appendix recommends a buffer at this location.
1	Redland Road (between MD 355 & Somerville Drive)	There is a strange curb/lip in the middle of the sidewalk along the south side of the roadway near the retail.	The Vision Zero table in this Appendix recommends a buffer at this location. Implementing the buffer would necessitate the removal of the lip.

Walking Route	Location	Comment	Response/ How Comment Could or Should Be Addressed
1	Redland Road (between MD 355 & Yellowstone Way)	The sharrows appear unsafe as cars appear to be driving at excessive speeds, particularly down the grade of Redland Road.	The Plan recommends a sidepath at this location and the Vision Zero table in this Appendix recommends an enforcement camera within the vicinity.
1	Redland Road (between Somerville Drive & Yellowstone Way)	It is surprising that a parking garage entry was allowed on Redland Road in the NB/EB direction given the visibility and speeds of the roadway. Is the road classified appropriately?	This Plan recommends classifying the road as a Business District Street with a 25 mile per hour target speed. The Vision Zero table in this Appendix recommends an enforcement camera within the vicinity.
1	Redland Road (between Somerville Drive & Yellowstone Way)	The remnants of an old driveway apron disrupt the landscape strip on the north side on the roadway (where the guard rail terminates). This should be removed.	Capital improvements should be addressed through ongoing street maintenance programs by MCDOT.
1	Redland Road (between Somerville Drive & Yellowstone Way)	There is a "people's choice path" into the Metro Station connecting to Redland Road near Yellowstone Way. This terminates in a drive aisle on the WMATA property, and is further separated by a fence. Better circulation should be provided to address more direct access to the Metro.	Improved access is anticipated through redevelopment of the WMATA Metro property.
1	Redland Road & Yellowstone Way	The "people's choice path" suggests that a crossing may be appropriate at Redland Road & Yellowstone Way. This would provide a better direct connection to Old Derwood.	Improved access is anticipated through redevelopment of the WMATA Metro property; the proposed street network assumes a four-way intersection at Redland Road and Yellowstone Way, which could be signalized if warranted.
1	Redland Road (between Somerville Drive and Needwood Road)	The buffer width between the sidewalk and cartway varies along the facility and should ideally be at least 5' wide.	As a component of its Vision Zero principles, the Plan recommends 6-foot buffers on all roadways. It additionally calls for vertical separation in locations where this width cannot be attained.
2	Redland Road	The posted speed is 35 mph. Can this be lowered to 30 mph?	The Vision Zero table in this Appendix recommends an enforcement camera on Redland Road.

Walking Route	Location	Comment	Response/ How Comment Could or Should Be Addressed
2	Entire Walking Route	Can the existing sharrows near MD 355 be replaced with shared use paths?	The Plan's bicycle recommendations exclude on-street facilities in favor of separated facilities.
2	Entire Walking Route	The roadways around the Metro Station should be reclassified as Business District Streets (or whatever the new Complete Streets Design Guidelines dictate)	The Plan proposes streets within the Metro, but notes that these could be developed as private streets to allow greater flexibility. Illustrative sections are provided.
2	Entire Walking Route	The streets were designed as highways, arterials, and industrial roadways which makes traveling at high speeds comfortable and easy.	This Appendix includes spot speed study information that demonstrates speeds are compromising safety within the Plan Area. The Vision Zero table in this Appendix proposes improvements to reduce speeds and improve safety.
2	Entire Walking Route	The streets should be designed with a more urban/new-suburban context to slow vehicular traffic, promote transit, walking and biking, and increase comfort for walking.	The Plan supports this comment. See illustrative sections provided in the Plan, as well as the general Vision Zero recommendations in the Plan.
2	MD 355 & King Farm Boulevard	Tighten the curb radii throughout the plan area, including MD 355, Redland Road, Crabbs Branch Way, and on the WMATA property.	The Plan supports this comment. Capital improvements should be addressed through ongoing street maintenance programs by MCDOT.
2	MD 355 and King Farm Boulevard	It's easier to cross at the southern leg than the northern leg because fewer people are turning right from either the east or the west.	Targeted right turn on red restrictions are proposed at this location in the Vision Zero table in this Appendix.
2	WMATA Connection to MD 355	Consider implementing a No Turn on Red for WMATA egress traffic onto northbound MD 355	Targeted right turn on red restrictions are proposed at this location in the Vision Zero table in this Appendix.
2	WMATA Connection to MD 355	Sidepath should be located on the north side.	The Plan recommends separated bike lanes (consistent with MD 355 recommendation) on the north side of King Farm Boulevard Extended.

Walking Route	Location	Comment	Response/ How Comment Could or Should Be Addressed
2	WMATA Property	Consider removing metered parking to make a more comfortable pedestrian experience with a wider sidewalk/sidepath and a tree lawn providing buffer from traffic.	The Plan recommends removing the metered parking to accommodate space for dedicated transit and an improved pedestrian environment. See illustrative section.
2	WMATA Property (Parking Lot)	Wayfinding is needed throughout the area around the Metro Station: To/from the EYA properties and the eastern Metro Station entrance; To/from King Farm and the Metro Station; To/from the trails around the stormwater ponds and the metro station.	Improved wayfinding could be provided through redevelopment of the WMATA Metro property and/or the existing MCPS bus facility. Assessment/evaluation should occur during the regulatory review process.
2	WMATA Property (Parking Lot)	There needs to be a more direct walking path from Redland Road and MD 355 to the station entrance.	Improved access is anticipated through redevelopment of the WMATA Metro property.
2	WMATA Property	Could the bus loop be stacked in two stories? That would increase capacity and provide direct access to the platform (another escalator to the platform is planned).	At this time, there are not plans to stack the bus loop and the Department defers to WMATA regarding operational needs; however, revisiting the loop—perhaps at a modest scale—could occur through the regulatory process for redevelopment of the WMATA Metro property.
2	WMATA Property (Bikeshare Station)	Move the bikeshare station location closer to the Station Entrance.	This falls within the jurisdiction of WMATA, but could be discussed through the regulatory review process for the redevelopment of the WMATA Metro property.

Walking Route	Location	Comment	Response/ How Comment Could or Should Be Addressed
2	WMATA Property (Western Side Stairs)	Provide bike runnels on the stairs to avoid dependence on the elevator.	This improvement could be discussed through the regulatory process for redevelopment of the WMATA Metro property
2	EYA Property	Why is there a fence around the surface lot as one walks towards the new sidewalk on the EYA property? Is this necessary for safety or security? It is off-putting.	This fence falls within the jurisdiction of WMATA, but could be discussed through the regulatory review process for the redevelopment of the WMATA Metro property. The fence is currently employed to control pedestrian flow through the parking lot.
2	BRT Stop Location at Sommerville/Redland	Should stop either at the bus loop (preference) or on MD 355. Stopping at Redland Road is not a good option when the station is out of sight distance.	The Plan proposes that BRT interface with the Metro Station to the closest extent possible, based on operational needs.
3	Shady Grove Road & Briardale Road	Permissive lefts create unsafe conditions for all users and split phasing may be a better solution.	The Vision Zero Appendix for this document recommends an LPI to support pedestrians at this location. While removal of permissive lefts is not proposed here, the Plan's principles would support the exploration of split phasing. Permissive lefts were shown to be problematic elsewhere in the Plan Area.
3	Shady Grove Road & Briardale Road	Street lighting needed on the NW corner of the intersection.	Capital improvements should be addressed through ongoing street maintenance programs by MCDOT.
3	Shady Grove Road & Briardale Road	Accessible Pedestrian Signal (APS) is not entirely accessible for mobility impaired individuals	ADA capital improvements should be addressed through ongoing street maintenance programs by MCDOT.
3	Shady Grove Road & Briardale Road	Lead-in sidewalk to the neighborhood on Briardale Road (east of Shady Grove Road) would provide a safe connection to the intersection	This Plan recommends the provision of a sidewalk on both sides of Shady Grove Road, where feasible, west of the I-370 interchange. This sidewalk would improve pedestrian connectivity to the neighborhoods points north.

Walking Route	Location	Comment	Response/ How Comment Could or Should Be Addressed
3	Shady Grove Road & Briardale Road	Sight distance for right-turning vehicles is poor – consider "no turn on red" restrictions	While not included in the Vision Zero table, the Plan's Vision Zero principles support the exploration of this improvement.
3	Shady Grove Road & Briardale Road	No pedestrian refuge provided for either crossing leg on Shady Grove Road	This Plan supports the provision of median noses to provide pedestrian refuges where possible.
3	Shady Grove Road & Briardale Road	Repurposing the bike shoulder, sidewalk, and existing ROW could accommodate a 10-foot sidepath on the east side of Shady Grove Road (from Briardale to Tupelo)	This Plan proposes a 10-foot bicycle facility on Shady Grove Road, which would replace the existing unsafe bicycle lanes.
3	Shady Grove Road & Tupelo Drive	No crosswalk on the east side of Briardale	While not included in the Vision Zero table, the Plan's Vision Zero principles support the exploration of this improvement.
3	Shady Grove Road & Tupelo Drive	No crosswalk on the south leg of Shady Grove Road	While not included in the Vision Zero table, the Plan's Vision Zero principles support the exploration of this improvement.
3	Shady Grove Road & Tupelo Drive	No crosswalks or APS on either leg of Tupelo Drive	ADA capital improvements should be addressed through ongoing street maintenance programs by MCDOT.
3	Shady Grove Road & Tupelo Drive	Crossing time (23 seconds) seem short.	While not included in the Vision Zero table, the Plan's Vision Zero principles support the exploration of this improvement.
3	Shady Grove Road & Tupelo Drive	No pedestrian refuge provided for either crossing leg on Shady Grove Road	While not included in the Vision Zero table, the Plan's Vision Zero principles support the exploration of this improvement.
3	Shady Grove Road & Tupelo Drive	Prohibit "right-turn on red" movements from southbound Tupelo Drive (onto Shady Grove Road) all day instead of current AM peak period (6-9 am)	While not included in the Vision Zero table, the Plan's Vision Zero principles support the exploration of this improvement.
3	Shady Grove Road & Tupelo Drive	Lead-in sidewalk to the neighborhood on Tupleo Drive (east of Shady Grove Road) would provide a safe connection to the intersection	While not included in the Vision Zero table, the Plan's Vision Zero principles support the exploration of this improvement.

Walking Route	Location	Comment	Response/ How Comment Could or Should Be Addressed
3	Shady Grove Road & Tupelo Drive	Southeast corner of the intersection is missing tactile warning strip.	ADA capital improvements should be addressed through ongoing street maintenance programs by MCDOT.
3	Shady Grove Road & Tupelo Drive	Bus stop on southwest corner is not fully accessible (grade changes)	ADA capital improvements should be addressed through ongoing street maintenance programs by MCDOT.
3	Shady Grove Road & Midcounty Highway	Right-turning movement from Shady Grove Road to Tupelo seems difficult due to speeds on Shady Grove Road	Speeds are high along Shady Grove Road; this Plan supports enforcement and engineering strategies, such as lane narrowing, to reduce speeds. See the illustrative section.
3	Shady Grove Road & Midcounty Highway	Crosswalk on southern leg of Shady Grove Road does not connect to west side	While not included in the Vision Zero able, the Plan's Vision Zero principles support the exploration of this improvement.
3	Shady Grove Road & Midcounty Highway	No pedestrian refuge provided for south leg of Shady Grove Road	While not included in the Vision Zero table, the Plan's Vision Zero principles support the exploration of this improvement.
3	Shady Grove Road & Midcounty Highway	There are no crosswalk or curb ramps provided crossing Midcounty Highway but APS is in place and active	ADA capital improvements should be addressed through ongoing street maintenance programs by MCDOT.
3	Shady Grove Road & Midcounty Highway	Southbound turning movements from Midcounty Highway to Shady Grove Road are dangerous and confusing to drivers	While not included in the Vision Zero table, the Plan's Vision Zero principles support the exploration of this improvement.
3	Redland Road (Beyond Needwood)	Sidewalks are missing for major stretches	This Plan advocates for the provision of continuous pedestrian facilities on Redland Road.
3	Redland Road (Beyond Needwood)	No crossing to bus stop on Redland directly south of ICC	This Plan recommends that all bus stops be located proximate to safe, accessible crossings.
3	Redland Road (Beyond Needwood)	No crossing for the bus stop at Redland and Briardale	This Plan recommends that all bus stops be located proximate to safe, accessible crossings.

Walking Route	Location	Comment	Response/ How Comment Could or Should Be Addressed
3	Redland Road (Beyond Needwood)	Sight distance issues for both pedestrian and vehicles at the intersection of Redland and Briardale could result in conflicts	Sight distance could be explored and improved through capital projects associated with the provision of a new sidewalk along Redland Road.

ii. Pedestrian Level of Comfort Analysis
The "Pedestrian Level of Comfort" analysis is a beta-level tool that assigns a score to pedestrian facilities based on a number of design and operational factors and a facility's given geographic context. Non-intersection walking facilities (i.e. sidewalks or paths) are scored based on the presence and quality of the following features:

- facility width;
- presence and width of a buffer, including parking lanes;
- presence and frequency of obstructions;
- posted traffic speed limit of adjacent segment;
- average daily traffic of adjacent segment;

Intersection facilities (i.e. crossings) are scored using the following factors:

- posted speed limit of the street being crossed;
- number of lanes of the street being crossed, including turning lanes;
- presence or absence of a pedestrian refuge;
- presence or absence of appropriate markings/signage;
- traffic controls at intersections (e.g. signalization, right-turn on red restrictions, etc.); and
- lighting

While the tool will further evolve per the direction of the Department's first *Pedestrian Plan*, the beta tool has also been used to assess pedestrian conditions for the *Veirs Mill Corridor Master Plan* and the *Montgomery Hills/Forest Glen Sector Plan*.[1] The tool identifies segments and crossings as "very comfortable," (safe for adults and small children) "comfortable," (safe for adults, but suitable only for small children if holding hands or guided) and "uncomfortable" (adults will walk if they have to, but the condition is not suitable for children). Gaps in facilities are noted but not scored. The "existing conditions" pedestrian level of comfort network is shown in Figure 5.

Staff ran a connectivity analysis to determine accessibility to WMATA's Shady Grove Metrorail Station to examine which residential units can access the station in a given amount of time, and how that connectivity decreases assuming people avoid uncomfortable pedestrian facilities. The analysis assumes that people walk at a speed of 3.5 feet per second and factors in average intersection delay of the study intersections (discussed in section iii below under the "Pedestrian Intersection Counts & Delay Analysis" header). Figure 6 shows "baseline" connectivity to the station on all existing pedestrian segments at 15, 20, 25, and 30-minute intervals. Figure 7 then shows how connectivity decreases after uncomfortable segments are removed. Table 2 summarizes the results of the analysis. There are 1,423 units within a 15-minute walk from the Shady Grove Metro Station, but only 28% (394) of those units can access the Metro Station by comfortable path. There are 5,015 units within a 30-minute walk from the Shady Grove Metrorail Station, but only 15% (736) can access the metro along a comfortable path.[1]

The analysis demonstrates that crossings present significant barriers. In order to access the Metro Station, many residents need to cross multilane roadways, including MD 355, Shady Grove Road, and Crabbs Branch Way. There are only two "comfortable" crossings of Redland Road within the vicinity of

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[1] The Pedestrian Level of Comfort methodology was updated by the Department following the Shady Grove Master Plan planning process. The new information is included as an addendum to this appendix. The update

the Metro Station at Metro Station Access Road and Needwood Road, and these are the only two crossings that provide “comfortable” access into the Shady Grove Metro Station Policy Area. Additional barriers include a wide an unbuffered sidewalk along MD 355, inadequate sidewalk facilities along Shady Grove Road, and unbuffered, unsafe facilities around WMATA’s Metrorail Bus Loop. Improving crossings and these facilities would improve comfortable connectivity in the Plan area.

Figure 5 – Pedestrian Level of Comfort Network

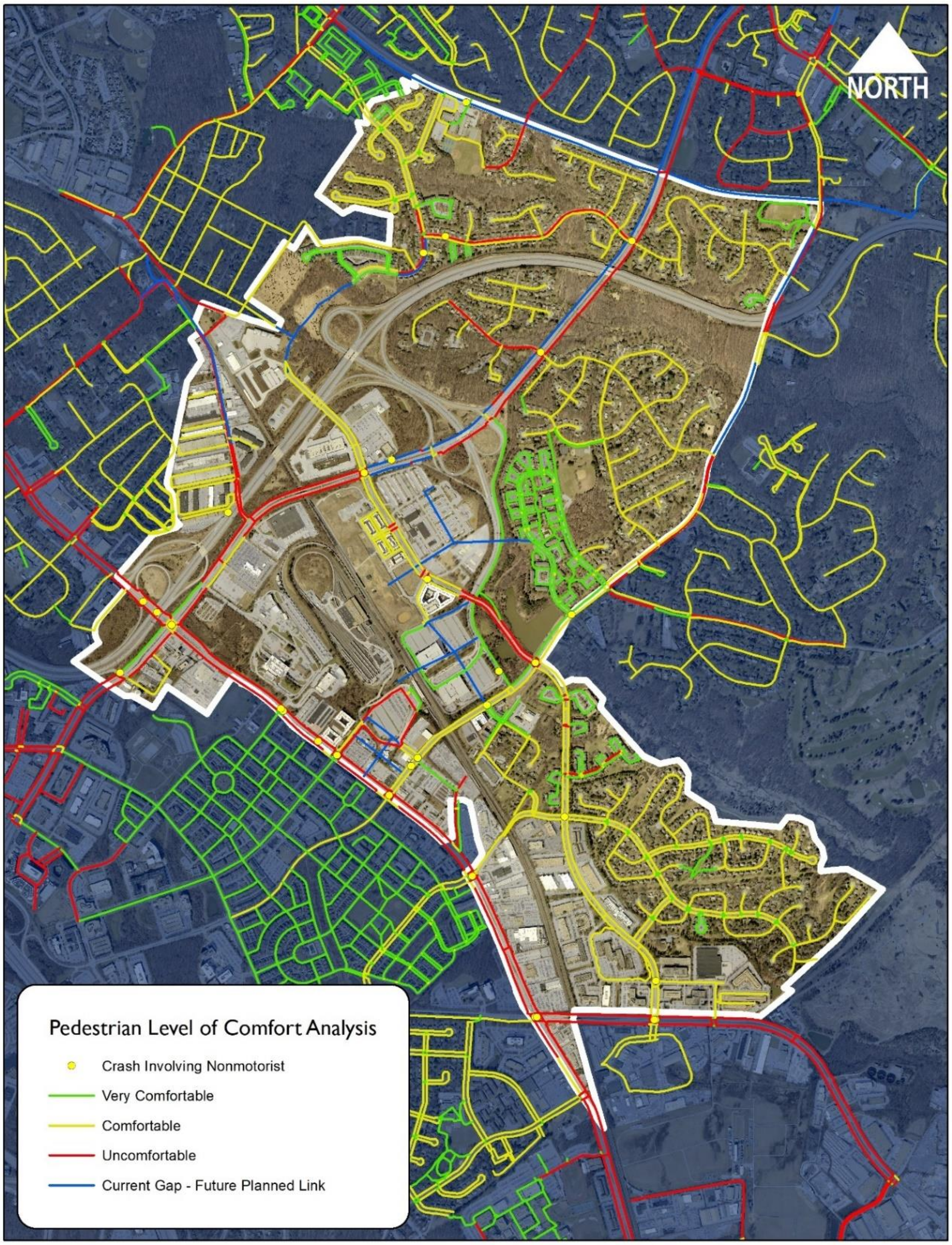


Figure 6 – Pedestrian Level of Comfort Baseline Analysis

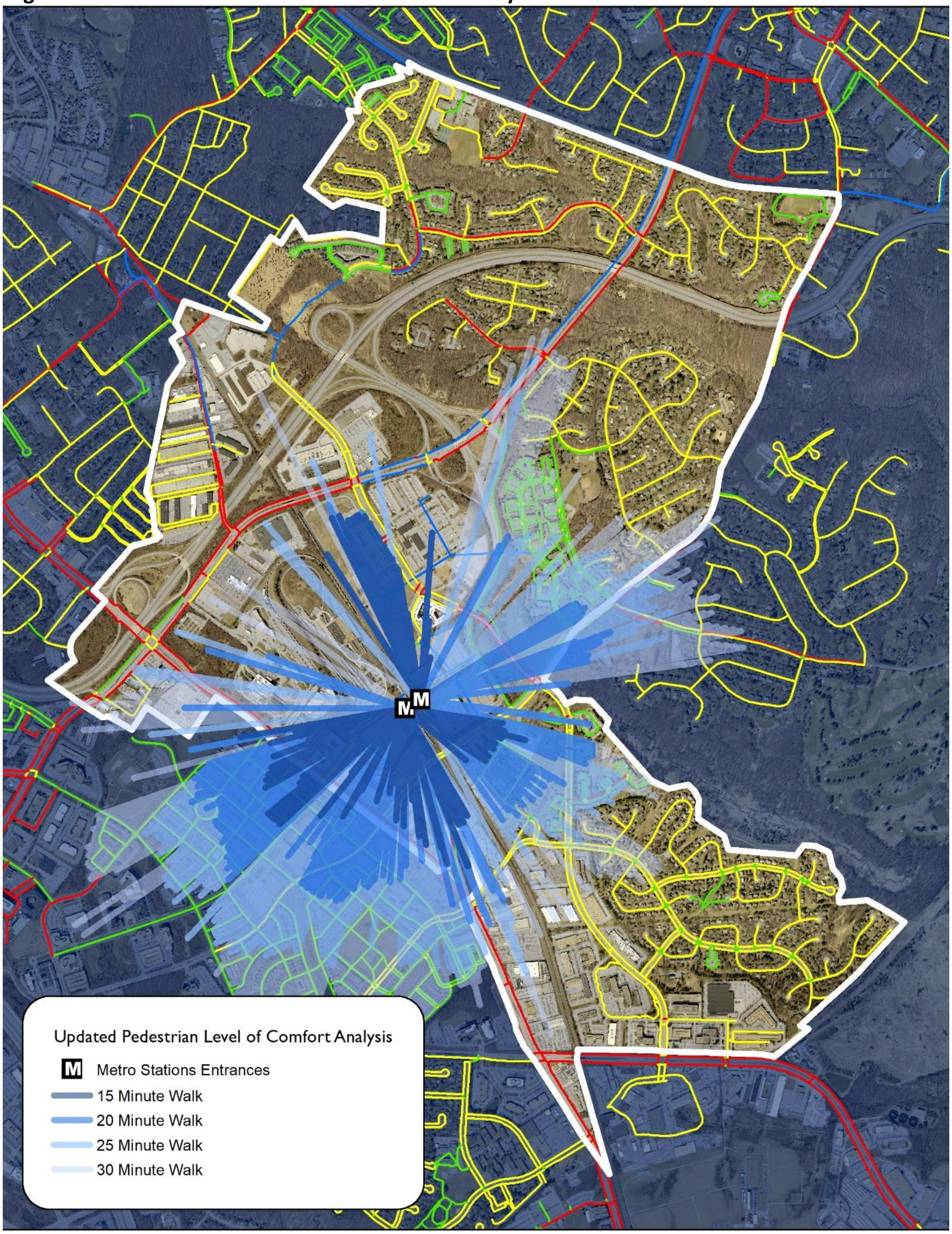


Figure 7 – Pedestrian Level of Comfort – Comfortable Walk Analysis

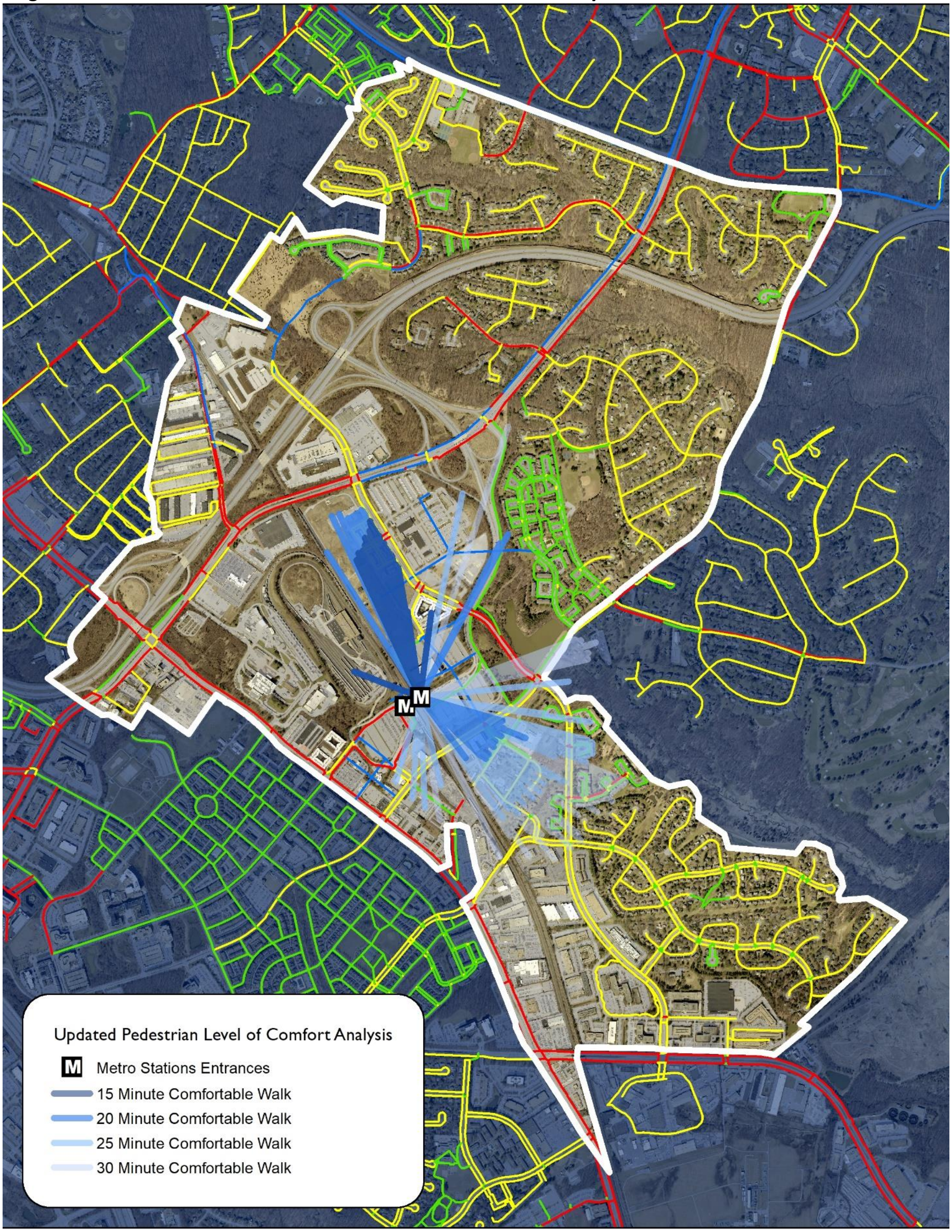


Table 2 – Pedestrian Level of Comfort Analysis: Dwellings Comfortably Connected to the Metro

	Dwelling Units	Dwelling Units Connected via Comfortable Facilities	Percent Connected
15 Minute Walkshed	1432	394	28%
20 Minute Walkshed	2798	457	16%
25 Minute Walkshed	4270	647	15%
30 Minute Walkshed	5015	736	15%

iii. Pedestrian Intersection Counts & Delay Analysis

Pedestrian counts were taken for several intersections within the Plan area and the immediate vicinity. Signal timing sheets were used to calculate the pedestrian delay for crossing intersection legs using the generally accepted equation from the *Highway Capacity Manual, 6th Edition* (2016):

$$\mathbf{d_p = (C - g_{walk,mi})^2 / 2C}$$

d_p = pedestrian delay
C = cycle length
$g_{walk,mi}$ = effective walk time

Effective walk time is calculated based on the signal settings in operation. Most of the signals in the Plan area are actuated rather than pre-timed and have the "rest in walk" enabled for the minor street, which provides automatic pedestrian service when the major street is in operation. In such situations, *Highway Capacity Manual, 6th Edition's* (2016) equation 19-55 was used:

$$\mathbf{g_{walk,mi} = D_{p,mi} - Y_{mi} - R_{c,mi} - PC_{mi} + 4.0}$$

D_{p} = duration of phase serving the subject crossing's associated through-movement
Y = yellow change interval
R_c = red clearance interval
PC = the pedestrian clearance setting

Pedestrian delay was not weighted by the number of pedestrians crossing the intersection; however, counts are included in Table 2 and reflect totals for the morning, lunchtime, and evening peak hours. This planning-level data provides an order of magnitude assessment regarding which intersections currently facilitate the greatest amount of pedestrian traffic.

Table 3 shows that crossing delay over larger roads, in particular MD 355, are excessive. The Plan supports minimizing crossing times to encourage walking as a mode of transportation. Reducing the amount of time it takes to walk to transportation nodes improves individuals' access and likelihood of "walking" as a realistic and desirable mode choice. The PLOC analysis detailed in section ii in tandem with pedestrian volumes suggest that improving the comfort and convenience of MD 355 crossings is paramount.

Table 3 – Pedestrian Counts and Delay

Pedestrian Crossing Counts and Delay Summary (counts taken between 6:30am-9:30am, 11:00am-1:00pm, and 4:00pm-7:00pm w/ some mild variation at lunch period)				
Intersection	**Approach**	**Total Pedestrian Crossings per Approach**	**Pedestrian Delay AM (seconds)**	**Pedestrian Delay PM (seconds)**
Indianola at Crabbs Branch	**Crabbs Branch Crossing at Indianola (north side)**	13	12.2	12.2
	Crabbs Branch Crossing at Indianola (south side)	7	12.2	12.2
	Indianola Crossing at Crabbs Branch (east side)	20	31.9	31.9
	Indianola Crossing at Crabbs Branch (west side)	15	31.9	31.9
E. Gude at Crabbs Branch	**Crabbs Branch Crossing at E. Gude (north side)**	8	44.1	44.1
	Cecil Crossing at W. Gude (south side)	20	31.4	31.4
	E. Gude Crossing at Crabbs Branch (east side)	11	64.4	64.4
	E. Gude Crossing at Crabbs Branch (west side)	19	64.4	64.4
Indianola/ Watkins Pond at 355	**355 Crossing at Indianola (north side)**	45	63.5	61.7
	355 Crossing at Indianola (south side)	2	N/A	N/A
	Indianola Crossing at 355 (east side)	37	28.2	30.7
	Watkins Pond Crossing at 355 (west side)	30	28.2	30.7
King Farm at 355	**355 Crossing at King Farm (north side)**	211	63.9	63.9
	355 Crossing at King Farm (south side)	117	63.9	63.9
	King Farm Crossing at 355 (east side)	30	20.3	20.3
	King Farm Crossing at 355 (west side)	24	20.3	20.3
Redland at 355	**355 Crossing at Redland (north side)**	71	63.9	63.9
	355 Crossing at Redland (south side)	64	63.9	63.9
	Redland Crossing at 355 (east side)	41	32.7	32.7
	Redland Crossing at 355 (west side)	41	32.7	32.7
Ridgemont at 355	**355 Crossing at Ridgemont (north side)**	0	N/A	N/A
	355 Crossing at Ridgemont (south side)	8	64.4	64.4
	Ridgemont Crossing at 355 (east side)	16	15	15
	Ridgemont Crossing at 355 (west side)	5	15	15
Gude at 355	**355 Crossing at Gude (north)**	3	N/A	N/A
	355 Crossing at Gude (south)	35	71.1	63.5
	E. Gude Crossing at 355 (east side)	18	34.7	38.9
	W. Gude Crossing at 355 (west side)	27	48	44.1
King Farm at Gaither Road	**Gaither Crossing at King Farm (north side)**	27	32.2	32.2
	Gaither Crossing at King Farm (south side)	64	32.2	32.2
	King Farm at Gaither (east side)	23	32.2	32.2
	King Farm at Gaither (west side)	35	32.2	32.2

Table 3 Continued

Intersection	Approach	Total Pedestrian Crossings per Approach	Pedestrian Delay AM (seconds)	Pedestrian Delay PM (seconds)
Piccard at Gaither	**Gaither Crossing at Piccard (north side)**	38	30.6	30.6
	Gaither Crossing at Piccard (south side)	20	30.6	30.6
	Piccard Crossing at Gaither (east side)	19	15.8	15.8
	Piccard at Gaither (west side)	21	15.8	15.8
Redland at Gaither	**Gaither Crossing at Redland (north side)**	32	No Data	No Data
	Gaither Crossing at Redland (south side)	49	No Data	No Data
	Redland Crossing at Gaither (east side)	21	No Data	No Data
	Redland Crossing at Gaither (west side)	32	No Data	No Data
W. Gude at Gaither	**Gaither Crossing at W. Gude (north side)**	7	39.6	39.6
	W. Gude Crossing at Gaither (east side)	0	N/A	N/A
	W. Gude Crossing at Gaither (west side)	30	43.1	43.1
King Farm at Pleasant	**Pleasant Crossing at King Farm (north side)**	49	No Data	No Data
	Pleasant Crossing at King Farm (south side)	82	No Data	No Data
	King Farm Crossing at Pleasant (east side)	51	No Data	No Data
	King Farm Crossing at Pleasant (west side)	48	No Data	No Data
Redland at Pleasant	**Pleasant Crossing at Redland (north side)**	71	No Data	No Data
	Pleasant Crossing at Redland (south side)	61	No Data	No Data
	Redland Crossing at Pleasant (east side)	74	No Data	No Data
	Redland Crossing at Pleasant (west side)	104	No Data	No Data
Redland at Thompson Dairy	**Thompson Dairy Crossing at Redland (north side)**	20	No Data	No Data
	Thompson Dairy Crossing at Redland (south side)	47	No Data	No Data
	Redland Crossing at Thompson Dairy (east side)	36	No Data	No Data
	Redland Crossing at Thompson Dairy (west side)	26	No Data	No Data
Redland at Crabbs Branch	**Crabbs Branch Crossing at Redland (north side)**	68	33.7	40
	Crabbs Branch Crossing at Redland (south side)	9	61.2	40
	Redland Crossing at Crabbs Branch (east side)	7	53.3	61.2
	Redland Crossing at Crabbs Branch (west side)	15	50.8	61.2
Redland at Needwood	**Needwood Crossing at Redland Road (north side)**	27	27	20.3
	Needwood Crossing at Redland (south side)	1	27	20.3
	Redland Crossing at Needwood (east side)	7	60.3	71.5
	Redland Crossing at Needwood (west side)	9	54.2	54.2
Redland Road at Metro Access	**Metro Access Crossing at Redland (north side)**	58	17.3	17.3
	Redland Crossing at Metro Access (east side)	2	N/A	N/A
	Redland Crossing at Metro Access (west side)	12	54.2	52.2

Table 3 Continued

Intersection	Approach	Total Pedestrian Crossings per Approach	Pedestrian Delay AM (seconds)	Pedestrian Delay PM (seconds)
Shady Grove at Gaither	Gaither Crossing at Shady Grove (north side)	39	63.9	63.9
	Gaither Crossing at Shady Grove (south side)	26	N/A	N/A
	Shady Grove Crossing at Gaither (east side)	58	38.9	43.3
	Shady Grove Crossing at Gaither (west side)	9	52.9	43.4
Shady Grove at Oakmont	Oakmont Crossing at Shady Grove (north side)	1	31.4	37.5
	Business Entrance Crossing at Shady Grove (south side)	3	27.6	33.3
	Shady Grove Crossing at Oakmont (east side)	10	N/A	N/A
	Shady Grove Crossing at Oakmont (west side)	1	46.8	49.2
Shady Grove at Crabbs Branch	Crabbs Branch Crossing at Shady Grove (north side)	27	59.4	50.8
	Crabbs Branch Crossing at Shady Grove (south side)	7	59.4	50.8
	Shady Grove Crossing at Crabbs Branch (east side)	30	63.9	63.9
	Shady Grove Crossing at Crabbs Branch (west side)	38	63.5	63.5
Shady Grove at 355	355 Crossing at Shady Grove (north side)	44	64.1	64.4
	355 Crossing at Shady Grove (south side)	14	N/A	N/A
	Shady Grove Crossing at 355 (east side)	10	61.2	56.8
	Shady Grove Crossing at 355 (west side)	70	53.5	63.9
Redland at Somerville	Somerville Crossing at Redland (north side)	77	12.4	12.4
	Somerville Crossing at Redland (south side)	28	12.4	12.4
	Redland Crossing at Somerville (east side)	40	42.9	42.9
	Redland Crossing at Somerville (west side)	82	42.9	42.9
W. Gude at Watkins Pond	Watkins Pond Crossing at W. Gude (north side)	2	30.9	34.7
	W. Gude Crossing at Watkins Pond (east side)	3	N/A	N/A
	W. Gude at Watkins Pond (west side)	33	37.6	41.6

iv. Existing and Planned Bicycling Conditions

The Plan currently contains several constructed bicycle facilities, including a sidepath on the eastern side of Metro Access Road, extending between Shady Grove Road and Redland Road, a sidepath on the northern side of Redland Road spanning between Needwood Road and Metro Access Road, and a sidepath on Crabbs Branch Way extending between Shady Grove Road and Redland Road. The 2006 *Shady Grove Sector Plan* recommended these facilities, and the facilities were implemented following the 2006 Plan's adoption by development interests, the Washington Metropolitan Area Transit Authority (WMATA), and the County. While these segments improve accessibility for local users, a lack of bicycle network connectivity beyond the Metro Station Policy Area inhibits the realization of these facilities full potential.

In addition to the facilities listed above, Gude Drive provides an eight-foot sidepath along the southern border of the Plan area. This facility makes up a portion of the City of Rockville's Carl Henn Millennium Trail. While it exists today, improvements to improve separation/buffering between the cartway and the facility would improve safety for pedestrians and bicyclists.

The 2018 *Bicycle Master Plan* amended the bicycle facility recommendations of the 2006 *Shady Grove Sector Plan*, both in terms of nomenclature and quality. The 2006 plan supported some on-street facilities, including bicycle lanes and sharrows, whereas the 2018 *Bicycle Master Plan* largely stepped away from such facilities (beyond bikeable shoulders) in favor of greater geometric separation between bicyclists and vehicles. Separation improves safety for users by vastly reducing the number of locations where vehicles and bicycles can interact and conflict.

In terms of nomenclature, the 2018 *Bicycle Master Plan* adopted the terms "separated bicycle lanes" and "sidepaths" when facilities are separated from traffic. Sidepaths can be dedicated for bicycle use (when a separate pedestrian facility is present), but can also facilitate both pedestrian and bicycle traffic when appropriately designed. In this regard, sidepaths are like the "shared use paths" recommended in the 2006 *Shady Grove Sector Plan*. The 2018 *Bicycle Master Plan* also adopts the concept of "Breezeways," which are facilities anticipated to facilitate greater volumes of bicycle traffic at higher speeds, requiring higher-quality design. The 2020 *Shady Grove Minor Master Plan Amendment* adopts the 2018 Plan's nomenclature. Figure 8 shows the 2006 Plan's Bicycle Network, and Figures 9 and 10 depict the 2018 Bicycle Master Plan's recommended bicycle network.

The 2020 *Shady Grove Sector Plan Minor Master Plan Amendment* amends the recommendations of the 2018 *Bicycle Master Plan*. The planning process provided a finer-grained look at local conditions, needs, and opportunities, and balanced the visionary principles of the 2018 *Bicycle Master Plan* with the realistic context of the Shady Grove Planning Area. Factors that influenced changes included the lack of development potential, the lack of right-of-way width with poor prospects to gain additional right-of-way, and the presence of mature tree canopy in some locations. It is important to note that existing mature trees contribute to the canopy coverage requirements detailed in the Plan's environmental recommendations.

The recommendations of the 2020 Plan could conceivably be implemented within the lifespan of the Plan should funding be available from the County. Most of the recommended facilities are not located near anticipated development. As such, the facilities would need to be programmed in the County's Capital Improvement Program (CIP).

Table 4 provides the existing and amended bicycle network with important additional qualifying footnotes to aid the development of future facilities. Facilities with additional qualification are highlighted. Table 5 identifies facilities that are removed from 2018 *Bicycle Master Plan*, including the rationale for their removal.

Figure 8 - 2006 Shady Grove Sector Plan Bicycle Network

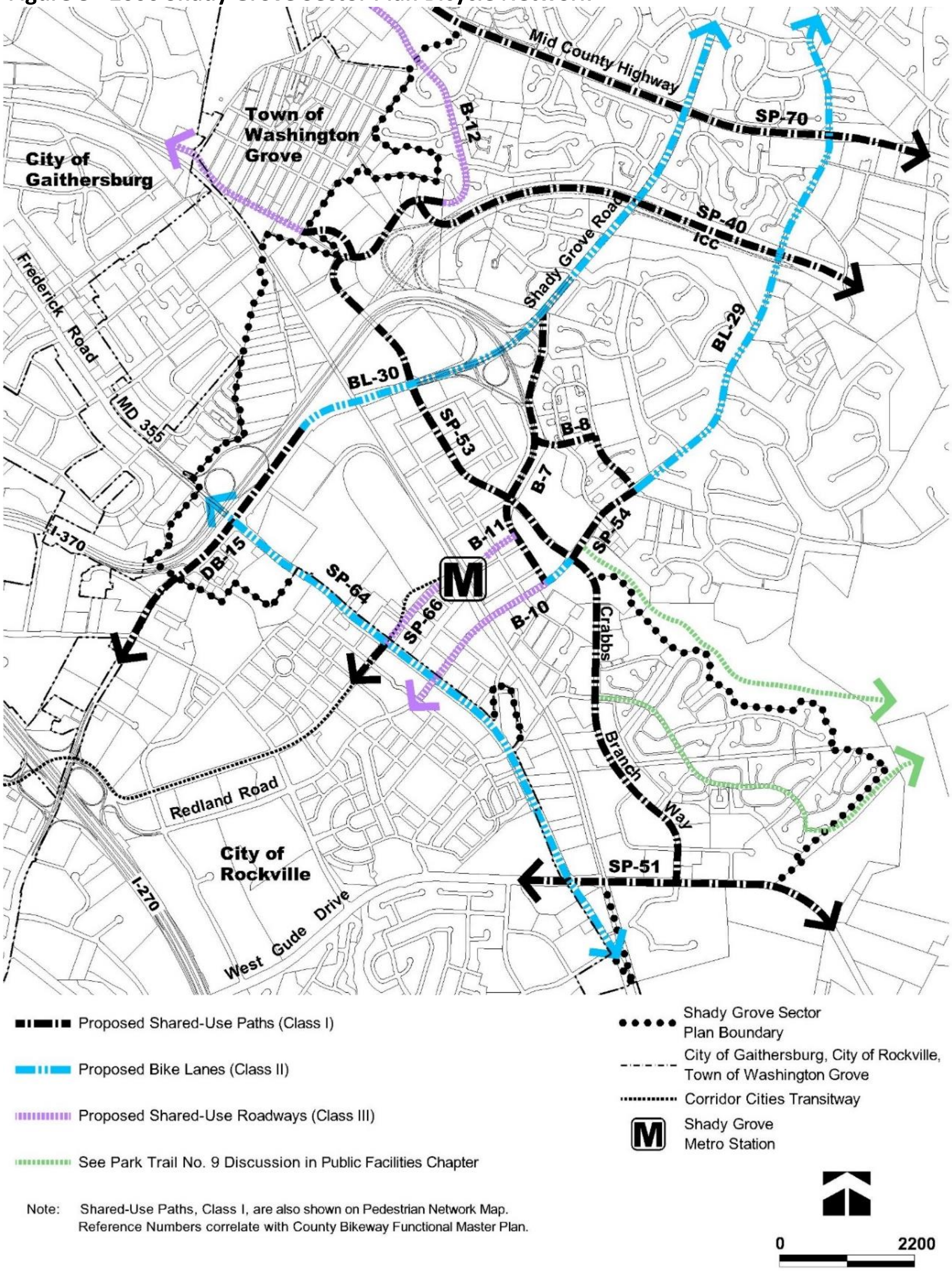


Figure 9 - 2018 Bicycle Master Plan Network for Derwood

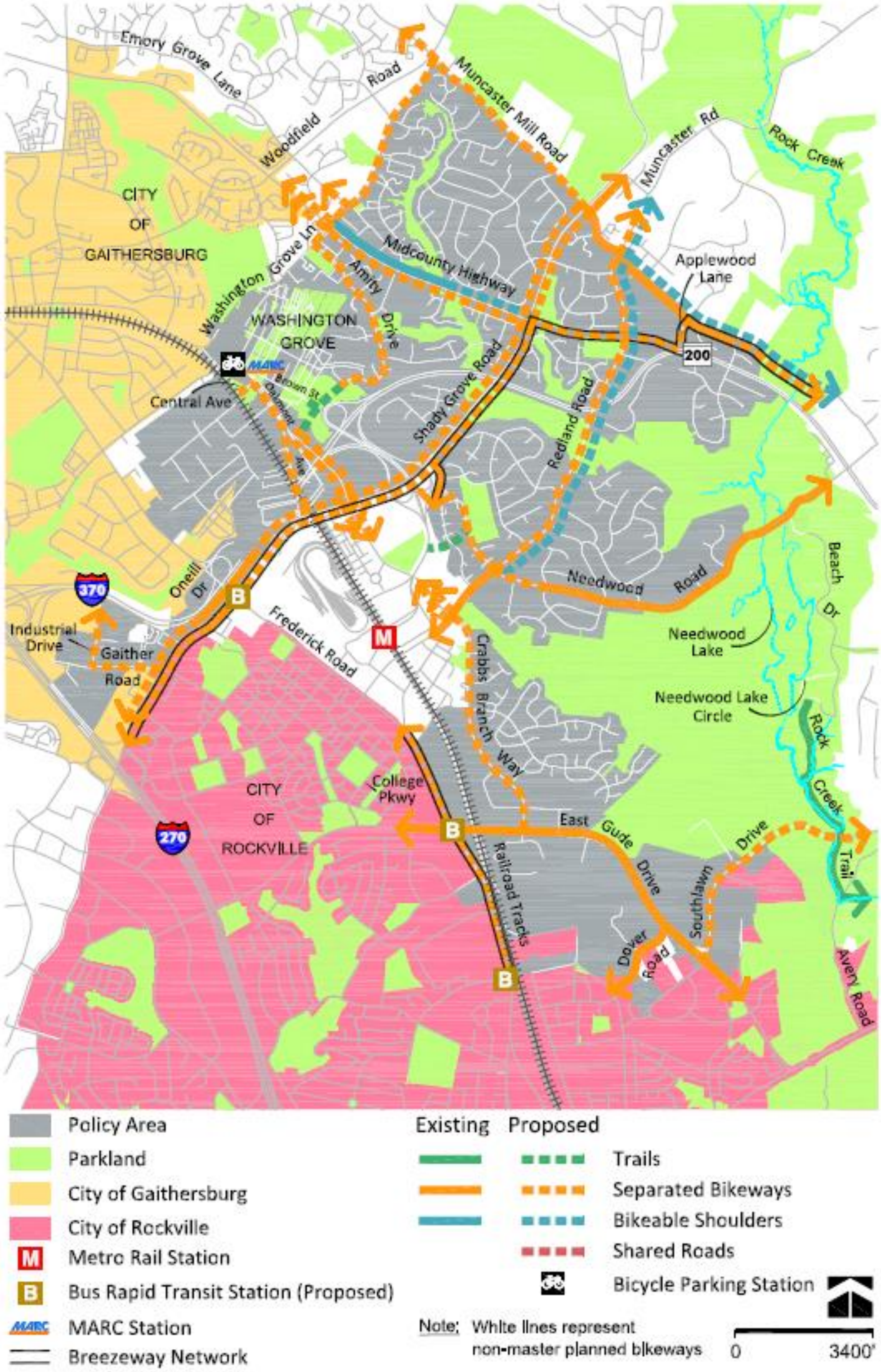


Figure 10 – 2018 Bicycle Master Plan for Metro Station Policy Area

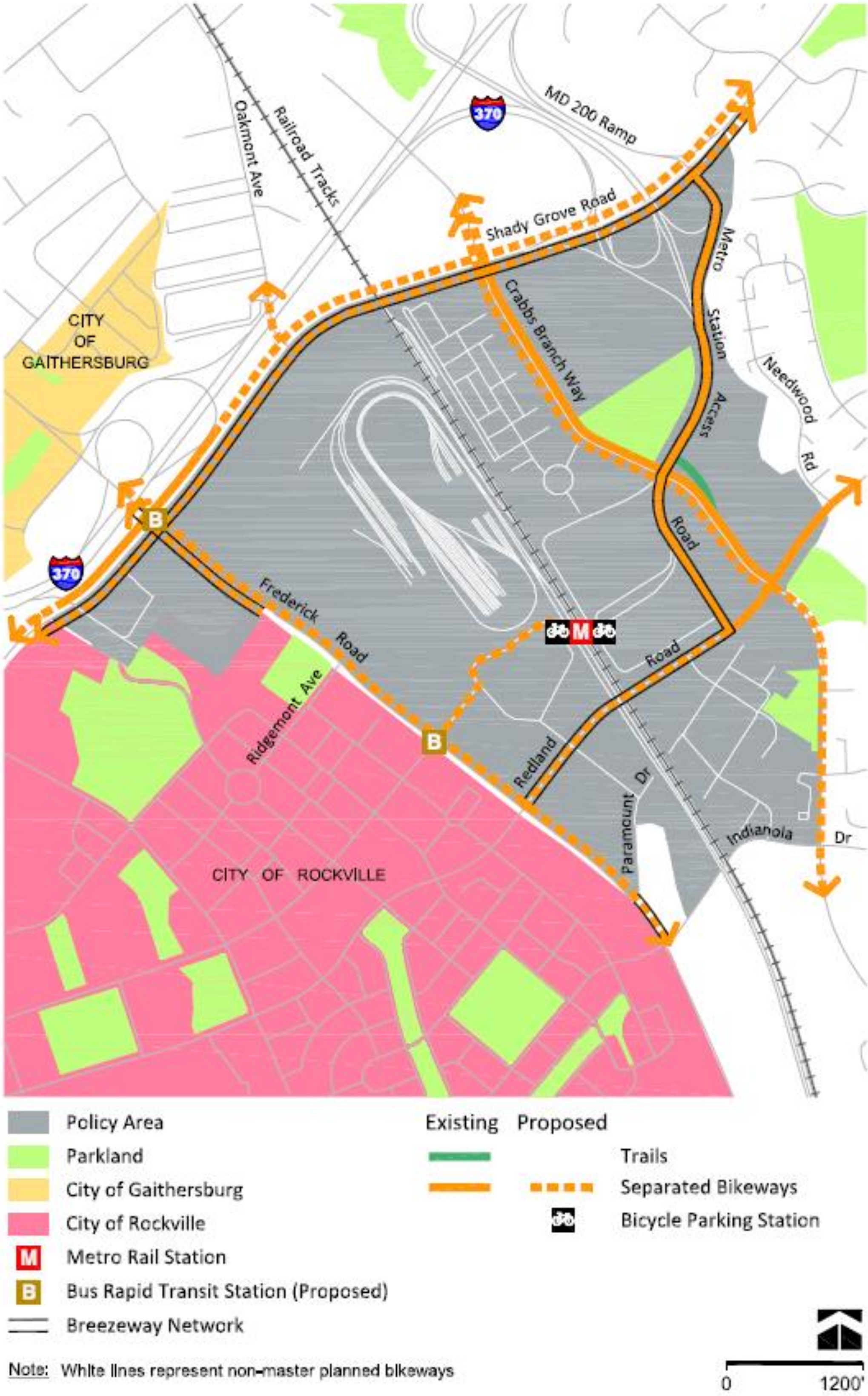


Table 4 – Constructed and Recommended Bicycle Network

PROJECT / STREET	TO	FROM	BIKEWAY TYPE	STATUS
CLARKSBURG TO CITY OF GAITHERSBURG BREEZEWAY				
Frederick Rd (MD 355)	City of Gaithersburg City Limits	Southern Plan Boundary	Separated Bike Lanes (Two-Way, East Side)	Proposed
INTERCOUNTY CONNECTOR TRAIL BREEZEWAY				
Redland Rd[1]	Frederick Rd (MD 355)	Metro Access Road	Sidepath (North Side)	Proposed
Metro Access Road[1]	Redland Rd	Shady Grove Rd	Sidepath (East Side)	Existing
Shady Grove Rd[1,3,4]	Metro Access Rd/I-370 Ramps	Midcounty Highway	Sidepath (South Side)	Proposed
Midcounty Hwy[1,2]	Shady Grove Rd	Redland Rd	Off-Street Trail	Proposed
LIFE SCIENCES CENTER TO SHADY GROVE METRO BREEZEWAY				
Shady Grove Rd	Western Plan Boundary	Shady Grove Access Rd/I-370 Ramps	Sidepath (South Side)	Proposed
ADDITIONAL RECOMMENDATIONS				
Amity Drive[3]	Washington Grove Ln	118’ West of Castanea Lane	Sidepath (North Side)	Proposed
Crabbs Branch Way	118’ West of Castanea Lane	Shady Grove Rd	Sidepath (East Side)	Proposed
Crabbs Branch Way	Shady Grove Rd	Redland Rd	Sidepath (East Side)	Existing
Crabbs Branch Way	Redland Rd	E Gude Dr	Sidepath (East Side)	Proposed
E Gude Drive[4]	City of Rockville Limits	Eastern Plan Boundary	Sidepath (West Side)	Improvement proposed
Indianola Dr	Frederick Rd (MD 355)	Crabbs Branch Way	Sidepath (North Side)	Proposed
Midcounty Hwy	Northern Plan Boundary	Shady Grove Rd	Sidepath (South Side)	Proposed
Midcounty Hwy[5]	Northern Plan Boundary	Shady Grove Rd	Bikeable Shoulders	Improvement proposed
Piedmont Crossing Local Park Trail	Brown St	Crabbs Branch Rd/Amity Dr Ext	Off-Street Trail	Proposed
Redland Rd[4]	Shady Grove Access Rd	Needwood Rd (north access)	Sidepath (North Side)	Improvement proposed
Redland Rd[3,4]	Needwood Rd (north access)	Northern Plan Area Boundary	Sidepath (North Side)	Proposed
King Farm Boulevard Ext	Frederick Rd (MD 355)	Shady Grove Metro Station	Separated Bike Lanes (Two-Way, North Side)	Proposed
Somerville Dr Ext	King Farm Blvd Ext	Redland Rd	Sidepath (North Side)	Proposed

[1]Due to constraints on Shady Grove Road and Redland Road, Intercounty Connector Trail Breezeway may be constructed to be 10' wide as consistent with the existing segments along Metro Access Road.

[2]Alternative treatments, such as flexible pavement or a structured facility, may be acceptable for conservation purposes.

[3]This Plan supports the retention of existing mature trees within the right-of-way, where possible

[4]Provide adequate separation between the facility and the roadway; if a buffer of at least 6' cannot be achieved, provide vertical separation between non-motorists and the roadway

[5]Where the shoulders cross deceleration and turning lanes, provide striping and markings to improve safety; if a future capital project repurposes existing right-of-way to accommodate the planned sidepath on the south side, the bikeable shoulders may be removed in support of a safer, separated facility.

Table 5 – Facilities Removed from the 2018 Bicycle Master Plan & Rationale

PROJECT / STREET	FROM	TO	BIKEWAY TYPE	RATIONALE
REMOVED FACILITIES				
Frederick Rd (MD 355)	Shady Grove Rd	Gude Drive	Sidepath (West Side)	Majority of Segment on West Side within City of Rockville
Redland Rd	Needwood Rd (southern access)	Muncaster Mill Rd	Bikeable Shoulders (South Side)	Focus on Protected Facility on North Side of Right-Of-Way
Crabbs Branch Way	1,000' North of I-370	Redland Rd	Sidepath (West Side)	Not Constructed with Recent Development; Space Limitations on Bridge
Oakmont Ave	Central Ave	Shady Grove Rd	Sidepath (East Side)	Changed Facility Classification to Industrial St; Focus on Safer Parallel Connection at Brown St
Needwood Rd	Redland Rd	Blueberry Hill Park	Sidepath (East Side)	Existing Wide Sidewalk Between Property Line and Mature Trees

v. Existing Transit Use

Consistent with macro-level trends, transit use in the Plan Area has declined over the past few years. Data from the Montgomery County Department of Transportation's (MCDOT) RideOn bus service and the Washington Metropolitan Area Transportation Authority (WMATA) suggest that the decline, however, may be leveling out along—at least for Metrorail use and some bus routes. Figure 11 depicts the Average number of weekday bus Riders for RideOn and WMATA lines that move through or terminate in the Plan area. The most noticeable losses are on RideOn's 55 line, and WMATA Metrobus's Q line. Figure 12 shows the average number of weekday entries and exits at WMATA's Shady Grove Metrorail Station.

Figure 11 - Average Weekday Bus Riders by Line FY2014-FY2018

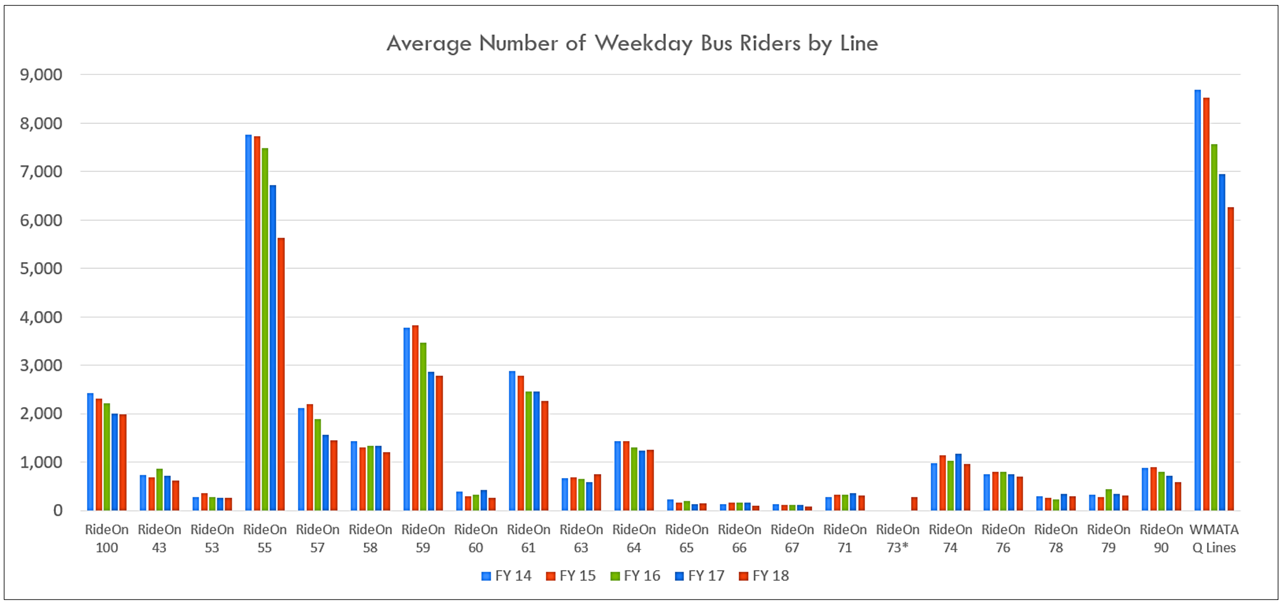
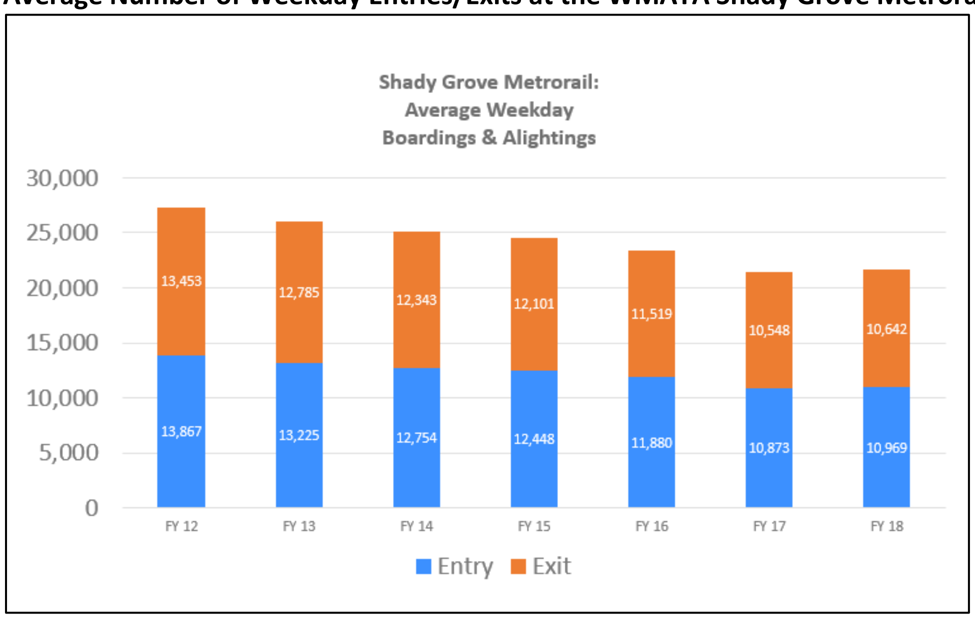


Figure 12 – Average Number of Weekday Entries/Exits at the WMATA Shady Grove Metrorail Station



Despite slight declines in ridership, WMATA's Shady Grove Metrorail Station remains an important node for the area. As a terminus for the redline, people access the station in various ways, including transfers from other transportation modes. Figure 13 shows how people access the Metrorail station, and Figure 14 shows daily boardings relative to other redline stations (based on 2017 data). At 11,139 average boardings per weekday (2017), Shady Grove is the second-most used station in the county, and the fifth-most used redline station. The Metrorail Station currently has 5,745 space lot capacity, and consistent with the slight uptick in average boardings between 2017 and 2018 (see Figure 13), paid parking transactions increased by 8% between 2018 and 2019, suggesting ridership trends are continuing to stabilize.

Figure 13 – How People Access the Shady Grove Metrorail Station (source: WMATA's 2016 Passenger Survey)

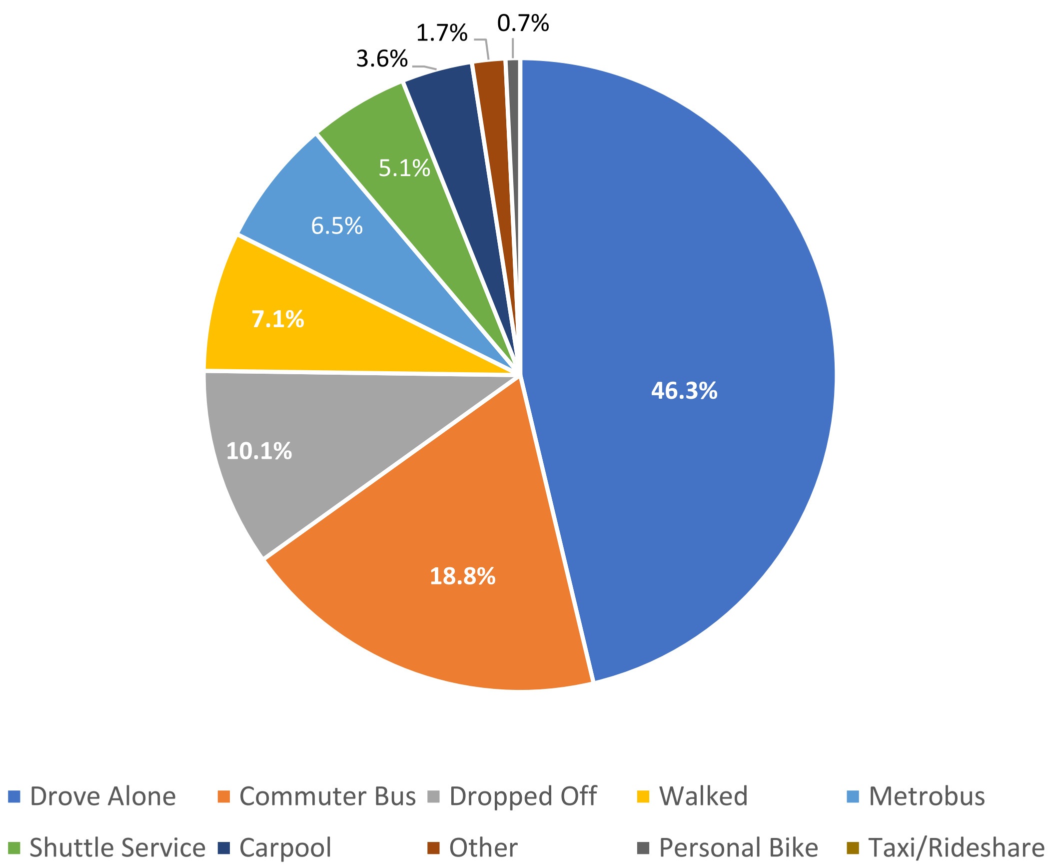
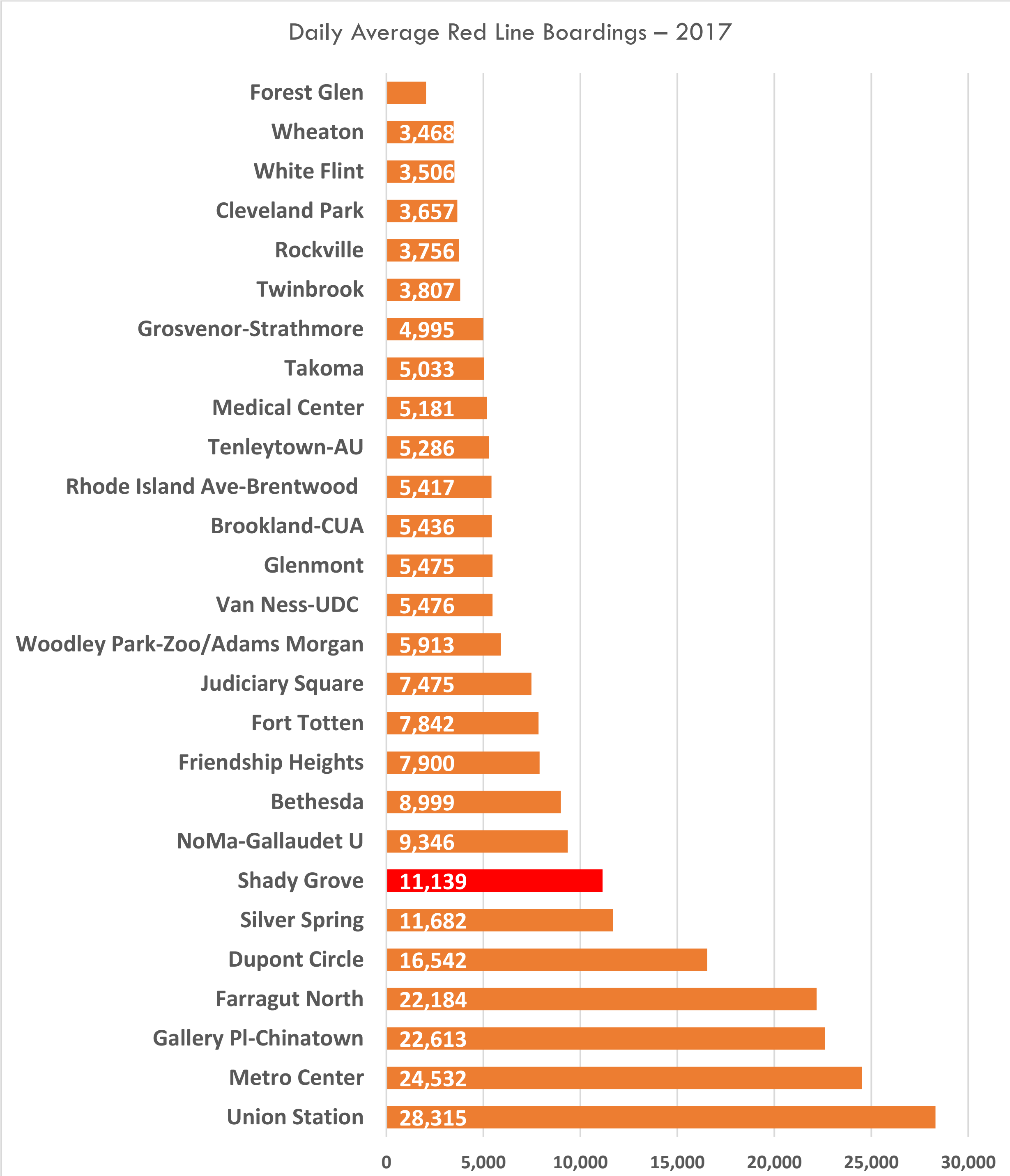


Figure 14 – Average Daily Redline Boardings (2017)



Beyond Metrorail, Metrobus, and RideOn, a number of Maryland Transit Authority (MTA) commuter buses serve the Plan Area. Table 6 depicts the average weekday ridership for these services in 2018.

Table 6 – Average Weekday Commuter Bus Ridership in FY 2018

MTA Commuter Bus Route	Service Route	Sector Plan - Vicinity Boarding/Alighting Location	Average Weekday Ridership FY2018
201	Gaithersburg to BWI Business District via ICC	Gaithersburg Park & Ride Stop	373
202	Gaithersburg to Fort Meade via ICC (discontinued)	Shady Grove Metro Station	54
204	Frederick to College Park via ICC	Gaithersburg Park & Ride	249
505	Hagerstown to Rock Spring via I-70 and I-270	Shady Grove Metro Station	376
515	Monacacy to Rock Spring via MD 355 and I-270	Shady Grove Metro Station	643

B. Vision Zero Analysis

Three of the county's "High-Injury Network" segments are located in the Plan Area, including:

- Frederick Road, for the extent of the Plan Area;
- Crabbs Branch Way, between Redland Road and Indianola Drive, and;
- Shady Grove Road, between the Metro Access Road/I-370 Interchange to Midcounty Highway

To better understand how to support improvements along the segments listed above and the Sector Plan Area at large, staff analyzed existing vehicular speeds and Plan Area crashes.

i. Speed Analysis
Excessive speeds reduce drivers' cones of vision and increase the potential for harm during crashes. Figure 15, based on the research and produced by the Vision Zero Network, shows that only one out of ten pedestrians survive when hit by a vehicle traveling at a speed of forty miles per hour. During scheduled meetings, the community cited concerns about speeding in the Plan Area. Participants in the Plan's Walkshop event also noted that drivers appeared to exceed posted speeds along major roadways like Crabbs Branch Way, Redland Road, and Shady Grove Road. As such, spot speed studies were taken to understand vehicle speeds along roadways in the Sector Plan Area. Figure 16 depicts the locations where tubes were placed to collect speed information for 13-hours (6:00am-7:00pm) on a typical weekday (Tuesday, April 2, 2019). Table 7 provides a summary of the speed collection for the six locations in both northbound and southbound directions.

Figure 15 – Pedestrian Crash Survival Based on Speed (Source: Vision Zero Network)

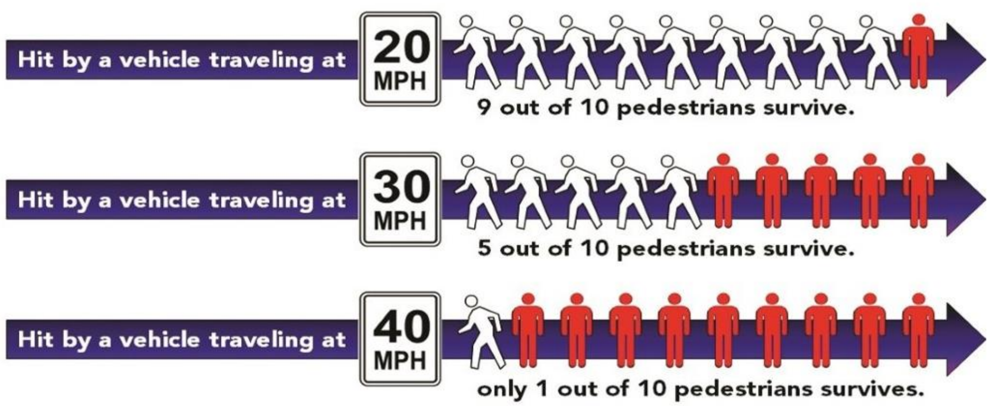


Figure 16 – Location of Tubes for Spot Speed Studies

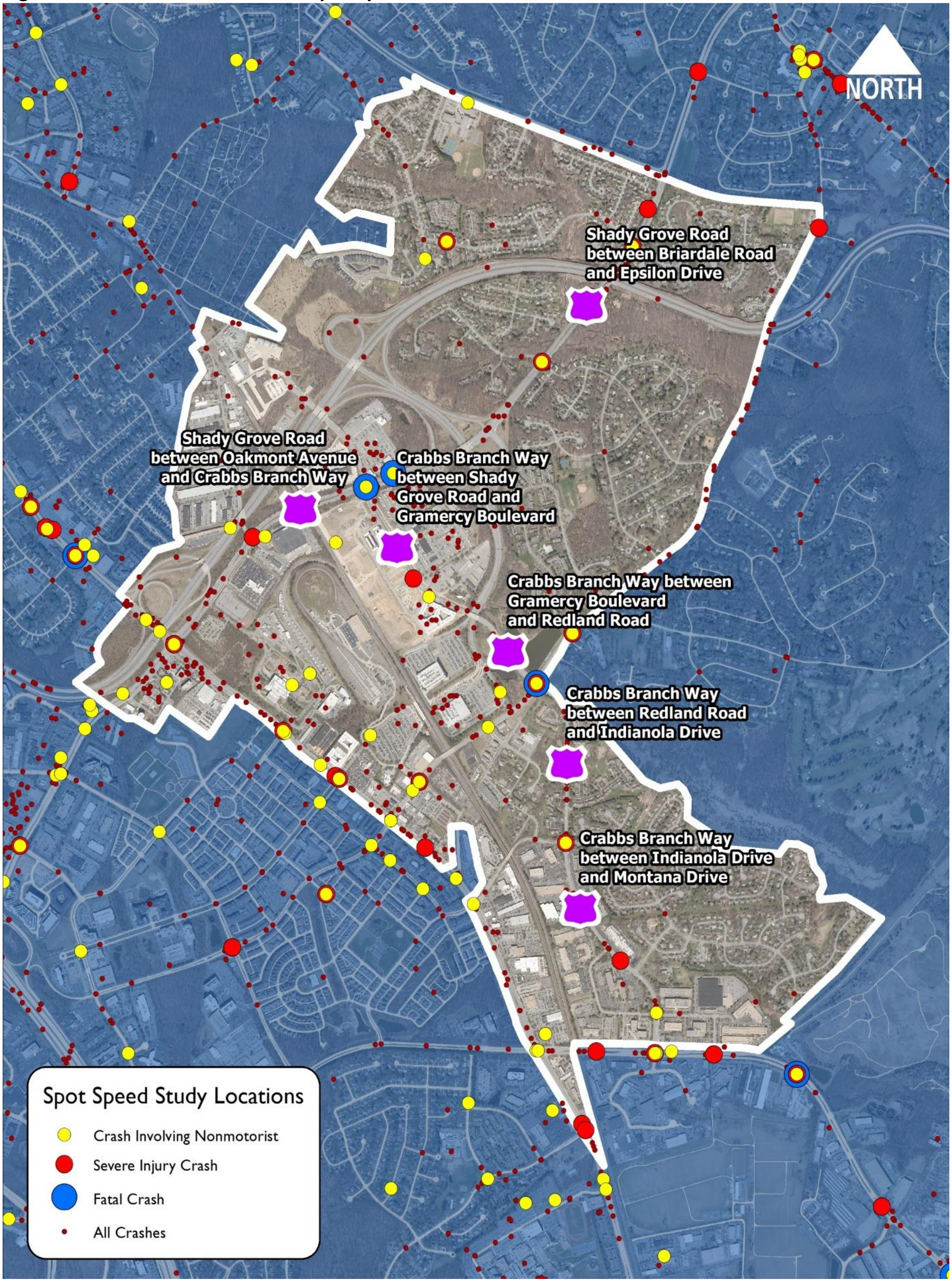


Table 7– Spot Speed Study Results

	Crabbs Branch Way Between Monona Drive and Indianola Drive					Crabbs Branch Way Between Monona Drive and Indianola Drive			
	SPEED	**FREQUENCY OF VEHICLES**	**CUMULATIVE FREQUENCY**	**SPEED PERCENTILE**		**SPEED**	**FREQUENCY OF VEHICLES**	**CUMULATIVE FREQUENCY**	**SPEED PERCENTILE**
NORTHBOUND	1-5 MPH	130	130	2%	**SOUTHBOUND**	1-5 MPH	96	96	1%
	6-10 MPH	28	158	2%		6-10 MPH	1	97	1%
	11-15 MPH	91	249	3%		11-15 MPH	10	107	1%
	16-20 MPH	202	451	6%		16-20 MPH	93	200	2%
	21-25 MPH	438	889	12%		21-25 MPH	270	470	6%
	26-30 MPH	954	1843	24%		26-30 MPH	464	934	11%
	31-35 MPH	2318	4161	54%		31-35 MPH	2385	3319	40%
	36-40 MPH	2335	6496	85%		36-40 MPH	3299	6618	80%
	41-45 MPH	950	7446	97%		41-45 MPH	1359	7977	96%
	46-50 MPH	203	7649	100%		46-50 MPH	259	8236	99%
	51-55 MPH	26	7675	100%		51-55 MPH	47	8283	100%
	56-60 MPH	10	7685	100%		56-60 MPH	10	8293	100%
	61-65 MPH	2	7687	100%		61-65 MPH	2	8295	100%
	66-70 MPH	0	7687	100%		66-70 MPH	1	8296	100%

	Crabbs Branch Way Between Redland Road and Gramercy Boulevard					Crabbs Branch Way Between Redland Road and Gramercy Boulevard			
	SPEED	**FREQUENCY OF VEHICLES**	**CUMULATIVE FREQUENCY**	**SPEED PERCENTILE**		**SPEED**	**FREQUENCY OF VEHICLES**	**CUMULATIVE FREQUENCY**	**SPEED PERCENTILE**
NORTHBOUND	1-5 MPH	1412	1412	27%	**SOUTHBOUND**	1-5 MPH	45	45	1%
	6-10 MPH	5	1417	27%		6-10 MPH	7	52	1%
	11-15 MPH	1	1418	27%		11-15 MPH	2	54	1%
	16-20 MPH	2	1420	27%		16-20 MPH	6	60	1%
	21-25 MPH	9	1429	27%		21-25 MPH	15	75	1%
	26-30 MPH	69	1498	29%		26-30 MPH	109	184	3%
	31-35 MPH	509	2007	38%		31-35 MPH	775	959	16%
	36-40 MPH	1607	3614	69%		36-40 MPH	2416	3375	55%
	41-45 MPH	1207	4821	92%		41-45 MPH	2025	5400	88%
	46-50 MPH	325	5146	99%		46-50 MPH	619	6019	98%
	51-55 MPH	62	5208	100%		51-55 MPH	113	6132	100%
	56-60 MPH	12	5220	100%		56-60 MPH	22	6154	100%
	61-65 MPH	2	5222	100%		61-65 MPH	2	6156	100%
	66-70 MPH	0	5222	100%		66-70 MPH	1	6157	100%

Crabbs Branch Way Between Redland Road and Indianola Drive					Crabbs Branch Way Between Redland Road and Indianola Drive				
NORTHBOUND	**SPEED**	**FREQUENCY OF VEHICLES**	**CUMULATIVE FREQUENCY**	**SPEED PERCENTILE**	SOUTHBOUND	**SPEED**	**FREQUENCY OF VEHICLES**	**CUMULATIVE FREQUENCY**	**SPEED PERCENTILE**
	1-5 MPH	627	627	9%		1-5 MPH	228	228	3%
	6-10 MPH	25	652	10%		6-10 MPH	38	266	3%
	11-15 MPH	3	655	10%		11-15 MPH	84	350	4%
	16-20 MPH	8	663	10%		16-20 MPH	168	518	6%
	21-25 MPH	43	706	11%		21-25 MPH	201	719	8%
	26-30 MPH	329	1035	16%		26-30 MPH	490	1209	13%
	31-35 MPH	1728	2763	42%		31-35 MPH	2036	3245	36%
	36-40 MPH	2547	5310	80%		36-40 MPH	3814	7059	78%
	41-45 MPH	1042	6352	96%		41-45 MPH	1625	8684	96%
	46-50 MPH	219	6571	99%		46-50 MPH	344	9028	99%
	51-55 MPH	32	6603	100%		51-55 MPH	54	9082	100%
	56-60 MPH	12	6615	100%		56-60 MPH	8	9090	100%
	61-65 MPH	2	6617	100%		61-65 MPH	1	9091	100%
	66-70 MPH	0	6617	100%		66-70 MPH	2	9093	100%

Crabbs Branch Way Between Shady Grove Road and Gramercy Boulevard					Crabbs Branch Way Between Shady Grove Road and Gramercy Boulevard				
NORTHBOUND	SPEED	**FREQUENCY OF VEHICLES**	**CUMULATIVE FREQUENCY**	**SPEED PERCENTILE**	**SOUTHBOUND**	**SPEED**	**FREQUENCY OF VEHICLES**	**CUMULATIVE FREQUENCY**	**SPEED PERCENTILE**
	1-5 MPH	60	60	1%		1-5 MPH	58	58	1%
	6-10 MPH	3	63	1%		6-10 MPH	4	62	1%
	11-15 MPH	41	104	2%		11-15 MPH	7	69	1%
	16-20 MPH	26	130	3%		16-20 MPH	39	108	2%
	21-25 MPH	54	184	4%		21-25 MPH	95	203	4%
	26-30 MPH	421	605	13%		26-30 MPH	410	613	12%
	31-35 MPH	1626	2231	48%		31-35 MPH	1615	2228	42%
	36-40 MPH	1630	3861	83%		36-40 MPH	1931	4159	79%
	41-45 MPH	617	4478	96%		41-45 MPH	838	4997	95%
	46-50 MPH	131	4609	99%		46-50 MPH	212	5209	99%
	51-55 MPH	25	4634	100%		51-55 MPH	35	5244	100%
	56-60 MPH	6	4640	100%		56-60 MPH	6	5250	100%
	61-65 MPH	0	4640	100%		61-65 MPH	1	5251	100%
	66-70 MPH	1	4641	100%		66-70 MPH	2	5253	100%

Shady Grove Road between Briardale Road and Epsilon Drive					Shady Grove Road between Briardale Road and Epsilon Drive				
NORTHBOUND	SPEED	**FREQUENCY OF VEHICLES**	**FREQUENCY OF VEHICLES**	**CUMULATIVE FREQUENCY**	SOUTHBOUND	**SPEED**	**FREQUENCY OF VEHICLES**	**CUMULATIVE FREQUENCY**	**SPEED PERCENTILE**
	1-5 MPH	384	384	2%		1-5 MPH	630	630	3%
	6-10 MPH	10	394	2%		6-10 MPH	149	779	4%
	11-15 MPH	18	412	2%		11-15 MPH	169	948	5%
	16-20 MPH	51	463	2%		16-20 MPH	292	1240	7%
	21-25 MPH	109	572	3%		21-25 MPH	424	1664	9%
	26-30 MPH	275	847	4%		26-30 MPH	587	2251	12%
	31-35 MPH	955	1802	8%		31-35 MPH	948	3199	17%
	36-40 MPH	3052	4854	23%		36-40 MPH	2144	5343	29%
	41-45 MPH	6122	10976	52%		41-45 MPH	4485	9828	52%
	46-50 MPH	5974	16950	80%		46-50 MPH	4917	14745	79%
	51-55 MPH	3202	20152	95%		51-55 MPH	2692	17437	93%
	56-60 MPH	893	21045	99%		56-60 MPH	948	18385	98%
	61-65 MPH	203	21251	100%		61-65 MPH	261	18646	100%
	66-70 MPH	37	21285	100%		66-70 MPH	84	18730	100%

Shady Grove Road between Crabbs Branch Way and Oakmont Avenue					Shady Grove Road between Crabbs Branch Way and Oakmont Avenue				
	SPEED	**FREQUENCY OF VEHICLES**	**CUMULATIVE FREQUENCY**	**SPEED PERCENTILE**		**SPEED**	**FREQUENCY OF VEHICLES**	**CUMULATIVE FREQUENCY**	**SPEED PERCENTILE**
NORTHBOUND	1-5 MPH	157	157	1%	SOUTHBOUND	1-5 MPH	114	114	1%
	6-10 MPH	22	179	2%		6-10 MPH	1	115	1%
	11-15 MPH	15	194	2%		11-15 MPH	2	117	1%
	16-20 MPH	44	238	2%		16-20 MPH	4	121	1%
	21-25 MPH	86	324	3%		21-25 MPH	56	177	1%
	26-30 MPH	319	643	5%		26-30 MPH	290	467	3%
	31-35 MPH	1200	1843	16%		31-35 MPH	1685	2152	15%
	36-40 MPH	3402	5245	44%		36-40 MPH	6092	8244	58%
	41-45 MPH	3985	9230	78%		41-45 MPH	3779	12023	85%
	46-50 MPH	1911	11141	94%		46-50 MPH	1522	13545	96%
	51-55 MPH	512	11653	99%		51-55 MPH	405	13950	99%
	56-60 MPH	123	11776	100%		56-60 MPH	117	14067	100%
	61-65 MPH	25	11801	100%		61-65 MPH	38	14105	100%
	66-70 MPH	10	11811	100%		66-70 MPH	11	14116	100%

The Montgomery County Department of Transportation (MCDOT) sets target speeds for roadways and ideally roadway design supports a selected target speed. The County's Urban Road Code Policy, which dictates that roads in defined urban areas must have a target speed of 25 miles per hour, was enacted after each of the studied roads in the Plan area were constructed (excluding the rebuilt portion of Crabbs Branch Way between Shady Grove Road and the Crabbs Branch Way bridge points south). Three of the six locations where spot speed information was collected fall within the Shady Grove Urban Road Code boundary. Today, posted speeds do not align with the policy because the current roadways support higher-speeds, as demonstrated by the speed percentile breakdown in Table 7 above. Posted road speeds for each of the locations is shown in Table 8 below. Table 8 also provides the percentage of drivers traveling above the posted speed limit at the collection locations.

Table 8 – Percent of Drivers Traveling Above the Posted Speed Limit

Location	Posted Speed	Percent Traveling Above Posted Speed Limit
Shady Grove Road		
Shady Grove Road between Briardale Road and Epsilon Drive	45 miles per hour	48% northbound 48% southbound
Shady Grove Road between Oakmont and Crabbs Branch Way	40 miles per hour	56% northbound 42% southbound
Crabbs Branch Way		
Crabbs Branch Way between Shady Grove Road and Gramercy Boulevard	35 miles per hour	52% northbound 58% southbound
Crabbs Branch Way between Gramercy Boulevard and Redland Road	35 miles per hour	62% northbound 84% southbound
Crabbs Branch Way between Redland Road and Indianola Drive	35 miles per hour	58% northbound 64% southbound
Crabbs Branch Way between Indianola Drive and Monona Drive	35 miles per hour	46% northbound 60% southbound

The Vision Zero Improvements Summary Table (Table 9) in this Appendix include measures that aim to reduce speeds through engineering and enforcement strategies.

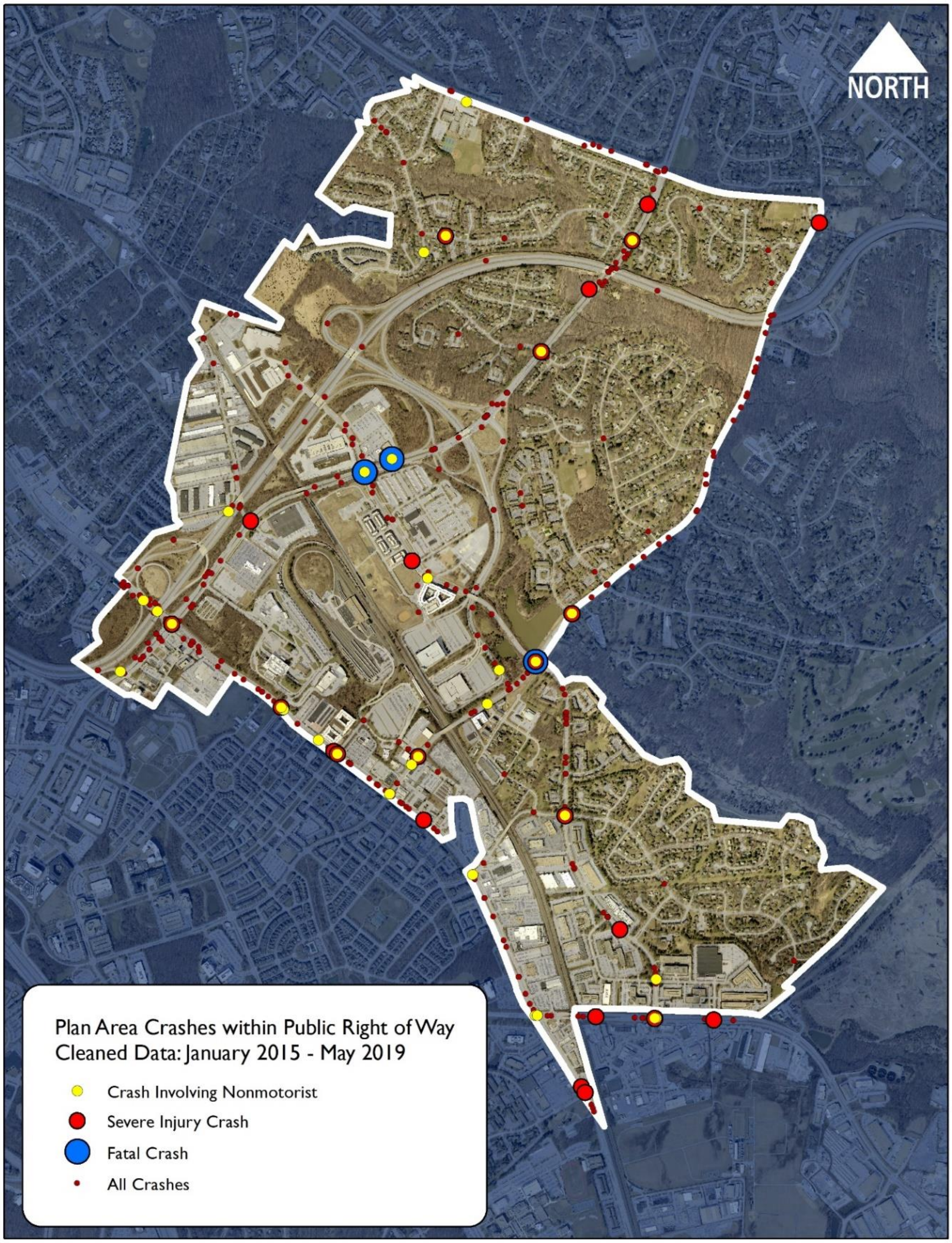
ii. Crash Analysis

In support of the effort, Planning staff analyzed crashes between January 2015 and May 2019. Department staff compiled geospatial crash data from the State, County, and proximate municipal governments and eliminated duplicate incident records. Crashes were then mapped based on coordinates in the geospatial record; however, staff notes that the reliability is not perfect. Sometimes geographic coordinates specify where a record is created rather than where a crash occurs. Where possible, geographic coordinates were cleaned to better represent the location of the crash. Records that were identified as occurring on private property (i.e. parking lots, garages, etc.) were removed from the dataset. Figure 17 depicts the locations of crashes based on crash type, following data clean-up.

1,347 crashes occurred in the Planning Area during the sample period. Approximately 2.45 percent (33) of these crashes resulted in a severe injury or fatality, and 3.79 percent (51) involved a non-motorist—

the network's most vulnerable user group. Six of the reported non-motorist crashes resulted in a severe injury or fatality. Three fatalities occurred in the Sector Plan Area between January 2015 and May 2019.

Figure 17 – Plan Area Crashes



To further understand crash trends, staff worked with the Montgomery County Police Department (MCPD) to obtain crash reports and movement diagrams for all crashes that resulted in a severe injury or fatality. Based on geospatial information, staff had access to 72 specific record identification numbers and requested each of the 72 records. The Montgomery County Police Department was able to provide 65 of the 72 requested records. Staff used these reports to strategically evaluate the Plan Area, using information in the geospatial database where actual records were not provided. While previous crashes are not necessarily predicative of future crashes, historical information can be used to determine if trends are present, or to assess movements that frequently result in crashes. Major findings include:

- Right-turn vehicle movements accounted for 31 percent of non-motorist crashes[1]. Hotspots included Crabbs Branch Way & Redland Road, Shady Grove Road & Crabbs Branch Way, and turns into commercial driveways on MD 355.

- All but one of the right-turn non-motorist crashes at intersections (i.e. not driveways) note that vehicles failed to yield to a non-motorist after coming to a stop. This suggests targeted right-turn on red restrictions may be appropriate.

- Left turning movements accounted for 23 percent of non-motorist crashes[2]. Hotspots included Crabbs Branch Way & Redland Road, Redland Road & Somerville Drive, MD 355 & King Farm Boulevard/King Farm Boulevard Extended, and MD 355 and Redland Road.

- Based on the crash records, it appears that reassessing the necessity of permissive lefts could improve safety for non-motorists at the locations listed above.

- 48 percent of crashes resulting in a severe or fatality injury resulted from a left-turn movement. Hotspots included MD 355 & King Farm Boulevard/King Farm Boulevard Extended, Shady Grove Road & Oakmont Avenue, Shady Grove Road & Epsilon Avenue

- Excessive speeds contributed to both non-motorist and severe and fatal crashes on segments of MD 355, Shady Grove Road, Crabbs Branch Way, Redland Road, and Gude Drive.

iii. Prioritized List of Vision Zero Improvements

Staff used the walkshop feedback, spot speed studies, crash analysis, and a qualitative review of the Plan area to develop a package of Vision Zero Improvements that could benefit the Plan Area. These improvements are rated as “high,” “medium,” and “low” priority based on professional judgement and ease of implementation. Table 9 describe these improvements below. Some of the proposed improvements could have the potential to impact vehicular capacity and were modeled in Synchro using existing volumes to assess impacts in the event the package of improvements were to be made in the near-term.

[2] Percentage is based on total number of records provided by MCPD, supplemented by geospatial data.

Table 9 – Prioritized List of Vision Zero Improvements

Location	Description	Priority	Within Current High-Injury Network	Capacity Impacts Modeled?
MD 355 through the Extent of the Plan Area	Provide a buffer between the sidewalk and the cartway of no less than 5' (ideally 6' for tree panels); where landscape panels cannot be accommodated, provide vertical separation (e.g. jersey barrier; sidewalk, etc.) Ideally, proposals for vertical separation should integrate well with the character of the urban environment.	High	Yes	No
MD 355 & King Farm Boulevard/King Farm Boulevard Extended	Implement a Leading Pedestrian Interval for the north and south intersection legs.	High	Yes	Yes
MD 355 & King Farm Boulevard/King Farm Boulevard Extended	Add pedestrian recall for phases across MD 355 for the morning peak, lunch hour, and evening peak hour.	High	Yes	Yes
MD 355 & King Farm Boulevard/King Farm Boulevard Extended	Remove protected/permissive program and potentially increase the left turn phases to accommodate turning traffic during the morning peak hour; if protected/permissive phasing is to be retained, convert the green ball into flashing yellow arrow and add "YIELD TO PEDESTRIAN" signage.	High	Yes	Yes
MD 355 & King Farm Boulevard/King Farm Boulevard Extended	Add right turn on red restrictions at all intersection legs.	High	Yes	Yes
MD 355 & King Farm Boulevard/King Farm Boulevard Extended	Tighten the curb radius on southern leg of the intersection and straighten the crosswalk. Extend the median beyond the crosswalk (i.e. provide a median nose).	Medium	Yes	No

Location	Description	Priority	Within Current High-Injury Network	Capacity Impacts Modeled?
MD 355 & King Farm Boulevard/King Farm Boulevard Extended	Reconstruct curb ramps on northeast and southeast legs of intersection, locating them perpendicular to the curb. Pull back east-west crossing over MD-355, including stop bar to straighten crosswalk, and cut through the median, aligning with new curb ramps.	Medium	Yes	No
MD 355 & King Farm Boulevard/King Farm Boulevard Extended	Tighten curb radius on northern leg of intersection with concrete curb extension.	Medium	Yes	No
MD 355 & King Farm Boulevard/King Farm Boulevard Extended	Tighten curb radius on the southern leg in the intersection.	Medium	Yes	No
MD 355 & King Farm Boulevard/King Farm Boulevard Extended	Raise the grade of intersection, tabling it for pedestrian visibility and establishing it as main gateway into the Metro Station for both pedestrians and future transit.	Low	Yes	No
MD355 & Redland Road	Provide a Leading Pedestrian Interval for the north and south intersection legs.	High	Yes	Yes
MD355 & Redland Road	Add pedestrian recall for phases across MD 355 for morning peak, lunchtime, and evening peak hour crossings.	High	Yes	Yes
MD355 & Redland Road	Remove the protected/permissive program for all legs and potentially allow only protected lefts at all intersection legs; if permissive phasing is to be retained, convert to a flashing yellow arrow.	High	Yes	Yes

Location	Description	Priority	Within Current High-Injury Network	Capacity Impacts Modeled?
MD355 & Redland Road	Add right turn on red restrictions at all intersection legs.	High	Yes	Yes
MD355 & Redland Road	Provide median noses on MD 355 to tighten left turns. Consider mountable nose to avoid conflicts with large vehicles and trucks.	Medium	Yes	No
MD355 & Redland Road	Tighten the curb radius at the western leg of the intersection (Redland Road, King Farm Side) to slow right turns.	Medium	Yes	No
MD355 & Ridgemont Road/Transfer Facility Entrance	Add right turn on red restrictions primarily for east and west intersection legs; consider restrictions for all legs of intersection. At minimum, consider "Yield to Pedestrian Signage" if no restrictions are added.	High	Yes	Yes
MD355 & Ridgemont Road/Transfer Facility Entrance	Covert the green ball to a flashing yellow arrow for permissive lefts.	High	Yes	No
MD355 & Ridgemont Road/Transfer Facility Entrance	Add noses to all intersection legs (or markings) to slow turns.	Medium	Yes	No
MD 355 – Segment between Gude & Redland	Review curb cut permits along MD 355 for properties with multiple driveway points. Revoke permits where duplicative access points exist today.	High	Yes	No
MD 355 – Segment between Gude & Redland	Raise the grade of the sidewalk to provide a consistent flush surface across all driveway aprons. This will require reconstruction of driveway aprons.	Medium	Yes	No
Redland Road & Crabbs Branch Way	Revise the existing right turn on red restriction to be at all times; strongly consider adding right turn on red restrictions at all intersection legs. At minimum, consider "Yield to Pedestrian Signage" if no restriction times are not amended and added.	High	Yes	Yes
Redland Road & Crabbs Branch Way	Provide a flashing yellow arrow (rather than green ball) for all permissive movements.	High	Yes	No

Location	Description	Priority	Within Current High-Injury Network	Capacity Impacts Modeled?
Redland Road & Crabbs Branch Way	Add a vegetated center median extending through the southern intersection leg's crosswalk for pedestrian refuge on Crabbs Branch Way, to continue into center turn lane (see section in Plan); restripe NB Crabbs Branch Way lanes to be left only (1), through (1), and shared through right (1).	High	Yes	Yes
Redland Road & Crabbs Branch Way	Add a vegetated center median on northern leg of Crabbs Branch Way in the location of existing left turns to slow traffic and provide for pedestrian refuge. Restripe SB Crabbs Branch Way to become left only (1) and shared through-right (1) OR provide dynamic signage to be left only at certain periods of day and shared through-lefts at other periods.	High	Yes	Yes
Redland Road & Crabbs Branch Way	Provide an automatic speed enforcement camera in the SB direction on Crabbs Branch Way just south of the bridge. Consider a NB speed enforcement camera as well. Add safe speed corridor signage.	High	Yes	No
Redland Road & Somerville Drive	Add a Leading Pedestrian Interval for the north and south legs of the intersection.	High	No	Yes
Redland Road & Somerville Drive	Add pedestrian recall to all phases, at least during morning, lunch, and afternoon peak hours. Staff's data collection suggests that lunch hour shows the highest level of demand for pedestrians.	High	No	Yes
Redland Road & Somerville Drive	Provide "Left-Turn Yield to Pedestrians" signage; consider removal of permissive lefts if no LPI can be provided	Low	No	No
Redland Road & Somerville Drive	Provide curb extensions on the eastern leg (WB) of Somerville in the parking lanes, providing tighter turning radii. Convert WB leg into one-lane shared-through right.	Low	No	Yes
Shady Grove Road & Crabbs Branch Way	Add right turn on red restrictions at all legs, particularly emphasizing the NB approach (south leg of Crabbs Branch Way).	High	No	Yes

Location	Description	Priority	Within Current High-Injury Network	Capacity Impacts Modeled?
Shady Grove Road & Crabbs Branch Way	Provide a leading pedestrian interval on phases that facilitate crossing Shady Grove Road, particularly the western leg.	High	No	Yes, west crosswalk only
Shady Grove Road & Crabbs Branch Way	Add pedestrian recall to the mainline phases for morning peak, lunchtime, and evening peak hour crossings.	Medium	No	Yes
Shady Grove Road & Crabbs Branch Way	Facilitate a photometric study and determine whether lighting at the intersection and adjoining leg segments is sufficient.	Medium	No	No
Redland Road – Segment Between MD 355 & Yellowstone Way	Provide an automatic speed enforcement camera in the EB and WB sections of Redland Road. Add safe speed corridor signage. The camera should be placed in a manner that enforces speed compliance down the grade of Redland Road toward the Metro Station entrance.	High	No	No
Redland Road – Segment Between MD 355 & Yellowstone Way	Remove the NB sidewalk concrete between MD 355 and Somerville Drive and add 5' vegetated planting strip along Redland Road to create buffer between pedestrians and traffic.	Medium	No	No
Crabbs Branch Way – Segment between Redland Road a& Indianola Avenue	Convert the existing section of Crabbs Branch Way into a four lane section, replacing the turn lane with a center median (see section in Plan).	High	Yes	Yes
Crabbs Branch Way – Segment between Redland Road & Indianola Avenue	Consistent with Urban Road Code policy, reduce posted speeds from 35 miles per hour to 25 miles per hour and consider interventions to support the required speed limit.	High	Yes	Yes

Location	Description	Priority	Within Current High-Injury Network	Capacity Impacts Modeled?
Crabbs Branch Way – Segment between Redland Road & Indianola Avenue	Provide an automatic speed enforcement camera in the SB direction on Crabbs Branch Way just south of the bridge. Consider NB speed enforcement camera as well. Add safe speed corridor signage.	High	Yes	Yes
Crabbs Branch Way & Indianola Avenue	Increase the "all red" time at the intersection to prevent conflicts along segments with high speeds and poor compliance.	High	Yes	Yes
Crabbs Branch Way & Indianola Avenue	Install red light cameras at the intersection.	High	Yes	Yes
Crabbs Branch Way & Indianola Avenue	Reconstruct the curb ramps, providing two curb ramps at each intersection corner. The curb radii may need to be tightened to support two ramps at each corner.	Medium	Yes	No
Shady Grove Road - Segment between Crabbs Branch Way & Epsilon Drive	Lower the posted speed to 35 miles per hour; provide a section with more narrow lane widths to reduce speeds (see section in Plan).	High	Yes	Yes
Shady Grove Road - Segment between Crabbs Branch Way & Epsilon Drive	Provide an automatic speed enforcement camera in the SB direction on Crabbs Branch Way just south of the bridge. Consider NB speed enforcement camera as well. Add safe speed corridor signage.	High	Yes	Yes

Location	Description	Priority	Within Current High-Injury Network	Capacity Impacts Modeled?
I-370/Metro Access Road & Shady Grove Road Interchange	Remove the channelized rights to enter and exit the interchange along the southern side of the intersection to support a safe, continuous bicycle facility. Prohibit right turn on red from new turn pockets.	High	Yes	No
I-370/Metro Access Road & Shady Grove Road Interchange	Remove the channelization from the EB I-370 off ramp to Shady Grove Road (WB) as there is very limited merge space and more than enough throat in along the ramp to support queues.	Medium	Yes	No
Crabbs Branch Way/Cecil Street & Gude Drive	Implement right turn on red restrictions from Cecil onto Gude due to poor visibility and high pedestrian and bicyclist volumes over Carl Henn Millennium Trail. Remove existing shrub/vegetation impacting visibility.	Medium	No	Yes
Crabbs Branch Way/Cecil Street & Gude Drive	Pull the existing median on the east leg of the intersection (WB) through the crosswalk/provide median nose to serve as pedestrian refuge.	Medium	No	No
Crabbs Branch Way/Cecil Street & Gude Drive	Provide a median in location of painted division on the western intersection leg (EB) approach.	Medium	No	No
Shady Grove Road & Epsilon Drive/Tupelo Drive	Provide a Leading Pedestrian Interval over Shady Grove Road	High	No	No
Shady Grove Road & Epsilon Drive/Tupelo Drive	Pull the existing median through the crosswalk to provide location for pedestrian refuge, or provide median nose beyond the crosswalk.	High	No	No
Shady Grove Road & Briardale Road	Provide a Leading Pedestrian Interval for phases that facilitate crossings of Shady Grove Road.	High	No	No

Location	Description	Priority	Within Current High-Injury Network	Capacity Impacts Modeled?
MD 355 & WB I-370 WB On-Ramp	Provide a vertical element (e.g. flexiposts) in extent of the triangular striping between the on-ramp and roadway to slow traffic entering the ramp through the pedestrian crossing OR consider curb extension(s) to reduce the crossing distance and improve visibility of pedestrians crossing the ramp.	Medium	Yes	No

iv. Synchro Modeling Results for Vision Zero Improvements

Many of the improvements expected to impact capacity were modeled in Synchro. Because the County intends to eliminate severe injuries and fatalities by 2030, existing volumes were employed to see how these improvements would impact the Planning Area if they were to be immediately implemented. Table 10 shows the magnitude of impact on average vehicle delay.

Table 10 – Impact of Modeled Vision Zero Improvements on Existing Vehicular Capacity

		Existing Conditions (Synchro)		Existing Conditions Vision Zero Improvements (Synchro)	
Intersection	**Delay Standard**	**AM Delay (avg. sec/veh)**	**PM Delay (avg. sec/veh)**	**AM Delay (avg. sec/veh)**	**PM Delay (avg. sec/veh)**
MD 355 & Redland Road	120	35.6	53.3	63	109.1
MD 355 & Gude Drive	63	95.8	71	96	70.9
Crabbs Branch Way & Redland Road	120	47.6	45.9	106.3	76.9
Shady Grove Road & Oakmont Avenue	120	31.2	31.3	35.5	33.3
Crabbs Branch Way & Shady Grove Road	120	38.2	48.2	80.6	61.1
MD 355 & Shady Grove Road	120	64.6	92.3	65.7	97.3
Crabbs Branch Way & Indianola Drive	120	16.1	15.1	24.7	17.7
Crabbs Branch Way & Gude Drive	59	37.9	44.5	39.3	44.8
MD 355 & King Farm Boulevard	120	14.5	65.2	23.8	76.4
MD 355 & Ridgemont Avenue	120	6.6	11	6.9	11.4
MD 355 & Watkins Pond Boulevard/Indianola Drive	63	20.8	22.2	20.5	22.5

Table 10 Continued

		Existing Conditions (Synchro)		Existing Conditions Vision Zero Improvements (Synchro)	
Intersection	**Delay Standard**	**AM Delay (avg. sec/veh)**	**PM Delay (avg. sec/veh)**	**AM Delay (avg. sec/veh)**	**PM Delay (avg. sec/veh)**
Gaither Road & King Farm Boulevard	63	18.2	21.3	18.2	21.3
Gaither Road & Piccard Drive	63	7.1	7.7	7.1	7.7
Gude Drive & Watkins Pond Boulevard	63	6.7	6.9	6.7	6.9
Gude Drive & Gaither Road	63	13.2	16.3	13.2	16.3
Needwood Road & Redland Road	59	33.8	16.5	33.5	17.8
Shady Grove Road & Gaither Road	63	43.8	55.6	44.6	56.2
Redland Road & Shady Grove Metro	120	17.9	30.7	16	37.2
Redland Road & Somerville Drive	120	12.2	16.3	15.9	22.7

Table 10 demonstrates that, generally speaking, average intersection is delay is anticipated to increase with the additional on the modeled Vision Zero Improvements. This is because many of the suggested improvements reallocate the capacity of a given turning or through movement to an associated movement, increased walk time, or increased stop time. Vision Zero requires a higher tolerance for traffic congestion to achieve increased safety for all road users and to eliminate traffic related fatalities and severe injuries. Staff notes that these improvements were modeled using Synchro, which does not capture queuing and spillback.

2. Consolidated Information on the Corridor Cities Transitway and MD 355 BRT

A. Corridor Cities Transitway

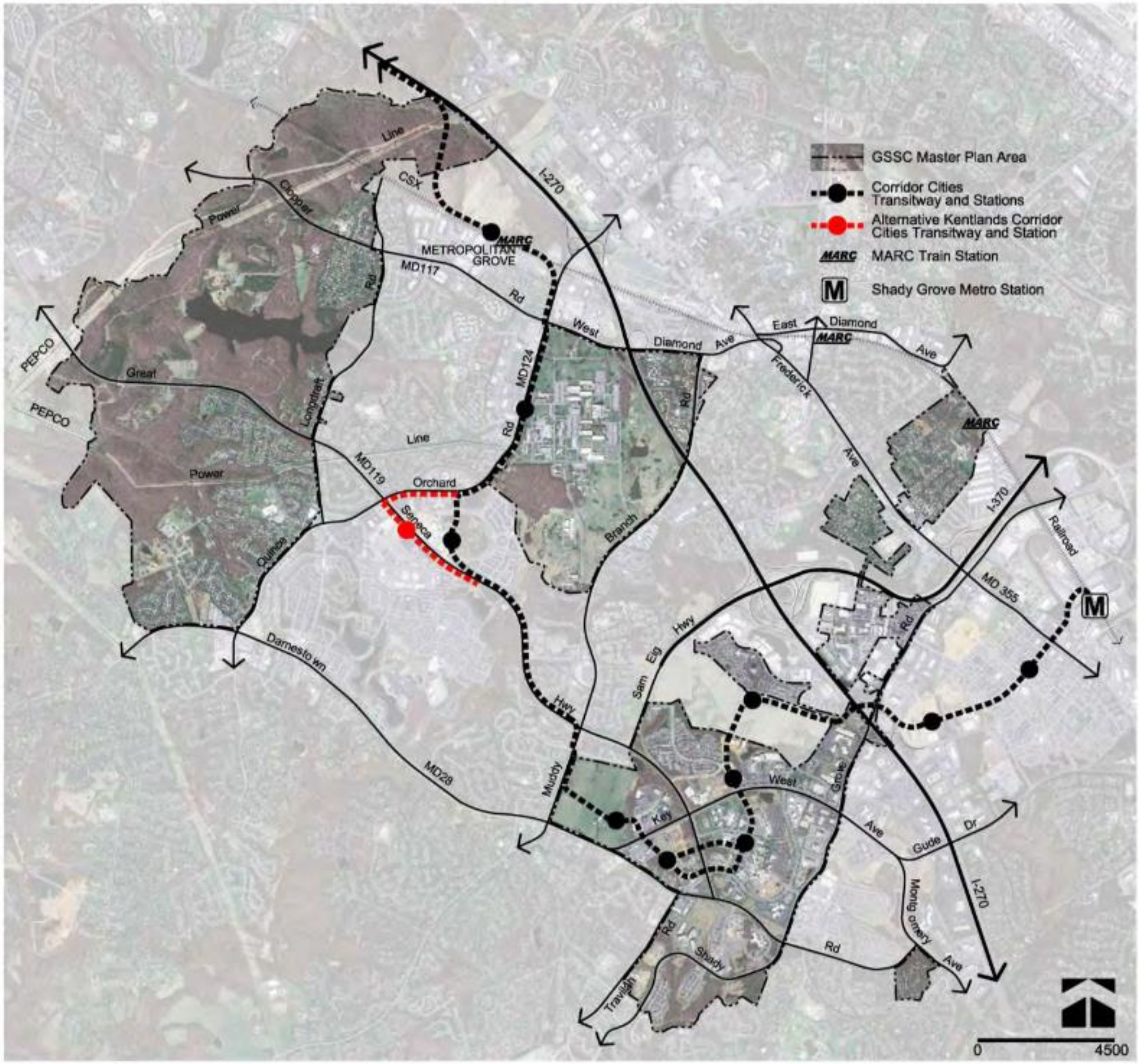
The Corridor Cities Transitway (CCT) is a transit guideway alignment, currently assumed to be bus service, which conceptually originated in 1970 when the Washington Metropolitan Area Transit Authority (WMATA) completed a sketch planning effort that assessed the potential alignment for transit service between Shady Grove and Metropolitan Grove. In 1990, the Maryland Department of Transportation identified significant transit demand in the corridor (*Statewide Commuter Assistance Study*) and Montgomery Planning completed a study of alternative alignments to serve demand (*I-270 Corridor Cities Transit Easement Study*). After years of study, the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) released a Draft Environmental Impact Statement (DEIS) for its *I-270/US 15 Multi-Modal Corridor Study*, which attempted to organize piecemeal transit planning and highway planning efforts in the corridor. In 2009, FHWA and FTA undertook an Alternatives Analysis and Environmental Assessment (AA/EA) to study additional alignments and options for both roadways and transit. While this effort addressed both modes, after the release of a supplemental AA/EA in 2010, in 2011 FHWA and FTA concluded that the CCT had "independent utility" from the studied roadway elements. This allowed studied highway and transit concepts to advance independently.

In 2010, the Planning Department's *Great Seneca Science Corridor* Plan was completed, setting in the place the mechanism to obtain land and easements to support the transitway. After additional study by the Maryland Department of Transportation Maryland Transit Authority (MTA) in 2011, the State announced the locally-preferred alignment and mode for the corridor in 2012 and officially split the route into two "phases"—a southern phase (phase 1) serving points within the Great Seneca Science Corridor between the Metropolitan Grove MARC Station and WMATA's Shady Grove Metrorail Station, and a northern phase (phase 2) serving points north to the COMSAT site just south of Clarksburg. The first phase, as documented in the *Great Seneca Science Corridor Master Plan*, is shown in Figure 18.

In 2017, the Maryland Transit Authority released another DEIS and 30 percent design drawings for phase 1 of the CCT. As of this writing, no additional funding commitments have been made to advance the $718 million project (in 2016 dollars). The 2017 DEIS projected that the bus line would facilitate 30,429 person trips per day. Service between Metropolitan Grove and the Shady Grove Metro Station would take roughly 42 minutes (excluding a loop through the Universities at Shady Grove) at 15-minute headways.

The *Shady Grove Sector Plan Minor Master Plan Amendment* supports the continued pursuit of the CCT to not only improve access to the Metro Station, but also improve access to employment centers points west for future residents of the Plan area. Transfer points should be located as close to the Shady Grove Metrorail Station as possible. Alternative alignments for the CCT may include considering alternative alignments for the CCT, will be further explored in *Corridor Forward*: *The I-270 Transit Plan.*

Figure 18 – Phase 1 of the Corridor Cities Transitway - *Great Seneca Sciences Corridor Master Plan*



The CCT's first phase will be from the Shady Grove Metro Station to the Metropolitan Grove MARC Station. The second phase would extend the line from Metropolitan Grove north to Germantown and Clarksburg. The CCT route and design will not only connect people and places, but its stations will be the focal point of new development in the Corridor.

B. MD 355 BRT

The Planning Board approved the *Countywide Transit Corridors Functional Master Plan* in 2013. This document recommends two BRT lines along MD 355 to provide service between Clarksburg and Bethesda. The northern and southern line meet at a transfer point in Rockville.

Beginning in 2015, the Montgomery County Department of Transportation (MCDOT) advanced the project through the creation of a Purpose and Need Statement and an assessment of Conceptual Alternatives. MCDOT initiated an Alternatives Analysis in 2018, which ran concurrently with *the Shady Grove Sector Plan Minor Master Plan Amendment's* planning process. At the time of this writing, an alternative has not been selected. As such, dedicated curb-running and median-running options were modeled during the master planning process. Initially, median-running options assumed two dedicated BRT lanes on MD 355; however, later scenarios were adjusted to assume one peak-hour BRT lane running through the Plan Area.

A draft of the Alternatives Analysis Summary Report was made available in October 2019. The study splits the corridor into seven different segments in order to develop conceptual sections. The segment running through the Plan area begins points south at College Parkway in Rockville and terminates points north at Summit Avenue in Gaithersburg. The three dedicated alternatives retained in the study are alternative "B," which includes two median running BRT lanes, "B Modified," which includes one median BRT lane that could be fixed or reversible through the plan area, and alternative "C," which provides two curb running lanes. Figure 19 and 20 below show alternatives "B Modified" and "C."

Figure 19 – Option B Modified, "Phase 2 Corridor Summary Report," October Draft

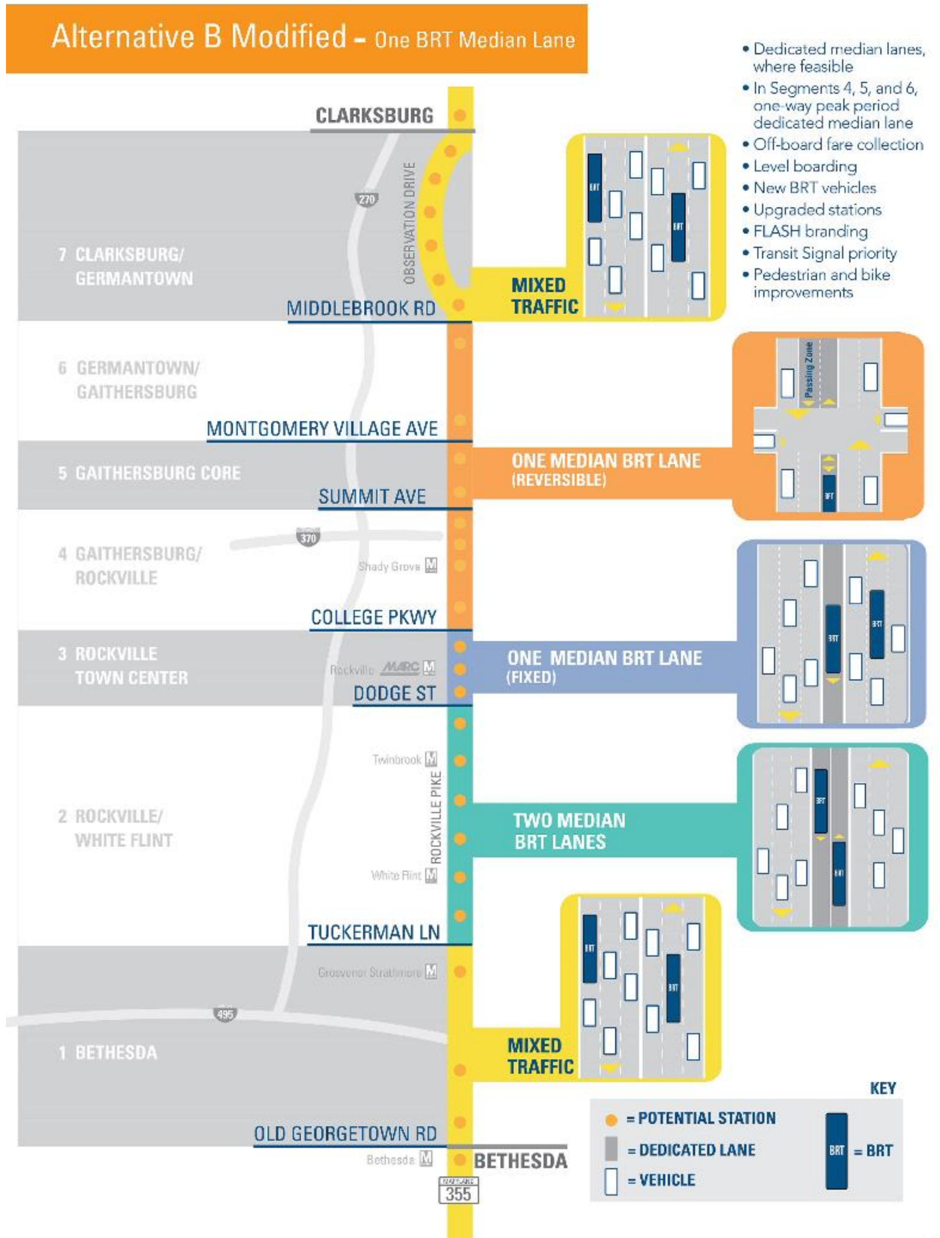
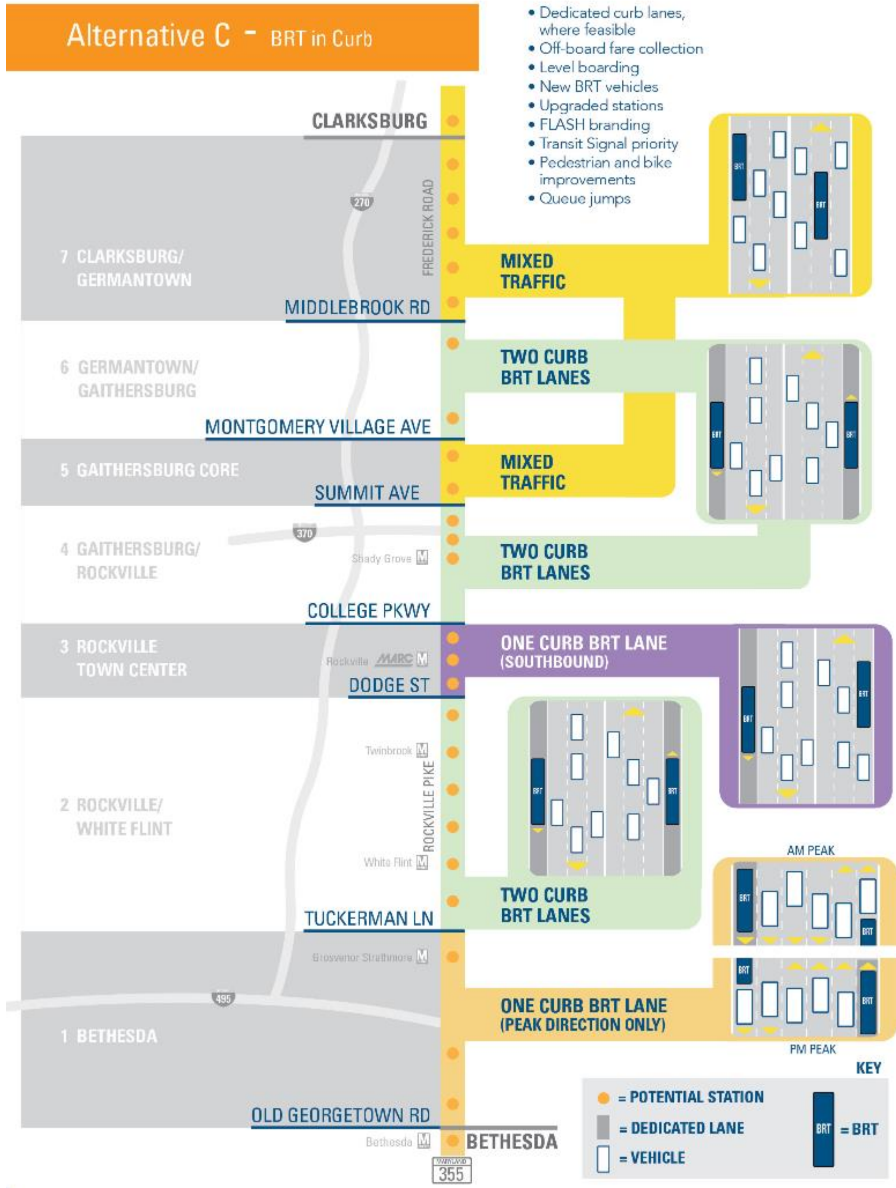


Figure 20 – Option C, "Phase 2 Corridor Summary Report," October Draft



The Planning Board reviewed a Mandatory Referral for the MD 355 BRT in July 2019, recommending median-running option B, which provides two dedicated lanes. Council subsequently reviewed the options but did not make a final determination on an alternative. While option "B Modified" has not officially been selected, at the time of this writing, this option appears to be highly advantageous given the operational performance and reliability benefits of a median-running system at lower capital and operating costs when compared to alternative "B," which provides two dedicated lanes. Option "B Modified" is estimated to cost $820 million to construct and $4.43 cents per rider to operate annually.[3] Table 11 summarizes various measures of effectiveness across the four studied alternatives. Because option "B Modified" was not initially modeled by MCDOT, outputs for Alternative "B" and "B Modified" are reported together.

[3]Montgomery County Department of Transportation, "Phase 2 Corridor Summary Report," October 2019 Draft.

The *Shady Grove Sector Plan Minor Master Plan Amendment* recommends that the MD 355 BRT interface with WMATA's Shady Grove Metrorail Station to the closest extent possible; however, recognizes that it may be difficult for the BRT to do this directly under current conditions. In current modeling runs, MCDOT assumes that the BRT will operate in mixed traffic with a station at Somerville Drive and Metro Access Loop Road. The *Shady Grove Sector Plan Minor Master Plan Amendment* proposes illustrative sections of Somerville Drive, Redland Road, and King Farm Boulevard Extended that allow the BRT to continue operating in a dedicated lane when leaving the MD 355 Corridor.

Table 11 – 2040 Ridership and Traffic Comparison, "Phase 2 Corridor Summary Report," October Draft

Comparison Factors	No-Build Alternative	TSM Alternative	Alternative A	Alternative B and B Modified	Alternative C
Total Daily Transit Boardings by Alternative	75,300	83,100	87,400	91,900	89,400
New transit riders along the corridor	0	4,400	8,900	9,400	8,900
Transit mode share along the corridor					
From Study Area	8.3%	8.4%	9.0%	9.0%	9.0%
To Study Area	6.6%	6.7%	7.3%	7.2%	7.2%
From Montgomery County	8.3%	8.3%	8.8%	8.7%	8.6%
Transit travel time between key origin-destination pairs					
Clarksburg to Shady Grove	50	56	62	50	46
Clarksburg to White Flint	90	90	77	79	61
Germantown to Shady Grove	44	42	40	33	35
Lakeforest to Rockville	43	43	38	29	31
Lakeforest to Bethesda	53	53	46	42	43
White Flint to Bethesda	30	26	23	21	23
Rockville to Bethesda	57	42	40	36	39
Transit travel time reliability along the corridor (Percent of BRT Vehicles Separated from Vehicle in Front of It by Between 7 and 13 Minutes at Cedar Avenue) – AM Peak Period					
FLASH 2: Lakeforest to Grosvenor Metrorail Station	N/A	N/A	100%	100%	100%
FLASH 1G: Germantown Transit Center to Montgomery College - Rockville Campus	N/A	N/A	83%	96%	81%
FLASH 1C: Clarksburg to Montgomery College - Rockville Campus	N/A	N/A	84%	82%	95%
Transit travel time reliability along the corridor (Percent of BRT Vehicles Separated from Vehicle in Front of It by Between 7 and 13 Minutes at Cedar Avenue) – PM Peak Period					
FLASH 2: Lakeforest to Grosvenor Metrorail Station	N/A	N/A	92%	87%	93%
FLASH 1G: Germantown Transit Center to Montgomery College - Rockville Campus	N/A	N/A	82%	94%	88%
FLASH 1C: Clarksburg to Montgomery College - Rockville Campus	N/A	N/A	64%	96%	83%
Peak Period (AM & PM) Weekday Person Throughput					
1 – Cedar Lane	32,800	32,700	33,100	31,800	32,500
2 – Twinbrook Parkway	32,300	32,500	33,500	33,700	33,400
3 - N. Washington Street	27,800	28,500	28,100	29,700	28,300
4 – Shady Grove Road	30,800	31,600	31,300	35,300	32,100
5 – Chestnut Street	27,200	27,900	27,900	31,700	28,700

Table 11 Continued – 2040 Ridership and Traffic Comparison, "Phase 2 Corridor Summary Report," October Draft (Continued)

Comparison Factors		No-Build Alternative	TSM Alternative	Alternative A	Alternative B and B Modified	Alternative C
6 – Watkins Mill Road		25,900	26,100	27,100	29,000	27,900
7 – Ridge Road		19,700	20,400	20,300	20,700	22,800
Number of jobs accessible by transit within 30, 45, and 60 minutes for households in the corridor	30 45 60	130,900 395,500 832,300	131,100 397,100 836,100	139,400 414,100 864,900	140,300 414,400 860,600	139,700 414,700 863,000
Number of activity centers accessible by transit within 30, 45, and 60 minutes for households in the corridor	30 45 60	5.7 17.4 38.5	5.7 17.4 38.7	6.4 18.1 38.6	6.5 18.2 38.3	6.4 18.2 38.6
Number of households that can reach jobs in the corridor by transit within 30, 45, and 60 minutes	30 45 60	98,400 260,800 547,800	94,400 261,100 549,400	98,400 268,900 562,000	99,900 269,300 560,100	98,900 267,700 559,700
Number of households that can reach activity centers in the corridor by transit within 30, 45 or 60 minutes	30 45 60	387,500 789,700 1,383,900	385,100 789,100 1,382,400	385,100 793,300 1,391,000	385,100 793,700 1,381,300	385,100 793,300 1,383,900
Number of households that have access to BRT stations within ½ mile network distance		20,100	26,600	27,000	27,100	26,600
Number of miles of LOS E or F along the corridor						
Northbound		2.6	2.7	2.7	3	3.2
Southbound		7.6	9.4	8.1	8.4	5.9
Average Person Travel Delay (in minutes) (AM/PM)		3.0/3.0	3.0/3.0	3.0/3.6	3.6/3.6	3.6/3.6
Number of Intersections Operating at LOS E or F in Segments 1 through 6 (AM/PM)		16/14	17/14	13/14	20/24	15/23

The Plan also supports the continued pursuit of an infill MD 355 BRT station at MD 355 and Indianola Avenue. MCDOT's June 2019 "Phase 2 Station Screening Report" notes that the station has siting location challenges due to existing roadway geometry and, at 450 daily projected riders, failed to meet the 500-rider threshold. Because the station was close to the 500-rider threshold, the station was retained as an option to reassess once service is operational. The *Shady Grove Sector Plan Minor Master Plan Amendment* supports improving connectivity to the retained potential infill station from points east by adding recommending a dedicated bicycle facility on Indianola Avenue.

3. Vehicle Modeling

Consistent with the existing Subdivision Staging Policy (SSP), staff undertook a capacity analysis to assess existing and potential future conditions in the Plan area. This process included:

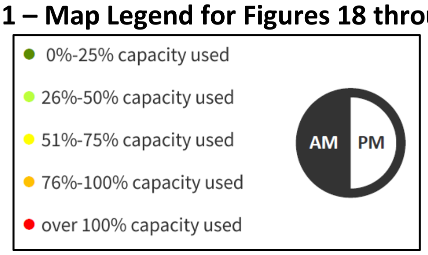
1) taking existing traffic counts at study intersections and modeling existing intersection capacity using operational software tools—in this case Synchro and VISSIM;
2) using the County's Travel Demand Model (Travel/4) to assess future network link demand based on projected land use;
3) using Travel Demand generated link volumes to generate future turning movement count assumptions, and;
4) using operational tools to compare projected future intersection capacity with existing conditions.

Modeling the Plan area proved to be relatively complex given the uncertainty of ongoing work of partner agencies. At the time of this writing, the Montgomery County Department of Transportation (MCDOT) is concurrently studying alignment options for the MD 355 Bus Rapid Transit (BRT) line, and no alignment has been chosen. As such, staff modeled Plan Area intersections along MD 355 using VISSIM, assuming both curb and median-running alignments. While the modeling process was underway, MCDOT developed a modified median-running option for one peak-hour BRT lane. Later stage modeling efforts were adjusted to account for MCDOT's progress.

The Maryland Department of Transportation's State Highway Administration (MDOT SHA) is currently studying options for managed lanes on I-270. These lanes and their potential access points will certainly impact volumes in the Plan Area; however, because the State's Draft Impact Environmental Statement (DEIS) was not available during modeling—and at the time of this writing, is still not available—network changes to the County's Travel/4 Travel Demand model were not made beyond what is available in the Metropolitan Washington Council of Government's (MWCOG) long-range travel network. The State may consider an access point at Gude Drive, which could potentially impact traffic conditions in the Plan Area. Consistent with MWCOG, the Travel/4 Model assumes two additional toll lanes in each direction on I-270. The travel demand analysis did not account for high-occupancy toll lanes on I-270, nor did it account for potential entry and exit points that do not exist today.

Table 12 provides an extensive modeling summary of the various scenarios examined during the planning process. Notes follow the summary to clarify the process. Table 13 summarizes the results of the capacity study, presenting delay in average seconds per vehicle. Table 14 reports intersection capacity as a percentage, where the numerator is the modeling output and the denominator is the relevant policy area threshold. Figures 22 through 36 depict the capacity of intersections as a percentage of intersection capacity utilized based on the relevant policy area threshold for vehicle delay. Figure 21 below provides a legend to read the capacity maps.

Figure 21 – Map Legend for Figures 18 through 32



A. Summary Table of 15 Scenarios and Assumptions

Table 12 – Summary Table

Scenario ID	Scenario Year and Build	Tools	Bus Rapid Transit (# dedicated lanes)	Travel Demand Run	Assumptions	Travel/4 Model: Transit Ridership Production (%)	Travel/4 Model: Transit Ridership Attraction (%)	Intersections above Existing Policy Area HCM Delay Standard
A	Existing Conditions	Synchro	None	1 & Field Counts	Existing signal phasing; TMCs from field counts	Metro Station Policy Area: 36.9 Sector Plan Boundary: 22.3	Metro Station Policy Area: 12.5 Sector Plan Boundary: 8.3	1. MD 355 & Gude Drive
B	Existing Conditions	VISSIM	None	1 & Field Counts	Existing signal phasing; TMCs from field counts	Metro Station Policy Area: 36.9 Sector Plan Boundary: 22.3	Metro Station Policy Area: 12.5 Sector Plan Boundary: 8.3	1. MD 355 & Gude Drive
C	2040 – 2006 Plan Buildout	Synchro	None	2	Existing signal phasing; TMCs projected via initial travel demand model runs	Metro Station Policy Area: 43.2 Sector Plan Boundary: 15.6	Metro Station Policy Area: 26.1 Sector Plan Boundary: 10.9	1. MD 355 & Gude Drive 2. MD 355 & Shady Grove Road 3. Crabbs Branch Way & Gude Drive
D	2040 – 2006 Sector Plan Buildout	VISSIM	Curb Running (2 lanes)	2	BRT phasing taken from State models, which assumed 2 dedicated lanes; TMCs projected via initial travel demand model runs' link loads	Metro Station Policy Area: 43.2 Sector Plan Boundary: 15.6	Metro Station Policy Area: 26.1 Sector Plan Boundary: 10.9	1. MD 355 & Redland Road 2. MD 355 & Gude Drive 3. MD 355 & Shady Grove Road 4. MD 355 & Watkins Pond/Indianola Drive
E	2040 – 2006 Sector Plan Buildout	VISSIM	Median Running (2 lanes)	2	BRT phasing taken from State models, which assumed 2 dedicated lanes; TMCs projected via initial travel demand model runs' link loads	Metro Station Policy Area: 43.2 Sector Plan Boundary: 15.6	Metro Station Policy Area: 26.1 Sector Plan Boundary: 10.9	1. MD 355 & Redland Road 2. MD 355 & Gude Drive 3. MD 355 & Shady Grove Road 4. MD 355 & Ridgemont Road 5. MD 355 & Watkins Pond/Indianola Drive
F	2040 – Proposed Amendment Buildout	Synchro	None	3	Existing signal phasing; TMCs projected via initial travel demand model runs' link loads	Metro Station Policy Area: 43.4 Sector Plan Boundary: 27.3	Metro Station Policy Area: 14.1 Sector Plan Boundary: 10.6	1. MD 355 & Gude Drive 2. Crabbs Branch Way & Shady Grove Road 3. MD 355 & Shady Grove Road
G	2040 – Proposed Amendment Buildout	VISSIM	Curb Running	3	BRT phasing taken from State models, which assumed 2 dedicated lanes; TMCs projected via initial travel demand model runs' link loads	Metro Station Policy Area: 43.4 Sector Plan Boundary: 27.3	Metro Station Policy Area: 14.1 Sector Plan Boundary: 10.6	1. MD 355 & Redland Road 2. MD 355 & Gude Drive 3. MD 355 & Shady Grove Road 4. MD 355 & Ridgemont Avenue 5. MD 355 & Watkins Pond/Indianola Drive
H	2040 – Proposed Amendment Buildout	VISSIM	Median Running (2 lanes)	3	BRT phasing taken from State models, which assumed 2 lanes; TMCs projected via initial travel demand model runs' link loads	Metro Station Policy Area: 43.4 Sector Plan Boundary: 27.3	Metro Station Policy Area: 14.1 Sector Plan Boundary: 10.6	1. MD 355 & Redland Road 2. MD 355 & Gude Drive 3. MD 355 & Shady Grove Road 4. MD 355 & Ridgemont Avenue 5. MD 355 & Watkins Pond/Indianola Drive
I	2040 – Proposed Amendment Buildout with Revised Assumptions	Synchro	None	5	Existing signal phasing; TMCs projected via second round travel demand model runs' link loads	Metro Station Policy Area: 50 Sector Plan Boundary: 35	Metro Station Policy Area: 50 Sector Plan Boundary: 35	1. MD 355 & Gude Drive 2. MD 355 & Shady Grove Road 3. MD 355 & King Farm Boulevard

J	2040 – Proposed Amendment Buildout with Revised Assumptions	VISSIM	Curb Running (2 lanes)	5	BRT phasing revised to account for 2 dedicated BRT lanes; TMCs projected via second round travel demand model runs' link loads	Metro Station Policy Area: 50 Sector Plan Boundary: 35	Metro Station Policy Area: 50 Sector Plan Boundary: 35	1. MD 355 & Gude Drive 2. MD 355 & Shady Grove Road 3. MD 355 & King Farm Boulevard 4. MD 355 & Ridgemont Avenue 5. MD 355 & Watkins Pond/Indianola Drive
Scenario ID	**Scenario Year and Build**	**Tools**	**Bus Rapid Transit (# dedicated lanes)**	**Travel Demand Run**	**Assumptions**	**Travel/4 Model: Transit Ridership Production (%)**	**Travel/4 Model: Transit Ridership Attraction (%)**	1. **Intersections above Existing Policy Area HCM Delay Standard**
K	2040 – Proposed Amendment Buildout with Revised Assumptions	VISSIM	Median Running (1 peak hour lane)	5	BRT phasing revised to account for only one peak-hour dedicated BRT lane; TMCs projected via second round travel demand model runs' link loads	Metro Station Policy Area: 50 Sector Plan Boundary: 35	Metro Station Policy Area: 50 Sector Plan Boundary: 35	2. MD 355 & Gude Drive 3. MD 355 & Shady Grove Road 4. MD 355 & King Farm Boulevard 5. MD 355 & Ridgemont Avenue 6. MD 355 & Watkins Pond/Indianola Drive
L	2040 – Proposed Amendment Buildout with Revised Assumptions, Mitigated	Synchro	None	5	Existing signal phasing with generic system-wide optimization (i.e. split and offset improvements) for mitigation; TMCs projected via second round travel demand model runs.	Metro Station Policy Area: 50 Sector Plan Boundary: 35	Metro Station Policy Area: 50 Sector Plan Boundary: 35	None, assumes MD 355 & Gude Drive delay threshold is increased to 80 seconds
M	2040 – Proposed Amendment Buildout with Revised Assumptions, Mitigated	VISSIM	Curb Running (2 lanes)	5	BRT phasing revised to account for two dedicated BRT lanes & generic system-wide optimization (i.e. split and offset improvements) for mitigation; TMCs projected via second round travel demand model runs.	Metro Station Policy Area: 50 Sector Plan Boundary: 35	Metro Station Policy Area: 50 Sector Plan Boundary: 35	1. MD 355 & Gude Drive 2. MD 355 & Shady Grove Road 3. MD 355 & Ridgemont Avenue
N	2040 – Proposed Amendment Buildout with Revised Assumptions, Mitigated	VISSIM	Median Running (1 peak hour lane)	5	BRT phasing revised to account for two dedicated BRT lanes & generic system-wide optimization (i.e. split and offset improvements) for mitigation; TMCs projected via second round travel demand model runs.	Metro Station Policy Area: 50 Sector Plan Boundary: 35	Metro Station Policy Area: 50 Sector Plan Boundary: 35	1. MD 355 & Gude Drive 2. MD 355 & Shady Grove Road 3. MD 355 & Ridgemont Avenue
O	Existing Conditions – Vision Zero Mitigations	Synchro	None	1 & Field Counts	Existing signal phasing; TMCs from field counts	Metro Station Policy Area: 36.9 Sector Plan Boundary: 22.3	Metro Station Policy Area: 12.5 Sector Plan Boundary: 8.3	PENDING

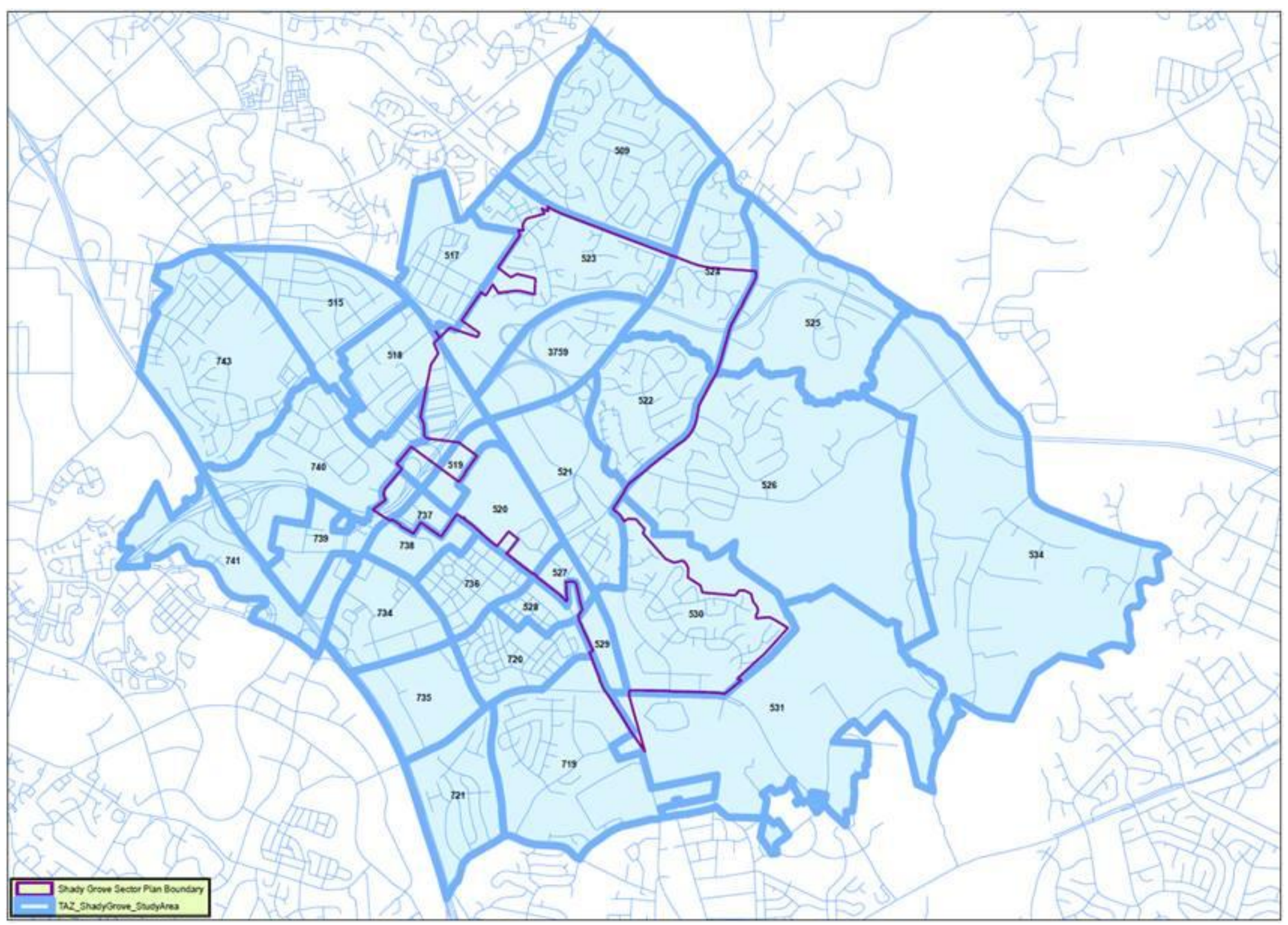
Bus Rapid Transit Notes

- Bus Rapid Transit operations were considered on the VISSIM-based networks only, and only the study intersections impacted by BRT were assessed. These include:
    - MD 355 & Redland Road
    - MD 355 & Gude Drive
    - MD 355 & Shady Grove Road
    - MD 355 & King Farm Boulevard
    - MD 355 & Ridgemont Avenue
    - MD 355 & Watkins Pond Boulevard/Indianola Drive
    - Gaither Road & King Farm Boulevard
- BRT phasing and geometric needs were not accounted for in the Synchro models. It should be noted that Synchro's delay calculation is generally consistent with the equations provided by the Institute of Highway Engineer's *Highway Capacity Manual* (HCM). Per the County's Subdivision Staging Policy (SSP), average intersection delay per HCM is used to determine whether an intersection is operating acceptably. VISSIM differs from the equation-based ("deterministic") Synchro system insofar as VISSIM in a stochastic simulation tool. In other words, VISSIM uses a random probability distribution to send anticipated volumes of drivers, pedestrians, and bicyclists through a network. VISSIM is better able to assess how modes impact one another and can better assess spillback impacts along a progression stream.
- All curb lane scenarios assume two dedicated lanes.
- Because the *Shady Grove Minor Master Plan Amendment* modeling process was running concurrently with the MD 355 BRT Alternatives Analysis run by the Montgomery County Department of Transportation (MCDOT), assumptions were refined for scenarios K and N to best reflect perceived alignments from MCDOT's alternatives analysis. Original scenarios D, E, G, and H assume 2 dedicated lanes for BRT operations, and signal programming subsequently accommodated the additional phase required for 2 dedicated lanes. Scenarios K and N for median-running transit were amended to best match Alternative B Modified, which includes one peak-hour BRT lane along segment 4 of the MD 355 BRT study area.

Travel Demand Run Notes

- To forecast travel, the Plan employed the Department's "Travel/4" model. This model is a stick-based network and is Montgomery County specific (i.e. differs from Council of Government's Regional Travel Demand Model, used for the MD 355 Bus Rapid Transit Study); the Travel/4 model includes some local links and has finer-grained TAZs.
- For the Shady Grove Plan, Travel/4 land use inputs for the White Flint 2 and Rock Spring planning areas were updated to account for recent approvals; "existing" scenario land use inputs were updated to reflect what exists on the ground today; future land use inputs reflect assumed growth within these plan areas expected for 2040, as consistent with the assumptions of previous plan approvals.
- The model assumes all Bus Rapid Transit Lines within the Constrained Long-Range Plan (CLRP) exist by 2040, including:

  - Veirs Mill Transitway
  - MD 355 Transitway (north and south segments)
  - North Bethesda Transitway
  - Randolph Road Transitway
  - US 29 Transitway
  - MD 650 Transitway
- Five rounds of travel demand modeling were run, as shown below:
  - 1 - 2016 Existing
  - 2 - 2040 -2006 Plan Build Out
  - 3 – 2040 Proposed Amendment Build Out
  - 4 – 2040 Proposed Amendment Build Out with Revised Speeds
  - 5 – 2040 Proposed Amendment Build Out with Revised Speeds & Non-Auto Driver Mode Share Goals
- The fourth and fifth round of travel demand modeling included the following updates to the Travel/4 Cube network:
  - Change to free flow speed on Shady Grove Road from 50 miles per hour to 35 miles per hour between Crabbs Branch Way and Midcounty Highway (Free Flow Speed West of Crabbs Branch Way was already 35 miles per hour in network).
  - Change to free flow speed on Crabbs Branch Way between Shady Grove Road and Indianola Drive from 35 miles per hour to 25 miles per hour, consistent with Vision Zero Principles and the Geographic Location (Urban Road Code)
  - Amendments to Travel/4's origin destination matrix to account for Non-Auto Driver Mode Share (NAMDS) goals:
    - 50 percent non-auto HBW trips for residents commuting from Metro Station Policy Area to elsewhere in the region;
    - 25 percent non-auto HBW trips for residents commuting from Sector Plan Area (excluding the Metro Station Policy Area) to elsewhere in the region; and
    - 12.5 percent non-auto HBW trips for employees commuting to the Sector Plan Area from elsewhere in the region.
- The fourth round of Travel/4 did not feed into any of the delay analyses.
- The Travel/4 Model assumes 2 additional toll lanes in each direction on I-270, as consistent with COG's latest network (at the time of this writing, version 2.3.75a). The travel demand analysis did not account specifically for high-occupancy toll lanes on I-270. Additionally, the forecast (nor the delay model networks) account for potential entry and exit points that do not exist today.
- Turning Movement Counts (TMCs) for the 2040 scenarios were developed using percentage splits based on adjacent 2040 load links, existing turning movement counts, and professional judgement.
- The TAZs for Travel Demand modeling can be found below in addition to more detailed information regarding Plan Area NADMS outputs/inputs from the modeling.



Production NADMS from Travel/4

	NADMS (%) Transit Ridership		
	MetroStation Policy Area	Sector Plan Boundary	Sector Plan Boundary - Policy Area
2016 Ext	36.9	25.5	22.3
2040 NB	43.2	29.9	26.1
2040Alt1	43.4	41.3	27.3
2040Alt1_RE _NADMS	50.0	N/A	35.0
Used TAZs	519, 520, 521, 527, 737	518-524, 527, 529-530, 737, 3759	518,522-524,529 530,3759
	5 TAZs	12 TAZs	7 TAZs

HBW trips commuting from

Attraction NADMS from Travel/4

	NADMS (%) Transit Ridership		
	MetroStation Policy Area	Sector Plan Boundary	Sector Plan Boundary - Policy Area
2016 Ext	12.5	9.1	8.3
2040 NB	15.6	11.9	10.9
2040Alt1	14.1	14.0	10.6
2040Alt1_RE _NADMS	25.0	N/A	25.0
Used TAZs	519, 520, 521, 527, 737	518-524, 527, 529-530, 737, 3759	518,522-524,529 530,3759
	5 TAZs	12 TAZs	7 TAZs

HBW trips commuting into

Mitigation Scenarios

- Scenarios L and M assume the following mitigations:

  MD 355 and Gude
  - Increase the delay threshold at MD 355 and Gude Drive to 80 seconds;
  - Convert the free southbound right turn lane into a shared through-right lane; add a southbound receiving lane on MD 355 to accommodate the additional through lane;
  - Create a channelized eastbound right turn lane; accommodate the free-right with additional merge lane on the southbound southern leg; and
  - Create a channelized westbound right turn lane; accommodate the free-right with additional merge space on the northbound northern leg

  MD 355 and Shady Grove Road
  - Remove the split phasing on Shady Grove Road and MD 355
  - Convert eastbound Shady Grove Road lane configuration to two exclusive lefts; four through lanes, and two exclusive right-turn lanes (remove dynamic right, which changes the lane movement restrictions during peak hours)
  - Convert the westbound Shady Grove Road lane configuration to two exclusive left-turn lanes and four through lanes; maintain the channelized right

  MD 355 and King Farm Boulevard
  - Add new EB turn lane on King Farm Boulevard, either within the median, or by adding a right-turn pocket and shifting the left and through lanes south

- Scenario N includes the mitigations listed in the bullet point above (scenarios L and M) AND the addition of a NB right-turn pocket on MD 355 at Redland Road.

B. Outputs by Study Intersection, Scenarios A-O

Table 13 – Capacity Analysis: Delay (average sec/veh)

			A. Existing Conditions (Synchro)		B. Existing Conditions (VISSIM)		C. 2040 2006 Plan Build Out (Synchro)		D. 2040 2006 Build Out (VISSIM Curb Running)		E. 2040 2006 Plan Build Out (VISSIM Center Running)		F. 2040 Alternative 1 (Synchro Only)		G. 2040 Alternative 1 (VISSIM Curb Running		H. 2040 Alternative 1 (VISSIM Center Running)		I. 2040 Alternative 1 (Synchro Revised Volumes)		J. 2040 Alternative 1 (VISSIM Revised Volumes Curb Running)		K. 2040 Alternative 1 (VISSIM Revised Volumes Center Running)		L. 2040 Alternative 1 (Synchro Revised Volumes Mitigated)		M. 2040 Alternative 1 (VISSIM Revised Volumes Mitigated Curb Running)		N. 2040 Alternative 1 (VISSIM Revised Volumes Mitigated Center Running)		O. Existing Conditions Vision Zero Imprvmts.	
Location	**VISSIM Used?**	**Area Std.**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**
MD 355 & Redland Road	YES	120	35.6	53.3	47.2	51.6	71	109.7	61.8	149.4	88.9	184.1	81.2	114.2	82	133.2	96.4	140.8	106.1	107.1	100.1	76	107.3	140.9	106	106	95.7	84.1	99.1	105.9	63	109.1
MD 355 & Gude Drive	YES	63	95.8	71	86.3	71	116.2	114	149.9	179	113.6	320.5	132.4	116.5	143	194.7	117.1	305.2	129	112.3	144.9	160.4	118.4	171.2	56.6	77.5	55.1	155.5	61	131.7	96	70.9
Crabbs Branch Way & Redland Road	NO	120	47.6	45.9	null	null	66.8	63.6	null	null	null	null	66.8	94	null	null	null	null	41.1	49.8	null	null	null	null	41.1	49.8	null	null	null	null	106.3	76.9
Shady Grove Road & Oakmont Avenue	NO	120	31.2	31.3	null	null	37.3	31.1	null	null	null	null	39.1	32.9	null	null	null	null	35	24.5	null	null	null	null	35.1	28.1	null	null	null	null	35.5	33.3
Crabbs Branch Way & Shady Grove Road	NO	120	38.2	48.2	null	null	44.4	118.1	null	null	null	null	60.1	161.8	null	null	null	null	45.3	53.7	null	null	null	null	41.9	66.8	null	null	null	null	80.6	61.1
MD 355 & Shady Grove Road	YES	120	64.6	92.3	46.8	41.1	88.5	128.4	205.8	107.1	222.4	117	91.3	150.5	238.8	176.7	219.6	244.2	87	139.5	240.3	52.8	202.2	74.3	78.5	58.6	223.6	76.4	236.2	76.9	65.7	97.3
Crabbs Branch Way & Indianola Drive	NO	120	16.1	15.1	null	null	22.3	14.9	null	null	null	null	29.4	13.8	null	null	null	null	10.3	9.1	null	null	null	null	10.3	9.1	null	null	null	null	24.7	17.7
Crabbs Branch Way & Gude Drive	NO	59	37.9	44.5	null	null	40.7	60	null	null	null	null	36.5	53.3	null	null	null	null	35.8	50.6	null	null	null	null	35.8	50.6	null	null	null	null	39.3	44.8
MD 355 & King Farm Boulevard	YES	120	14.5	65.2	34.9	20.5	13.3	49	60.3	99.7	83.9	119	21.3	116.8	87.8	91.7	88.7	97.1	187.9	118.3	144.3	40.3	137.2	41.2	50.9	63.2	114	43	102.3	46.4	23.8	76.4
MD 355 & Ridgemont Avenue	YES	120	6.6	11	16	5.4	8.9	21.9	98.1	110.7	143.9	117.7	10.3	23.1	136.5	142.8	142.5	160.1	10.9	24	127.1	11.5	125.2	15.4	9.9	24.4	124.5	10	121	14.8	6.9	11.4
MD 355 & Indianola Drive	YES	63	20.8	22.2	26.7	13.9	21.1	25.7	73.1	167.8	118.2	232.7	24.1	26.1	132.4	140.8	138.1	129.8	17	11.5	73	21.5	90.3	53.2	18.6	13.1	20.4	24	30.9	25.7	20.5	22.5
Gaither Road & King Farm Boulevard	YES	63	18.2	21.3	12.8	15.2	16.2	19.7	11.4	12.6	11.1	12.2	16.7	19.5	11.2	11.8	10.8	12.3	17.9	19.3	11.2	13.3	11.6	13	17.9	19.3	11	13.1	11.2	13.7	18.2	21.3
Gaither Road & Piccard Drive	NO	63	7.1	7.7	null	null	8.3	9.5	null	null	null	null	8.3	9.8	null	null	null	null	8.6	10	null	null	null	null	8.6	10	null	null	null	null	7.1	7.7
Gude Drive & Watkins Pond Blvd.	NO	63	6.7	6.9	null	null	8.3	7.7	null	null	null	null	8.4	7.5	null	null	null	null	8	7.6	null	null	null	null	8	7.6	null	null	null	null	6.7	6.9
Gude Drive & Gaither Road	NO	63	13.2	16.3	null	null	16.3	20.4	null	null	null	null	16.2	20.7	null	null	null	null	16.4	22.4	null	null	null	null	16.4	22.4	null	null	null	null	13.2	16.3
Needwood Road & Redland Road	NO	59	33.8	16.5	null	null	34.3	18.5	null	null	null	null	38	23.5	null	null	null	null	38.5	22.7	null	null	null	null	38.5	22.7	null	null	null	null	33.5	17.8
Shady Grove Road & Gaither Road	NO	63	43.8	55.6	null	null	52.7	52.8	null	null	null	null	55.6	54.1	null	null	null	null	62.9	53.9	null	null	null	null	60	53.9	null	null	null	null	44.6	56.2
Redland Road & Shady Grove Metro	NO	120	17.9	30.7	null	null	23.2	27.9	null	null	null	null	25.9	35.4	null	null	null	null	43.5	32.6	null	null	null	null	43.4	32.6	null	null	null	null	16	37.2
Redland Road & Somerville Drive	NO	120	12.2	16.3	null	null	11.2	17	null	null	null	null	21.9	67.8	null	null	null	null	21.1	65.2	null	null	null	null	21.2	65.2	null	null	null	null	15.9	22.7

Table 14 – Capacity Analysis: Average Intersection Delay as a Percentage of Policy Area Threshold

			A. Existing Conditions (Synchro)		B. Existing Conditions (VISSIM)		C. 2040 2006 Plan Build Out (Synchro)		D. 2040 2006 Build Out (VISSIM Curb Running)		E. 2040 2006 Plan Build Out (VISSIM Center Running)		F. 2040 Alternative 1 (Synchro Only)		G. 2040 Alternative 1 (VISSIM Curb Running		H. 2040 Alternative 1 (VISSIM Center Running)		I. 2040 Alternative 1 (Synchro Revised Volumes)		J. 2040 Alternative 1 (VISSIM Revised Volumes Curb Running)		K. 2040 Alternative 1 (VISSIM Revised Volumes Center Running)		L. 2040 Alternative 1 (Synchro Revised Volumes Mitigated)		M. 2040 Alternative 1 (VISSIM Revised Volumes Mitigated Curb Running)		N. 2040 Alternative 1 (VISSIM Revised Volumes Mitigated Center Running)		O. Existing Conditions Vision Zero Imprvmts.	
Location	**VISSIM Used?**	**Area Std.**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**	**AM Delay**	**PM Delay**
MD 355 & Redland Road	YES	120	30%	44%	39%	43%	59%	91%	52%	125%	74%	153%	68%	95%	68%	111%	80%	117%	88%	89%	83%	63%	89%	117%	88%	88%	80%	70%	83%	88%	53%	91%
MD 355 & Gude Drive	YES	63	152%	113%	137%	113%	184%	181%	238%	284%	180%	509%	210%	185%	227%	309%	186%	484%	205%	178%	230%	255%	188%	272%	90%	123%	87%	247%	97%	209%	152%	113%
Crabbs Branch Way & Redland Road	NO	120	40%	38%	null	null	56%	53%	null	null	null	null	56%	78%	null	null	null	null	34%	42%	null	null	null	null	34%	42%	null	null	null	null	89%	64%
Shady Grove Road & Oakmont Avenue	NO	120	26%	26%	null	null	31%	26%	null	null	null	null	33%	27%	null	null	null	null	29%	20%	null	null	null	null	29%	23%	null	null	null	null	30%	28%
Crabbs Branch Way & Shady Grove Road	NO	120	32%	40%	null	null	37%	98%	null	null	null	null	50%	135%	null	null	null	null	38%	45%	null	null	null	null	35%	56%	null	null	null	null	67%	51%
MD 355 & Shady Grove Road	YES	120	54%	77%	39%	34%	74%	107%	172%	89%	185%	98%	76%	125%	199%	147%	183%	204%	73%	116%	200%	44%	169%	62%	65%	49%	186%	64%	197%	64%	55%	81%
Crabbs Branch Way & Indianola Drive	NO	120	13%	13%	null	null	19%	12%	null	null	null	null	25%	12%	null	null	null	null	9%	8%	null	null	null	null	9%	8%	null	null	null	null	21%	15%
Crabbs Branch Way & Gude Drive	NO	59	64%	75%	null	null	69%	102%	null	null	null	null	62%	90%	null	null	null	null	61%	86%	null	null	null	null	61%	86%	null	null	null	null	67%	76%
MD 355 & King Farm Boulevard	YES	120	12%	54%	29%	17%	11%	41%	50%	83%	70%	99%	18%	97%	73%	76%	74%	81%	157%	99%	120%	34%	114%	34%	42%	53%	95%	36%	85%	39%	20%	64%
MD 355 & Ridgemont Avenue	YES	120	6%	9%	13%	5%	7%	18%	82%	92%	120%	98%	9%	19%	114%	119%	119%	133%	9%	20%	106%	10%	104%	13%	8%	20%	104%	8%	101%	12%	6%	10%
MD 355 & Indianola Drive	YES	63	33%	35%	42%	22%	33%	41%	116%	266%	188%	369%	38%	41%	210%	223%	219%	206%	27%	18%	116%	34%	143%	84%	30%	21%	32%	38%	49%	41%	33%	36%
Gaither Road & King Farm Boulevard	YES	63	29%	34%	20%	24%	26%	31%	18%	20%	18%	19%	27%	31%	18%	19%	17%	20%	28%	31%	18%	21%	18%	21%	28%	31%	17%	21%	18%	22%	29%	34%
Gaither Road & Piccard Drive	NO	63	11%	12%	null	null	13%	15%	null	null	null	null	13%	16%	null	null	null	null	14%	16%	null	null	null	null	14%	16%	null	null	null	null	11%	12%
Gude Drive & Watkins Pond Blvd.	NO	63	11%	11%	null	null	13%	12%	null	null	null	null	13%	12%	null	null	null	null	13%	12%	null	null	null	null	13%	12%	null	null	null	null	11%	11%
Gude Drive & Gaither Road	NO	63	21%	26%	null	null	26%	32%	null	null	null	null	26%	33%	null	null	null	null	26%	36%	null	null	null	null	26%	36%	null	null	null	null	21%	26%
Needwood Road & Redland Road	NO	59	57%	28%	null	null	58%	31%	null	null	null	null	64%	40%	null	null	null	null	65%	38%	null	null	null	null	65%	38%	null	null	null	null	57%	30%
Shady Grove Road & Gaither Road	NO	63	70%	88%	null	null	84%	84%	null	null	null	null	88%	86%	null	null	null	null	100%	86%	null	null	null	null	95%	86%	null	null	null	null	71%	89%
Redland Road & Shady Grove Metro	NO	120	15%	26%	null	null	19%	23%	null	null	null	null	22%	30%	null	null	null	null	36%	27%	null	null	null	null	36%	27%	null	null	null	null	13%	31%
Redland Road & Somerville Drive	NO	120	10%	14%	null	null	9%	14%	null	null	null	null	18%	57%	null	null	null	null	18%	54%	null	null	null	null	18%	54%	null	null	null	null	13%	19%

Figure 22 – A. Existing Conditions (Synchro)

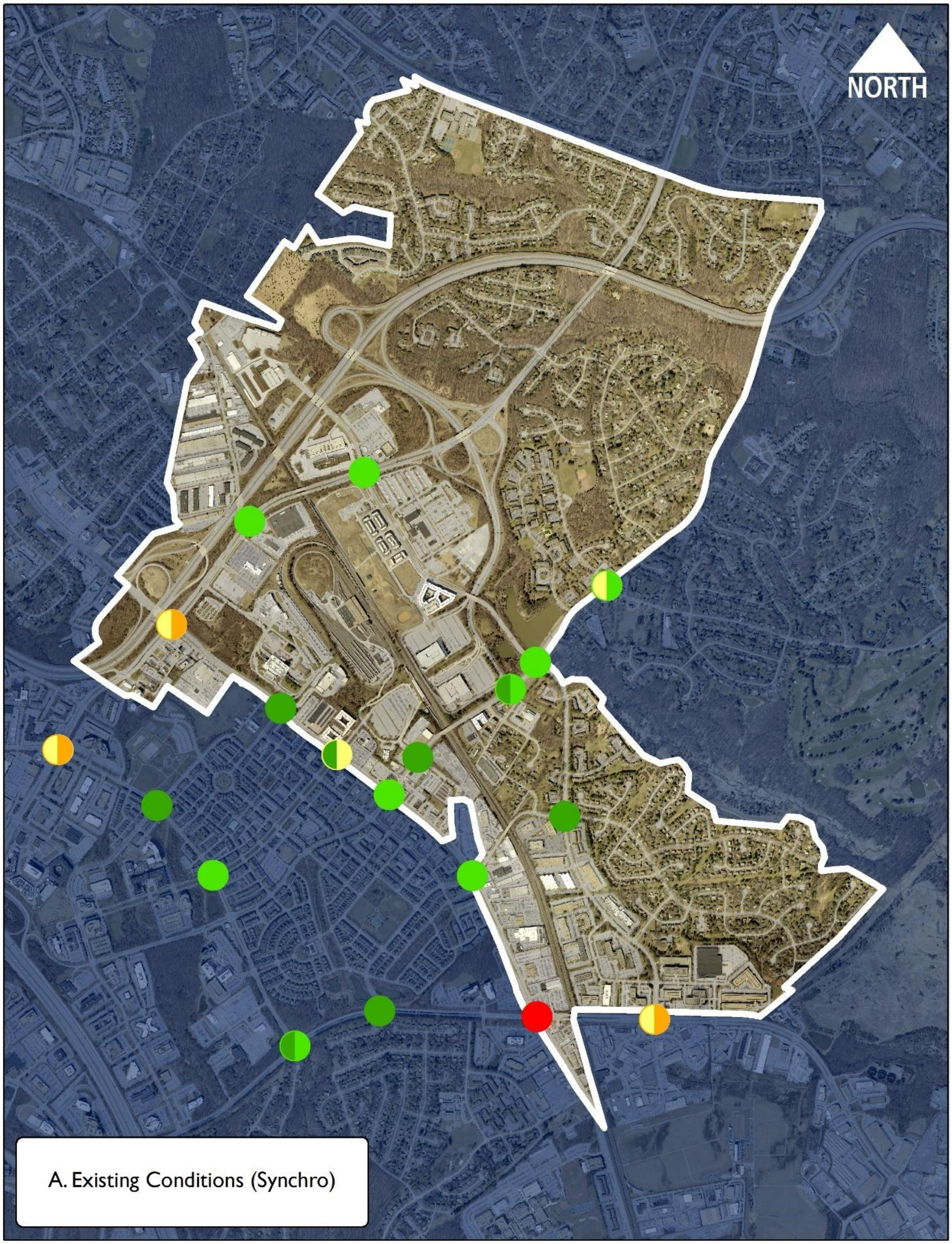


Figure 23 – B. Existing Conditions (VISSIM)

Figure 24 – C. 2040 Plan Build Out (Synchro)

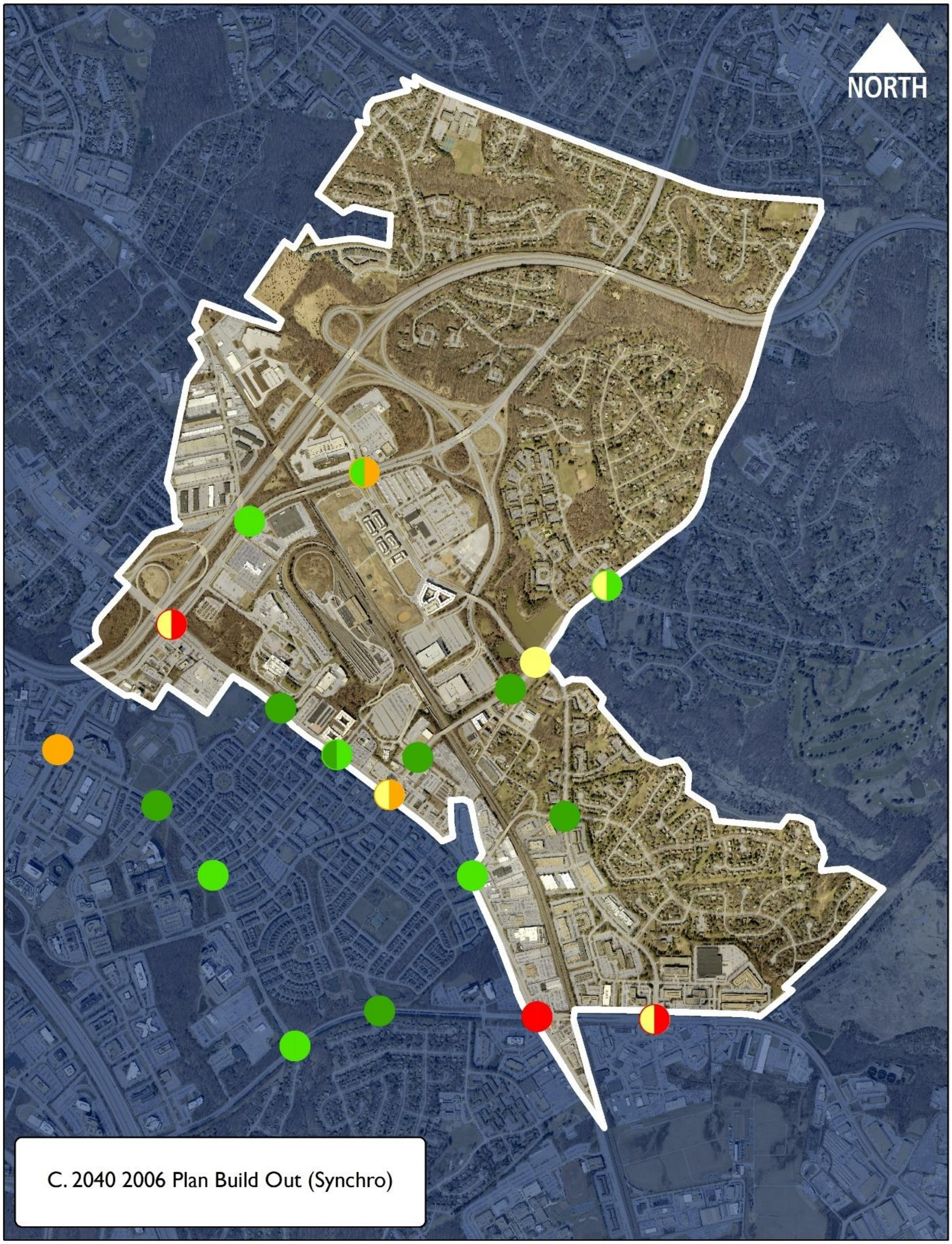


Figure 25 – D. 2040 2006 Plan Build Out (VISSIM, Curb Running)

Figure 26 – E. 2040 2006 Plan Build Out (VISSIM, Center Running)

Figure 27 – F. 2040 Alternative 1 (Synchro)

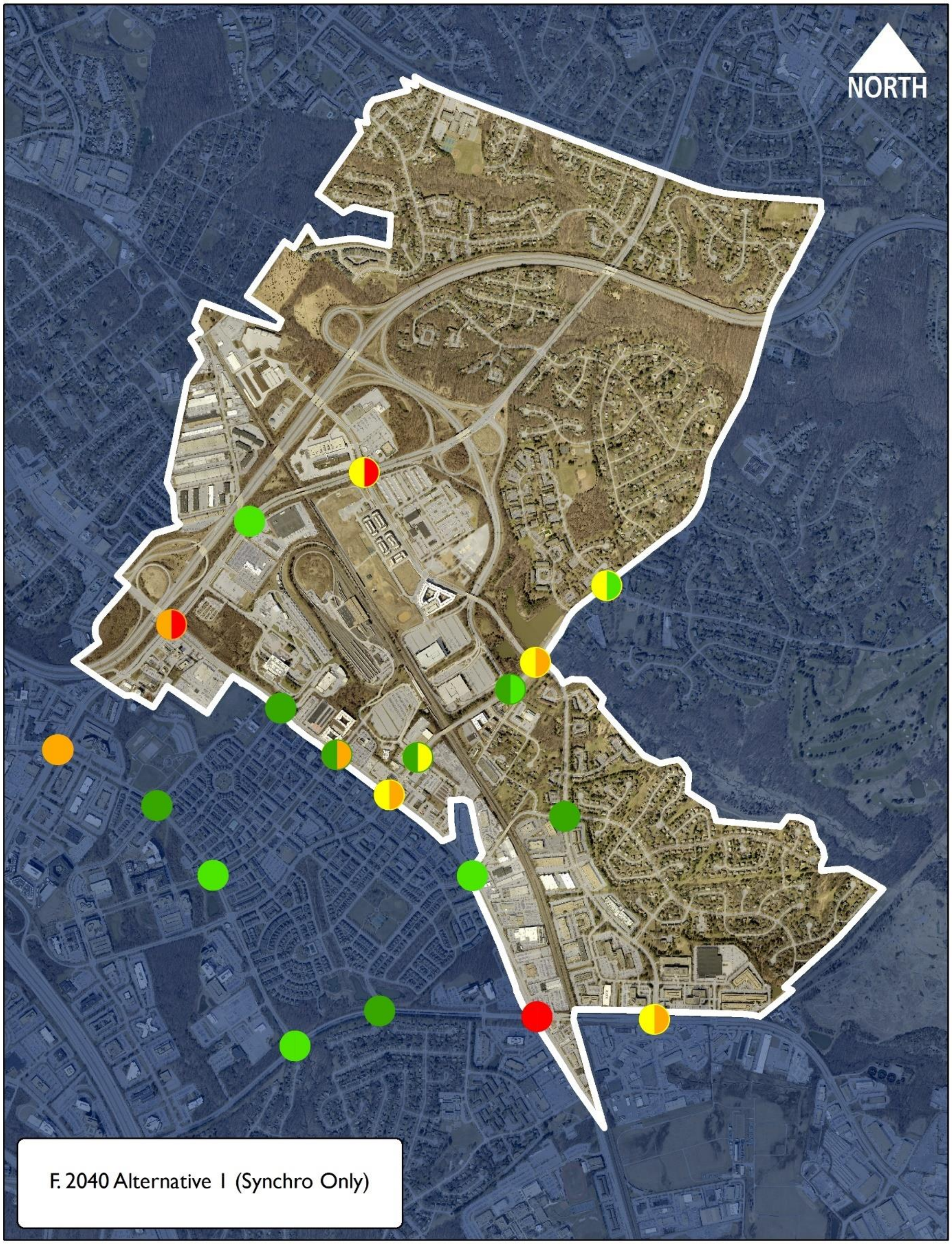


Figure 28 – G. 2040 Alterative 1 (VISSIM, Curb Running)

Figure 29 – H. 2040 Alternative 1 (VISSIM, Center Running)

Figure 30 – I. 2040 Alternative 1 (Synchro, Revised Volumes)

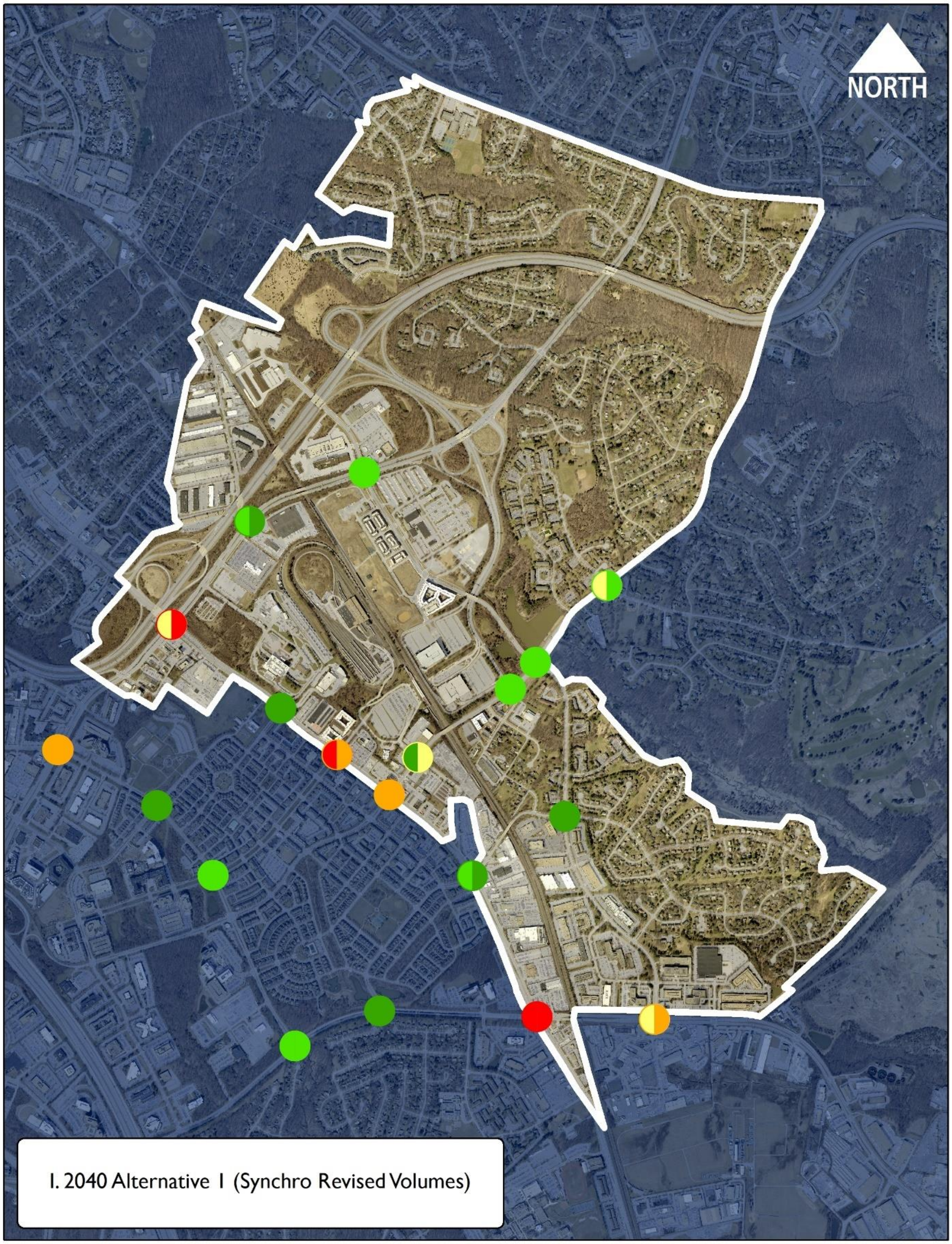


Figure 31 – J. 2040 Alternative 1 (Synchro, Revised Volumes, Curb Running)

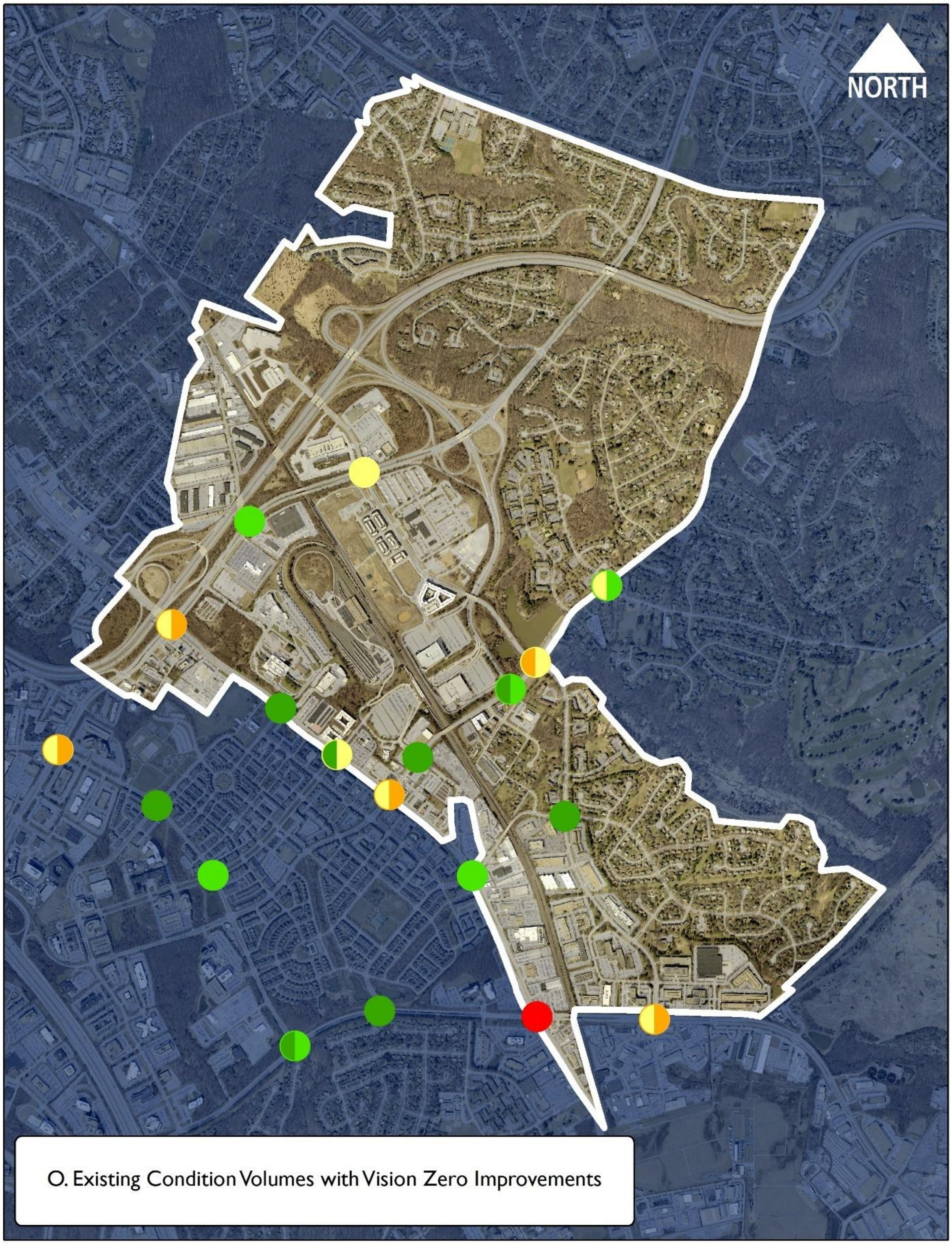
Figure 32 – K. 2040 Alternative 1 (VISSIM, Revised Volumes, Center Running)

Figure 33 – L. 2040 Alternative 1 (Synchro, Revised Volumes, Mitigated)

Figure 34 – M. 2040 Alternative 1 (VISSIM, Revised Volumes Mitigated, Curb Running)

Figure 35 – N. 2040 Alternative 1 (VISSIM, Revised Volumes Mitigated, Center Running)

Figure 36 – O. Existing Conditions Volumes with Vision Zero Improvements



C. Discussion of Trade-Offs

Based on the capacity analyses, vehicular capacity improvements are necessary to accommodate future conditions per the existing Subdivision Staging Policy; however, these improvements favor vehicular capacity over safety, either by adding lanes, adding channelized rights, maintaining channelization for rights, or by removing split phasing. These improvements are often not desirable and may not be necessarily improve future conditions. Travel Demand Modeling, which was used to generate turning movement counts for 2040 scenarios, is not a reliable indicator of future conditions due to the variability of future travel patterns, future land use, future roadway and transit network, and future user preferences.

In cases where new development triggers review of vehicular capacity and such a review results in a determination of lacking vehicular infrastructure based on delay metrics, this Plan recommends that these improvements be low-priority, and that any determination should factor in an assessment of safety needs. Alternative improvements or payments could be made to support this Plan's safe, multimodal vision. An infrastructure prioritization scheme can be found in section 6.

4. Interchange Feasibility Analysis

The 2006 *Shady Grove Sector Plan* recommended an interchange at MD 355 and Gude Drive, as well as a partial interchange at Crabbs Branch Way and Metro Access Road. The capacity analysis for this effort indicates that the partial interchange is not necessary assuming smaller mitigations can be made and the Plan's non-auto driver mode share goals (NADMS) can be met. Additionally, it would be difficult to implement based on the environmental and stormwater constraints in the vicinity of the Plan area.

The MD 355 and Gude Drive intersection does not meet the capacity standards for any of the studied scenarios, including the mitigated scenarios under the current policy area standard of 63 seconds. To understand whether this intersection warranted a full interchange or other improvement(s), the Department contracted with a third-party to undertake an interchange feasibility analysis. The results of the feasibility analysis demonstrate that implementing an interchange at MD 355 and Gude Drive would result in significant environmental, utility, and property costs. Additionally, total project costs range between $25 and $75 million dollars. More modest improvements, including retention of the existing free-right, reconfiguration of the intersection and its associated phasing, and targeted widening, could result in an intersection that meets a revised policy area standard (80 seconds of average delay/vehicle).

While the Department advanced two options—a single-point interchange and a Gude Drive overpass—for third-party study, ultimately the study's dynamic modeling (done in VISSIM) showed that the traffic flow benefits of the interchange for MD 355 were minimal due to the close spacing of nearby signalized intersections.

This Plan recommends that capital expenditures be directed toward projects that achieve the Plan's multimodal vision rather than projects that extend the auto-centric lifespan of the current environment. The third party's memo on the benefits and drawbacks of each studied option is available in the following section.

July 19, 2019
Revised
October 16, 2019

Patrick Reed, AICP
Transportation Planner Coordinator
Montgomery County Planning Department
Planning Area 2

Subject: RFQ-35-118 – On-Call Transportation Planning and Engineering Services
Task 18 Shady Grove Minor Master Plan Amendment Vision Zero Assessment and Interchange Feasibility Study
SAI File: 15-43 Task 18

Dear Mr. Reed:

Sabra & Associates Inc. (SAI) has identified and evaluated 6 options for reducing congestion at the intersection of Gude Drive at MD 355. MD 355 is a corridor that is heavily traveled currently and one that will experience increased congestion in 2040. Of the six options evaluated, three are at-grade improvements and an additional three options are grade-separated. The intersection of Gude Drive at MD 355 is projected to have a failing Level of Service and an average vehicle delay that far exceeds the Master Plan's delay standard in Year 2040 under the Alternative 1 Master Plan Amendment. The goal of this evaluation is to determine what options are available to reduce the overall congestion at the intersection and to highlight the benefits and disadvantages of each option. These six options were chosen because of their relatively-small footprints and impacts on surrounding land uses. They are as follows:

- At-Grade Improvements:
  - Option 1: Reduction to 80 second Average Delay via free right turns on the eastbound, westbound, and southbound directions
  - Option 2: Reduction to 100 second Average Delay via free right turns on the eastbound and westbound directions
  - Option 3: Exaggerated Jug Handle to remove of all Left Turns
- Grade-Separated Improvements:
  - Option 4: Single Point Urban Interchange (SPUI) under structure, Gude Drive free flow
  - Option 5: Northbound/southbound left-turn Flyover Ramps
  - Option 6: Single Point Urban Interchange (SPUI), MD 355 free flow

A description of each of these options, as well as a visual representation of how the option impacts the control of each movement at the intersection, is shown in Table 4. Additionally, an evaluation matrix summarizes and compares the overall impacts of each option across the following metrics:

1. Traffic
   - Changes to Traffic Operations
   - Traffic Delay Changes
   - Bus Rapid Transit (BRT) Impacts
2. Approximate Construction Cost
3. Property Impacts
   - Right of Way (ROW) Impacts
   - Commercial Driveway access Impacts

4. Environmental and Utility Impacts
    - Change in Impervious Area
    - Above-ground Utility Impacts
    - Trees Impacts
5. Pedestrian Safety and Convenience

Finally, each option is shown conceptually in plan-view at the end of this memorandum. Based on subsequent discussions, Options 1, 2, 4 and 6 are also shown with an additional uni-directional BRT-only lane, an example of which is depicted in Figure 1. The BRT lane is shown as a 12' bus-only lane with 4' wide curbs on either side. This additional dedicated travel lane is not expected to alter the number of driveways impacted or property takes, however it is expected to add about $2,000,000 in the costs for these options (shown in the matrix in Table 5) based on the added ROW needed and additional construction cost.

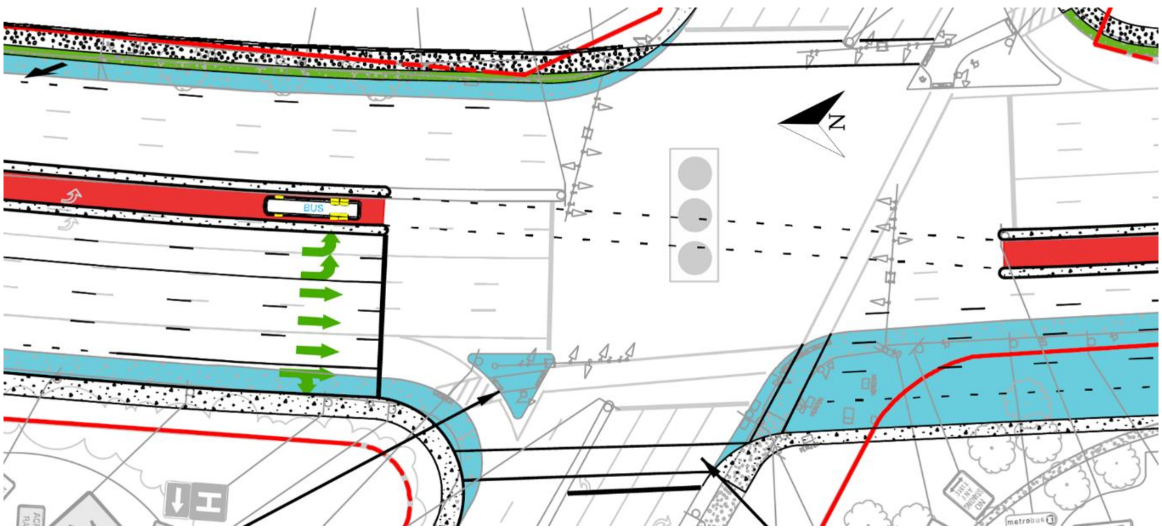


Figure 1: Potential Uni-directional BRT-only Lane running in the Center median of MD 355.

All six options show a conceptual proposed side path along the east side of MD 355.

Year 2040 Volumes

SAI based our traffic analysis on Year 2040 volumes on the land use projections for the Alternative 1 Master Plan Amendment. These volumes were used to evaluate changes in static traffic operations at the Gude Drive / MD 355 intersection (see Matrix below), for each of the six options tested. It should be noted that while industry-standards tools like Synchro™ model changes in static delay at a given intersection, other traffic modeling software also considers the impacts from adjacent intersections. For example, a *downstream* congested intersection can result in limited available capacity to receive upstream traffic, such that an *upstream* intersection is not able to process as much traffic through it. Accordingly, we also used a dynamic modeling software, Vissim™, to evaluate changes in travel time through the MD 355 corridor from Shady Grove through Gude Drive to College Parkway.

After our static modeling effort, but prior to our dynamic modeling of corridor travel time, we received an update to the 2040 forecast volumes for the Alternative 1 Master Plan Amendment; these new volumes were based on a slightly-modified mode split. SAI balanced these raw forecast volumes prior to applying them to our Vissim model. A comparison of the original balanced volumes, new raw volumes, and new balanced volumes is shown in Figure 2 below for the intersection of MD 355 at Gude Drive. Raw volumes were balanced along MD 355 first and then between adjacent intersection along Gude Drive.

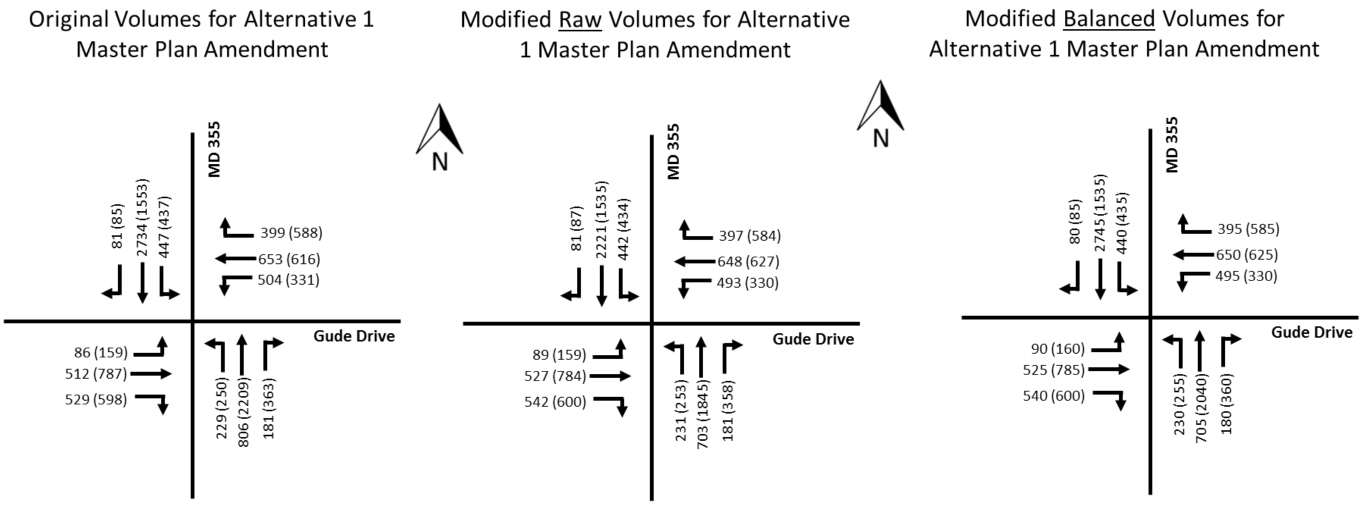


Figure 2: Comparison of Original Alt 1 Master Plan Amendment Volumes with modified Raw and balance volumes

As shown in Figure 2, the modified balanced volumes are similar to the original volumes used in our original synchro analysis. With these new 2040 volumes, SAI evaluated travel times along the MD 355 corridor using Vissim, from Shady Grove Road to College Parkway. We compared the Year 2040 no-build scenario with the Option 4 scenario that provides a Gude Drive overpass and reduces the number of signal phases at MD 355/Gude from 4 to 3, which results in more green time along MD 355. We evaluated AM and PM peak hours for each direction of MD 355. The results for the general-purpose travel lanes are the average of five travel-time runs and are shown in Table 1 below.

Table 1: Travel Time Summary for General purpose vehicle lanes for both the 2040 No-build and Option 4 scenarios

Travel Time Summary Table (min:sec) MD 355 between Shady Grove Road and College Parkway														
General Purpose Vehicles	Southbound							Northbound						
	Segment		AM Peak		PM Peak			Segment		AM Peak		PM Peak	
			2040 No Build	2040 Option 4	2040 No Build	2040 Option 4				2040 No Build	2040 Option 4	2040 No Build	2040 Option 4
	A	Shady Grove Rd to Ridgemont Ave	03:46	03:27	00:50	00:49	A	Ridgemont Ave to Shady Grove Rd	01:20	01:21	01:21	01:22
	B	Ridgemont Ave to King Farm Blvd	01:54	01:43	00:47	00:49	B	King Farm Blvd to Ridgemont Ave	00:25	00:25	00:25	00:25
	C	King Farm Blvd to Redland Rd	01:28	01:18	00:50	00:50	C	Redland Rd to King Farm Blvd	00:30	00:32	00:47	00:46
	D	Redland Rd to Indianola Rd	02:10	01:06	00:37	00:37	D	Indianola Rd to Redland Rd	01:02	01:01	02:46	03:14
	E	Indianola Rd to Gude Dr	03:27	01:12	01:34	00:52	E	Gude Dr to Indianola Rd	01:25	01:15	01:43	04:45
	F	Gude Dr to College Pkwy	00:28	00:30	00:29	00:38	F	College Pkwy to Gude Dr	01:09	00:53	02:52	02:54
	Total		13:12	09:16	05:05	04:36	Total		05:51	05:29	09:54	13:25

For general purpose travel lanes:

- The southbound direction in the AM sees large improvements due to the congestion relief on the southbound approach to Gude Drive and also the southbound approach to Indianola (since the queues spill back from Gude toward Indianola – which limits the amount of southbound throughput at Indianola, as well). It should be noted that if there is substantial congestion south of College

Parkway in the AM southbound direction, these results will not be as beneficial as shown in the table[1].

- The southbound direction in the PM is the non-peak direction and sees modest improvement, due almost entirely to the amount of new green time provided by the Option 4 scenario.
- The northbound direction in the AM is the non-peak direction and sees modest improvement, also due almost entirely to the amount of new green time provided by the Option 4 scenario.
- The northbound direction in the PM experiences significantly worse congestion in the Option 4 scenario, largely due to the MD 355 segment between Gude Drive and Indianola Road. The northbound direction of this segment becomes congested with vehicles *faster* under the Option 4 improvements, because they allow cars from both Gude Drive and points south along MD 355 to progress into this space more efficiently. Meanwhile the ability of the Indianola Road to process these additional vehicles hasn't changed. This results in longer queues approaching Indianola Road in the Option 4 scenario, since the improved Gude Drive intersection doesn't meter traffic as slowly. As a result, Option 4 results in a more efficient intersection when viewed in isolation only, but results in worse traffic conditions when it is part of a system of closely-spaced intersections.
    - *Preliminary Plans are for a new interchange access point at Gude/I-270 will likely result in increased volumes along Gude Drive. It is unknown how many new trips will divert to Gude and from where they will divert. Once the new volumes for the interchange have been determined, re-evaluating the impacts to the Gude intersection at MD 355 is recommended.*

Changes to travel time for buses in the BRT lanes, between the No-build scenario and the Option 4 scenario, are negligible because these buses are in dedicated lanes and have no queue/congestion-related delay. Any delay experienced by a bus in a BRT lane is *signal-related* for both the No-build scenario and the Option 4 scenario; accordingly, infrastructure improvements that add green time to the main line at one intersection won't materially affect the performance of BRT along the entire corridor. In order to reduce travel time for BRT buses in dedicated lanes, transit signal priority (TSP) would need to be applied or traffic signal timings would have to be coordinated to known and constant bus travel speeds[2].

Static Comparison of Options 4 and Options 6

Options 4 and 6 are similar in that both are Single Point Urban Interchanges (SPUIs), where Option 4 has Gude Drive through movements free via an overpass, while option 6 has MD 355 through movements free via an underpass. A comparison of delay, by movement, is shown for both options in the following table.

1 Because the BRT network being analyzed ends at College Parkway, any congestion that may exist south of that intersection is not being incorporated into the traffic model.

2 Coordination of two signals is highly unlikely if there is a bus stop in between them, as boarding/alighting times can vary significantly.

Table 2: Comparison of Delay, by movement, between Option 4 and Option 6

Intersection	Movement*	Option 4				Option 6			
		Delay		Level of Service		Delay		Level of Service	
		AM	PM	AM	PM	AM	PM	AM	PM
MD 355 at Gude Drive	Overall	-	-	-	-	-	-	-	-
	EBL	55.4	71.4	E	E	72.5	73.5	E	E
	EBT	free	free	A	A	61.2	54.3	E	D
	EBR	0.6	0.7	A	A	0.6	0.7	A	A
	WBL	46.3	34.2	D	C	57.0	83.0	E	F
	WBT	free	free	A	A	65.2	19.8	E	B
	WBR	0.3	0.3	A	A	0.3	0.4	A	A
	NBL	82.5	72.9	F	E	69.3	71.1	E	E
	NBT	59.7	32.9	E	C	free	free	A	A
	NBR	0.2	0.4	A	A	0.2	0.4	A	A
	SBL	25.0	65.8	C	E	25.7	29.0	C	C
	SBT	32.7	17.0	C	B	free	free	A	A
	SBR	12.6	11.8	B	B	36.5	40.5	D	D

As shown in Table 2, almost all movement have "passing" LOS of E or better, with the exception of the Northbound left turn in AM peak hour and the westbound left turn in the PM peak hour. Excluding the uncontrolled eastbound/westbound movements, Option 4 is expected to operate at an LOS C in the AM and PM peak hours. Excluding the uncontrolled northbound/southbound movements, Option 6 is expected to operate at an LOS C in the AM and LOS D in the PM.

The static delay experienced for the BRT under Option 6 would be zero, given that Northbound Movements and southbound movements are free. Under Option 4 the Northbound and Southbound delay for BRT would depend on the ability to coordinate adjacent signals. For example, heading northbound in the PM, if the College Parkway signal and the Gude Drive signal are coordinated, then the BRT bus would arrive at Gude Drive with a "green light" already waiting for it. Similarly, if the BRT signal had TSP, then the bus would also have zero seconds of static delay due to the intersection.

Spot Emissions at Gude

Simulated Emissions were evaluated at the intersection of Gude Drive at MD 355, comparing the No Build option with Option 4. Note, that this this comparison only accounts for the peak hours, and does not factor in important criteria, such as percent buses and percent heavy vehicles. Emissions were based on SimTraffic's internal estimate for Fuel Consumption, which itself is based on: vehicle miles traveled, total signal delay, vehicle stops per hour, and free flow speed, and is consistent across other simulations programs.

Table 3: Peak Hour Emissions

Emission Particulate	No Build		Option 4	
	Grams in AM Peak Hour	Grams in PM Peak Hour	Grams in AM Peak Hour	Grams in PM Peak Hour
HydroCarbons	140	178	100	108
Carbon Monoxide	4932	5654	4265	4715
Nitrogen Oxides	412	542	338	373

Findings:

1. The current congestion standard for Gude/MD 355 is 63 seconds and is expected to be exceeded by 2040 in the Alternative 1 Land Use Plan. Based on the Highway Capacity Manual (HCM) methodology, the AM and PM peak hour delays are expected to be 132 seconds and 117 seconds in the AM and PM peak hour, respectively.
2. Of the six alternatives tested only Option 4 – the Gude Drive overpass – met the congestion standard. However, while the SPUI (option 6) does not meet the congestion standard, MD 355 through-traffic is uncontrolled (i.e. it has no delay). This lack of delay on the main line is not reflected in the Synchro outputs for congestion.
3. Options 3 through 6 remove one or more phases from the existing four-phase signal operation. Options 1 and 2 don't remove any signal phase, but add travel lanes on MD 355, such that eastbound and westbound right turns are no longer controlled by the signal, but operate "freely."
4. Options that remove a phase allow the existing signal timing to be reallocated to the remaining phases such that the overall signal can operate more efficiently. This has a positive impact, not only on overall traffic congestion, but also on BRT traffic (assuming no queue jumps are planned). All options, except for Option 2, benefit BRT traffic by reducing northbound and/or southbound traffic delay for all vehicles.

a. Additionally, Option 3 and Option 6 would allow for center-median running BRT line, because the northbound and southbound left turn movements would be relocated.

5. Option 6 is the most expensive option and most disruptive to adjacent commercial properties, requiring multiple full parcel takes and several strip takes (property takes involving a thin sliver of the land). Where only strips of parcels are taken, commercial driveways would have to be reconstructed.
6. All options will require a significant amount of utility relocation.
7. Option 3 and Option 6 have the largest impact to both 1) large tree removal; and 2) increase in impervious surface.
8. The impacts to pedestrian safety and convenience vary across all options. For example, Option 3 would allow for all four legs to have crossings and would even allow for pedestrian refuge island to break up the crossings. Alternatively, both the SPUI (option 6) and Option 4 would require pedestrians to cross MD 355 via an elevated structure; the sidepaths along Gude Drive and MD 355 would be grade-separated at the intersection, making going from one path to the other an inconvenient and cumbersome endeavor. Options 1 and 2 retain at-grade pedestrian crossings, however both widen MD 355, making the crossing longer for cyclists and pedestrians.
9. Improving traffic at Gude Drive at MD 355 in isolation does little to improve traffic flow in general purpose travel lanes *through the corridor*. Downstream congestion prevents improvements at Gude/MD 355 from having any residual impacts through the corridor.
10. Improving Gude Drive at MD 355 does not improve BRT operations through the corridor, since the No-Build option has no congestion-related delay, due to the dedicated BRT lanes. The only delay is due to the signal, but TSP or signal coordination can reduce the signal delay to zero.
11. Preliminary Plans are for a new interchange access point at Gude/I-270 will likely result in increased volumes along Gude Drive. Once the new volumes for the interchange have been determined, re-evaluating the impacts to the Gude intersection at MD 355 is recommended.
12. Improving MD 355 at Gude Drive intersection through physical reconstruction is not recommended if the improvement will only be made in isolation along the corridor, as no significant changes in peak hour (peak direction) travel time will be achieved.

Table 4: Description of the Operation of Each Option

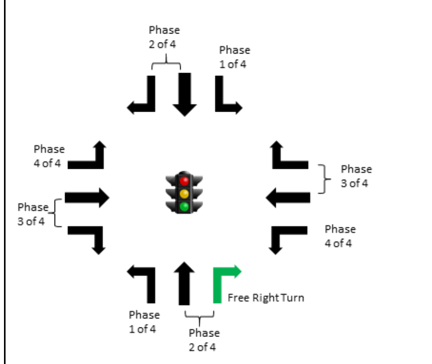
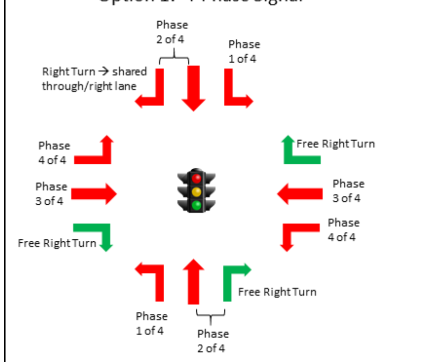
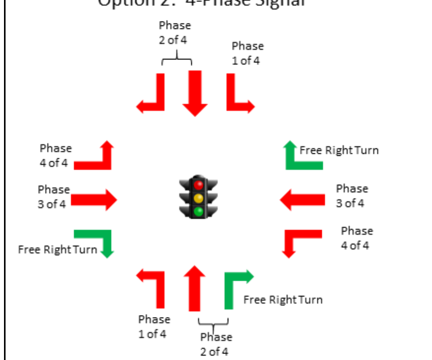
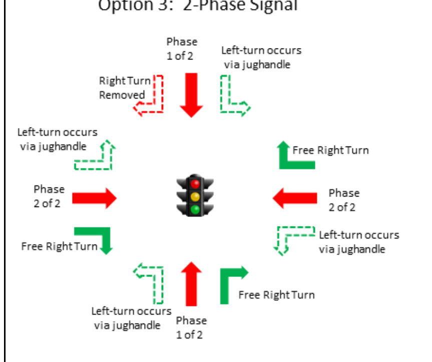
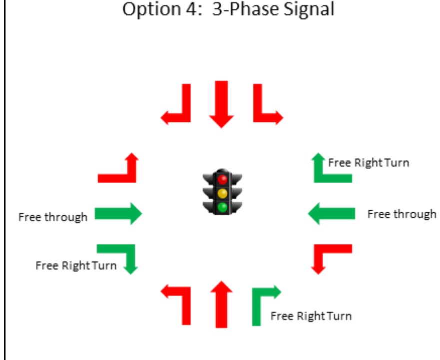
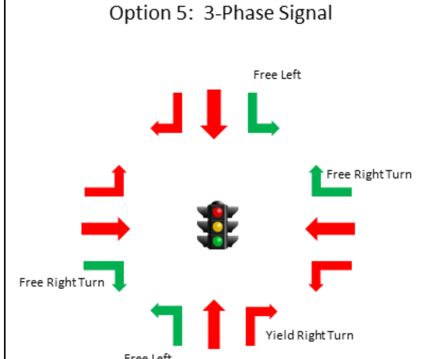
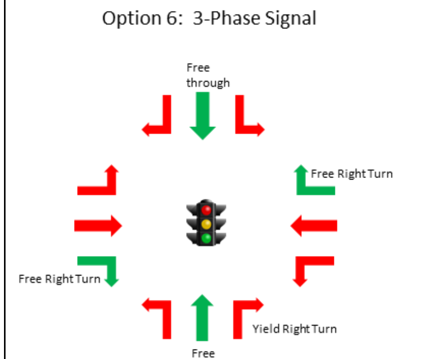
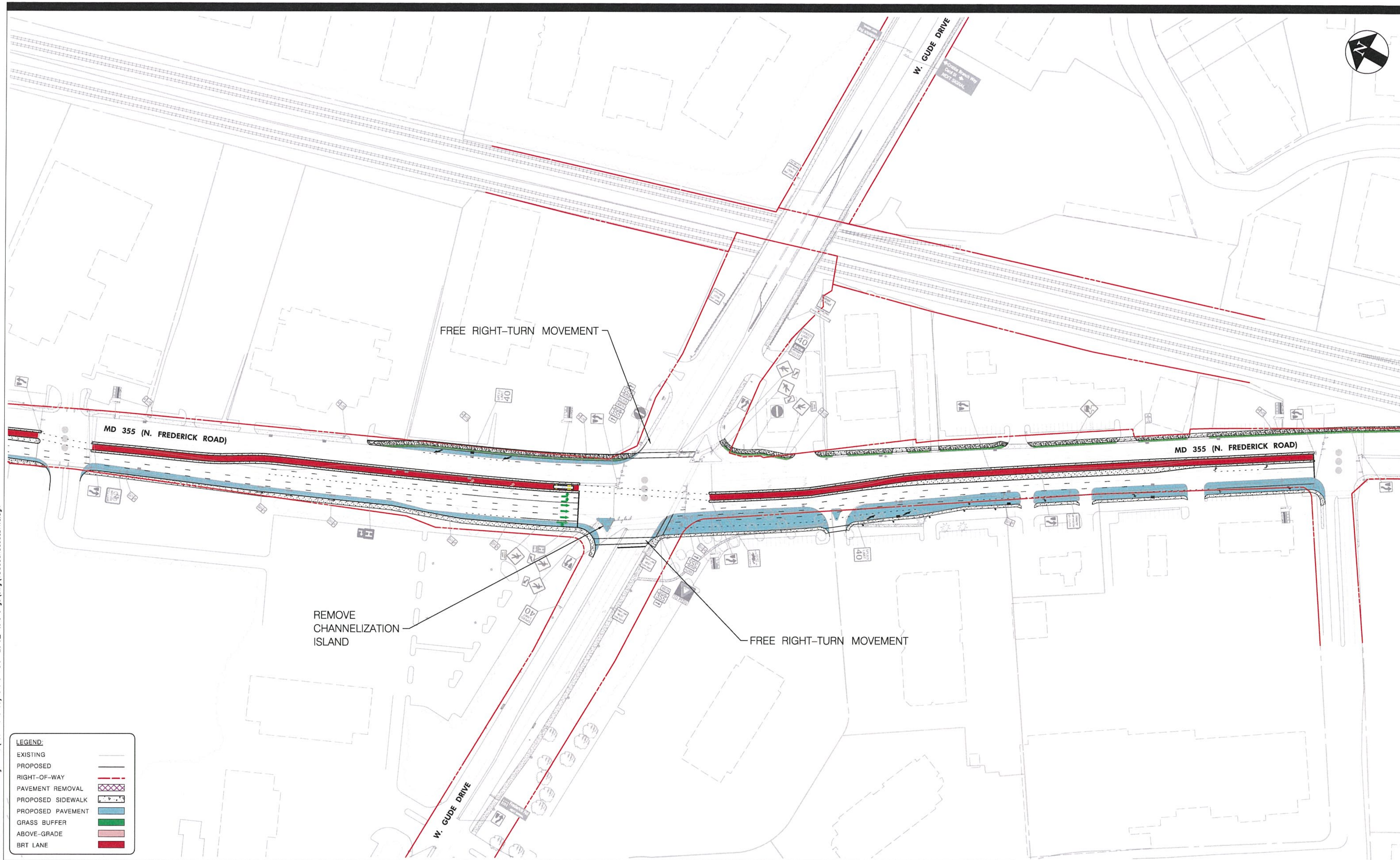
<table>
<tr><th colspan="2">Option</th><th>Name</th><th colspan="2">Description of how the Intersection Operates</th></tr>
<tr><td colspan="3">Existing Conditions</td><td>All Turn Movements are controlled by the traffic Signal, with the exception of the Northbound Right Turn on Gude Drive, which is a free movement. There are four phases: Northbound and Southbound traffic has a green light at the same time. Northbound and Southbound left-turning traffic has a green light at the same time. Eastbound and Westbound traffic has a green light at the same time. Eastbound and Westbound left-turning traffic has a green light at the same time.</td><td>Existing 4-Phase Signal
</td></tr>
<tr><td rowspan="3">At grade</td><td>1</td><td>80 sec delay Standard</td><td>Eastbound and Westbound right turns become "free" movements, where each has their own receiving lane on MD 355. Additionally, the southbound right turn lane is converted to a shared through/right lane. Northbound MD 355 is widened to add one curbside travel lane. Southbound MD 355 is widened to add one curbside travel lane.</td><td>Option 1: 4-Phase Signal
</td></tr>
<tr><td>2</td><td>100 sec delay Standard</td><td>Eastbound and Westbound right turns become "free" movements, where each has their own receiving lane on MD 355. Northbound and Southbound MD 355 are widened to add one curbside travel lane.</td><td>Option 2: 4-Phase Signal
</td></tr>
<tr><td>3</td><td>Northwest Jug handle</td><td>All left turn movement are removed from the intersection of MD 355 at Gude Drive. All-Left turn movements become two-stage turn movements via an exaggerated jug handle at the northwest quadrant of the intersection. The southbound right turn lane is removed due to redundancy.</td><td>Option 3: 2-Phase Signal
</td></tr>
<tr><td rowspan="3">Grade Separated</td><td>4</td><td>East/West Overpass</td><td>Eastbound and Westbound through movements become uncontrolled and free via an overpass over MD 355. Eastbound and Westbound right turns become "free" movements, where each has their own receiving lane on MD 355. Northbound and Southbound MD 355 are widened to add one curbside travel lane.</td><td>Option 4: 3-Phase Signal
</td></tr>
<tr><td>5</td><td>North/South Left Turn Flyovers</td><td>Northbound and southbound left turn lanes become flyover ramps onto westbound and eastbound Gude, respectively. Southbound flyover ramp transitions directly into the curbside eastbound travel lane near the bridge over the CSX tracks. Northbound flyover ramp transitions into a new acceleration lane on the north side of Gude Drive. Northbound right turn lane becomes a yield-only control, with a wider channelized right turn thru existing property</td><td>Option 5: 3-Phase Signal
</td></tr>
<tr><td>6</td><td>Single Point Urban Interchange (SPUI)</td><td>Gude Drive overpass is constructed above MD 355, whose southbound and northbound through movements will be free. Left turn movements from MD 355 will ramp up to the Gude overpass and be controlled. Gude Drive through movements and left turn movements will be controlled</td><td>Option 6: 3-Phase Signal
</td></tr>
</table>

Table 5: Matrix comparing select metrics for each Option

Option		Name	Description	Traffic			Cost	Property Impacts		Environmental and Utility Impacts			Safety
				Traffic Operations Changes	Traffic Delay	BRT Impacts	Capital Cost	ROW Impacts	Commercial Driveway access Impacts	Change in Impervious Area	Utility Impacts	Trees Impacts	Pedestrian Safety
				Signal Phases Removed or movements made free (uncontrolled)	Changes to AM/(PM) peak hour delay	Impacts to north/south delay time. Ability to free up space in North/South corridor for dedicated bus lanes.	Rough Order of Magnitude Construction Cost of Project	How many parcels are likely to be affected? Strip takes (where only a sliver of a property is taken) or full takes?	How many driveways are removed or adjusted?	Approximate change in impervious area	Above-ground utility relocation	# of Trees removed	To what extent are pedestrian conditions improved?
At grade	1	80 sec delay Standard	Eastbound and Westbound right turns become "free" movements, where each has their own receiving lane on MD 355. Additionally, the southbound right turn lane is converted to a shared through/right lane. Northbound MD 355 is widened to add one curbside travel lane. Southbound MD 355 is widened to add one curbside travel lane.	Eastbound and Westbound right turns are uncontrolled (e.g. zero delay)	2040 Intersection Delay is reduced from 132 sec in the AM and 117 sec in the PM to 76 seconds and 74 seconds, respectively.	Option would not allow for center median bus lanes through the intersection. Southbound peak hour AM \ (PM) delay changes from 141s \ (53s) to 93s \ (70s). Northbound peak hour AM/(PM) delay changes from 49s \ (148s) to 55s \ (81s).	~$5 Million	4 Strip Takes; 0 Full Takes	4 driveways adjusted	25,000 additional square feet of impervious surface	15 Utility Poles, 6 Light Poles, 5 Signal Poles, 3 Pedestrian Signal Poles, 0 Controller Cabinets, 8 Hand boxes, 1 Hydrants, 1 Communication Boxes, 0 CCTY cameras, 1 Transformers, 1 Power meters, 2 Inlets and 22 Street Signs	6	Lane Widening for two additional lanes requires additional crossing distance for pedestrians crossing the south leg of the intersection. Free right turns tend to occur at higher speeds than yield-control right turns; this impacts pedestrian crossing in front of right-turning vehicles that turn right on red.
At grade	2	100 sec delay Standard	Eastbound and Westbound right turns become "free" movements, where each has their own receiving lane on MD 355. Northbound and Southbound MD 355 are widened to add one curbside travel lane.	Eastbound and Westbound right turns are uncontrolled (e.g. zero delay)	2040 Intersection Delay is reduced from 132 sec in the AM and 117 sec in the PM to 99 seconds and 75 seconds, respectively.	Option would not allow for center median bus lanes through the intersection. Southbound peak hour AM \ (PM) delay is unchanged at 141s \ (53s). Northbound peak hour AM/(PM) delay is unchanged at 49s \ (148s).	~$5 Million	4 Strip Takes; 0 Full Takes	4 driveways adjusted	20,000 additional square feet of impervious surface	15 Utility Poles, 6 Light Poles, 4 Signal Poles, 2 Pedestrian Signal Poles, 0 Controller Cabinets, 6 Hand boxes, 1 Hydrants, 1 Communication Boxes, 0 CCTY cameras, 0 Transformers, 0 Power meters, 2 Inlets and 20 Street Signs	5	Single lane Widening requires additional crossing distance for pedestrians crossing the south leg of the intersection. Free right turns tend to occur at higher speeds than yield-control right turns; this impacts pedestrian crossing in front of right-turning vehicles that turn right on red.
At grade	3	Northwest Jug handle	All left turn movement are removed from the intersection of MD 355 at Gude Drive. All-Left turn movements become two-stage turn movements via an exaggerated jug handle at the northwest quadrant of the intersection. The southbound right turn lane is removed due to redundancy.	Northbound/southbound left-turn movements are removed from the MD 355/Gude Intersection. Eastbound/Westbound left-turn movements are removed from the MD 355/Gude Intersection. These four turn movements reduce the signal operation from 4 phases down to 2.	2040 Intersection Delay is reduced from 132 sec in the AM and 117 sec in the PM to 70 seconds and 40 seconds, respectively. However, this requires the creation of a new signal (with added delay) along Gude Drive west and redirected traffic to a lightly-used signal at MD 355/Lexus Dealership.	Option would allow for center median bus lanes through the intersection. Southbound peak hour AM \ (PM) delay changes from 141s \ (53s) to 85s \ (41s). Northbound peak hour AM/(PM) delay changes from 49s \ (148s) to 13s \ (37s).	~$15 Million	6 Strip Takes; 0 Full Takes	4 driveways adjusted	70,000 additional square feet of impervious surface	15 Utility Poles, 9 Light Poles, 4 Signal Poles, 2 Pedestrian Signal Poles, 0 Controller Cabinets, 6 Hand boxes, 1 Hydrants, 1 Communication Boxes, 0 CCTY cameras, 0 Transformers, 0 Power meters, 4 Inlets and 27 Street Signs	55	Single lane Widening requires additional crossing distance for pedestrians crossing the south leg of the intersection. Removal of right turn lane will narrow the crossing distance for the west leg of the intersection. Removal of the left turns at the intersection will allow for ped refuges at all three of the existing crossings.
Grade Separate d	4	East/West Overpass	Eastbound and Westbound through movements become uncontrolled and free via an overpass over MD 355. Eastbound and Westbound right turns become "free" movements, where each has their own receiving lane on MD 355. Northbound and Southbound MD 355 are widened to add one curbside travel lane.	East and West through movements would be uncontrolled, reducing the number of signal phases from 4 to 3.	2040 Intersection Delay is reduced from 132 sec in the AM and 117 sec in the PM to 33 seconds and 26 seconds, respectively. This delay does not average in the EB and WB Gude Drive movements that are now free.	Option would not allow for center median bus lanes through the intersection. Southbound peak hour AM \ (PM) delay changes from 141s \ (53s) to 31s \ (27s). Northbound peak hour AM/(PM) delay changes from 49s \ (148s) to 55s \ (32s).	~$25 Million	3 Strip Takes; 0 Full Takes	I driveway removed from Eastbound Gude Drive	15,000 additional square feet of impervious surface	11 Utility Poles, 10 Light Poles, 4 Signal Poles, 3 Pedestrian Signal Poles, 0 Controller Cabinets, 10 Hand boxes, 1 Hydrants, 1 Communication Boxes, 1 CCTY cameras, 0 Transformers, 0 Power meters, 3 Inlets and 21 Street Signs	24	Single lane Widening requires additional crossing distance for pedestrians crossing the south leg of the intersection. Free right turns tend to occur at higher speeds than yield-control right turns; this impacts pedestrian crossing in front of right-turning vehicles that turn right on red.
Grade Separate d	5	North/South Left Turn Flyovers	Northbound and southbound left turn lanes become flyover ramps onto westbound and eastbound Gude, respectively. Southbound flyover ramp transitions directly into the curbside eastbound travel lane near the bridge over the CSX tracks. Northbound flyover ramp transitions into a new acceleration lane on the north side of Gude Drive. Northbound right turn lane becomes a yield-only control, with a wider channelized right turn thru existing property.	North and South left turn movements would be uncontrolled, reducing the number of signal phases from 4 to 3.	2040 Intersection Delay is reduced from 132 sec in the AM and 117 sec in the PM to 87 seconds and 65 seconds, respectively.	Option would not allow for center median bus lanes through the intersection. Southbound peak hour AM \ (PM) delay changes from 141s \ (53s) to 107s \ (36s). Northbound peak hour AM/(PM) delay changes from 49s \ (148s) to 24s \ (64s).	~$25 Million	1 Strip Takes; 2 Full Takes	2 driveways removed	10,000 additional square feet of impervious surface	7 Utility Poles, 3 Light Poles, 2 Signal Poles, 1 Pedestrian Signal Poles, 0 Controller Cabinets, 0 Hand boxes, 0 Hydrants, 0 Communication Boxes, 0 CCTY cameras, 0 Transformers, 0 Power meters, 2 Inlets and 9 Street Signs	4	Minimal impacts to Pedestrians. Potential for pedestrian refuge on south leg
Grade Separate d	6	Single Point Urban Interchange (SPUI)	Gude Drive overpass is constructed above MD 355, whose southbound and northbound through movements will be free. Left turn movements from MD 355 will ramp up to the Gude overpass and be controlled. Gude Drive through movements and left turn movements will be controlled.	Northbound and Southbound through movements would be uncontrolled, reducing the number of signal phases from 4 to 3. These are the heaviest movements at the intersection and removing signalized control from them will have the biggest operation impact.	2040 Intersection Delay is reduced from 132 sec in the AM and 117 sec in the PM to 83 seconds and 58 seconds, respectively. This delay does not average in the NB and SB MD 355 movements that are now free.	Option would allow for center median bus lanes through the intersection. Southbound peak hour AM \ (PM) delay changes from 141s \ (53s) to 0s \ (0s). Northbound peak hour AM/(PM) delay changes from 49s \ (148s) to 0s \ (0s).	~$50 - $75 Million	6 Strip Takes; 5 Full Takes	11 driveways removed	40,000 additional square feet of impervious surface	38 Utility Poles, 8 Light Poles, 8 Signal Poles, 5 Pedestrian Signal Poles, 1 Controller Cabinets, 12 Hand boxes, 3 Hydrants, 1 Communication Boxes, 1 CCTY cameras, 1 Transformers, 2 Power meters, 19 Inlets and 52 Street Signs	92	All east/west pedestrian traffic - including Carl Henn trail - will have to cross the intersection above-grade. This will require two signalized crossings as opposed to the one current crossing.

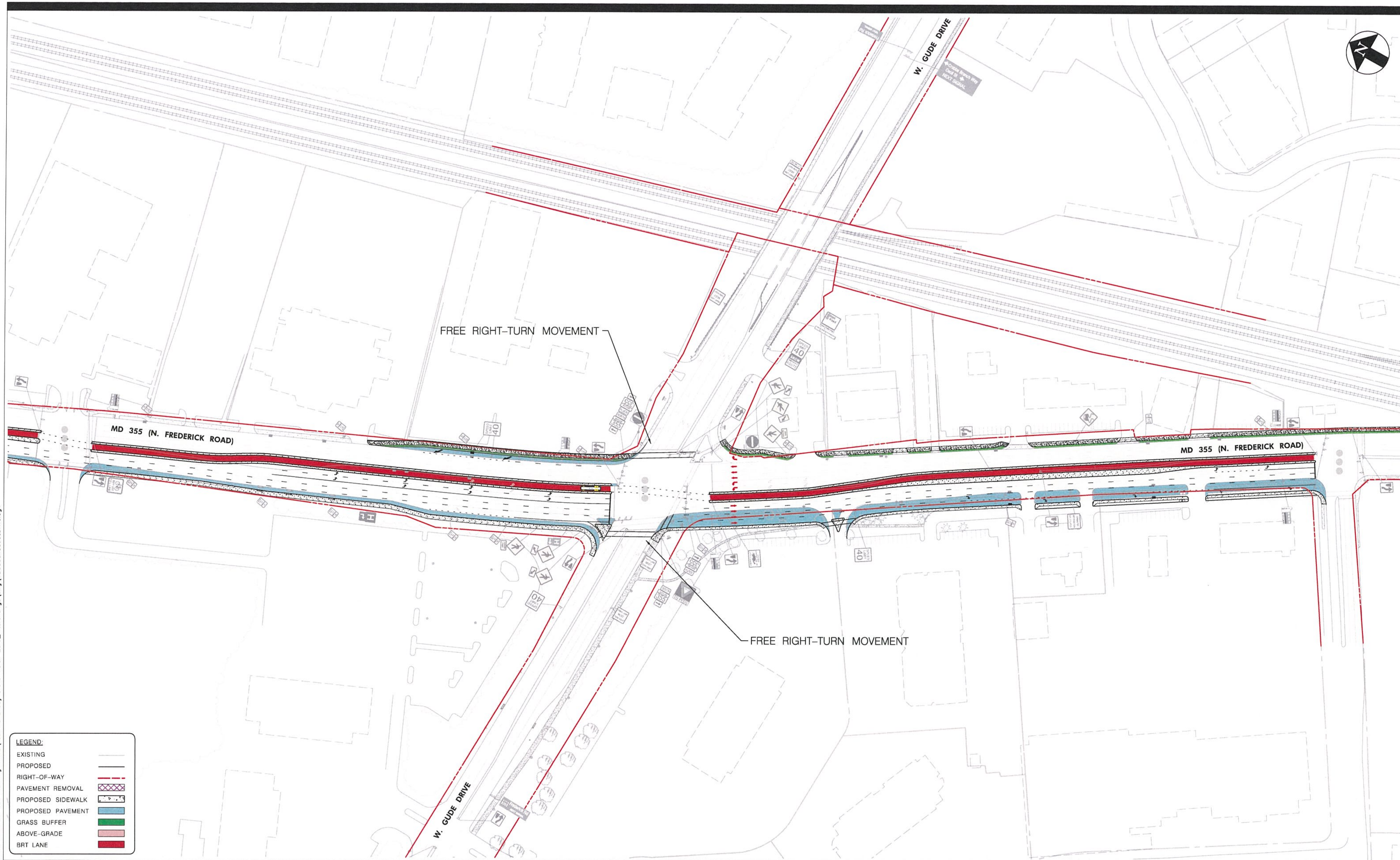


SABRA & ASSOCIATES
Engineering Innovative Solutions

MD 355 (N. Frederick Road) at W. Gude Drive
Proposed Improvements: At-Grade Option 1 – 80 Second Congestion Standard

80' 0 80' 160'
SCALE: 1" = 80'

OPERATOR:ckeller - PLOTTED: Monday, September 30, 2019 AT 11:25 AM
FILE NAME: \2015\43 MNCPPC Mont On-Call Planning Prime\Task 18 Shady Grove Vision Zero_Interchange\dwg\MD355andGudeDrive.dgn



OPERATOR:ckeller - PLOTTED: Tuesday, August 20, 2019 AT 03:47 PM
FILE NAME: \2015\43 MNCPPC Mont On-Call Planning Prime\Task 18 Shady Grove Vision Zero_Interchange\dwg\MD355andGudeDrive.dgn

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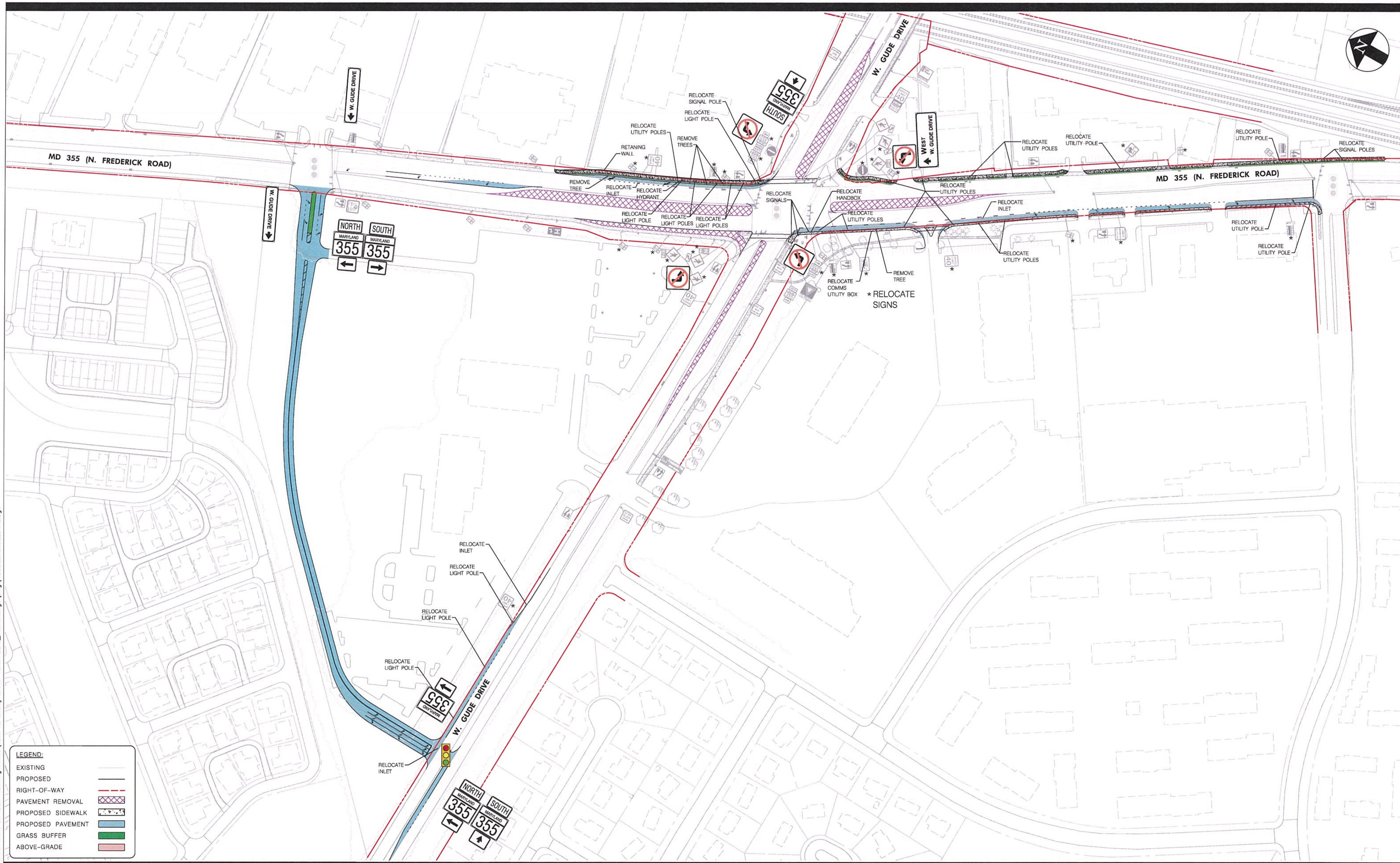
Engineering Innovative Solutions

MD 355 (N. Frederick Road) at W. Gude Drive
Proposed Improvements: At-Grade Option 2 – 100 Second Congestion Standard

80' 0 80' 160'
SCALE: 1" = 80'



MD 355 (N. Frederick Road) at W. Gude Drive

Proposed Improvements: At-Grade Option 3 – Left-Turn Phase Removal

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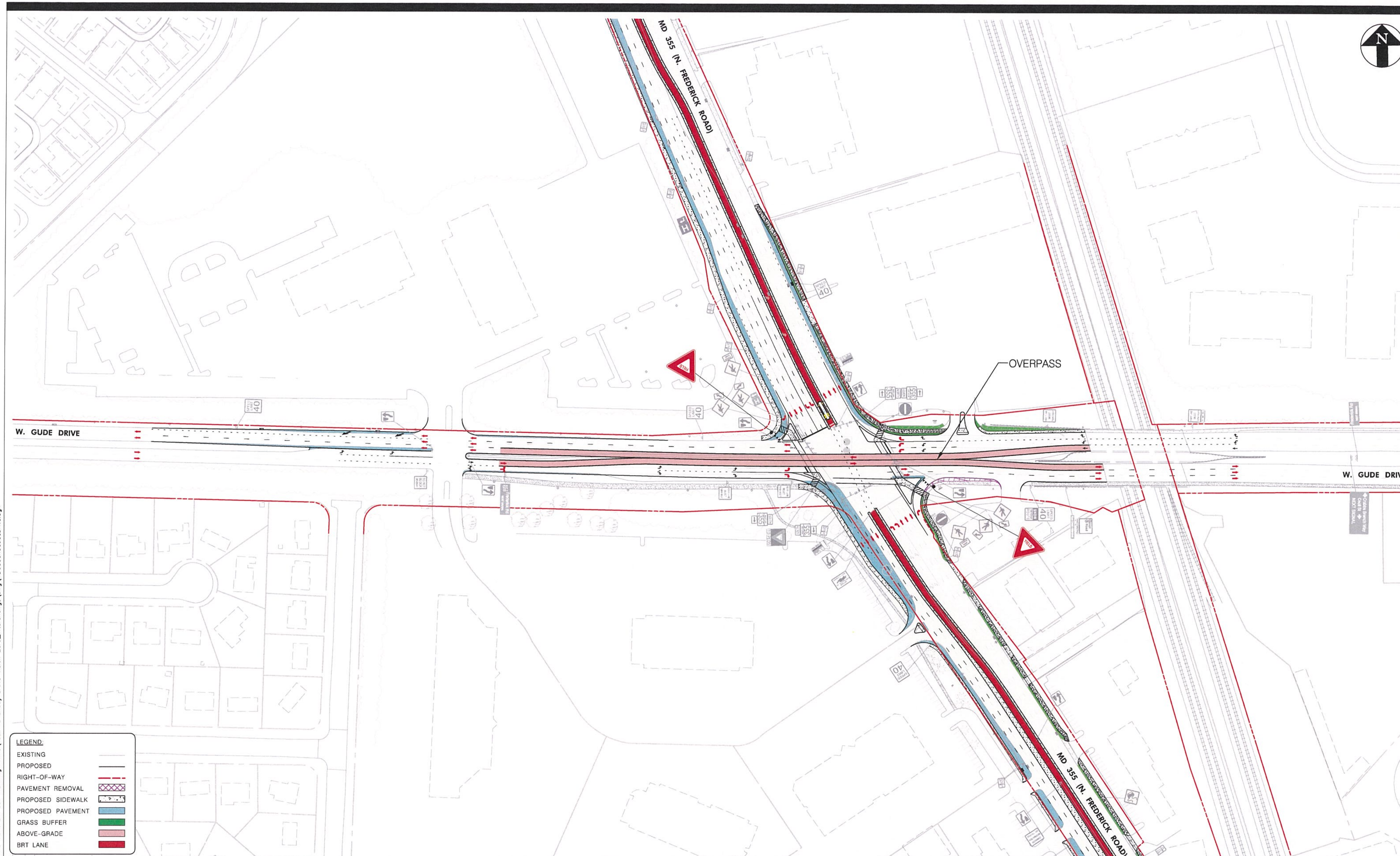
Engineering Innovative Solutions

100' 0 100' 200'

SCALE: 1" = 100'

OPERATOR:ckeller — PLOTTED: Thursday, July 18, 2019 AT 11:39 AM

FILE NAME: \2015\4.3 MNCPPC Mont On-Call Planning Prime\Task 18 Shady Grove Vision Zero_Interchange\dwg\MD355andGudeDrive.dgn



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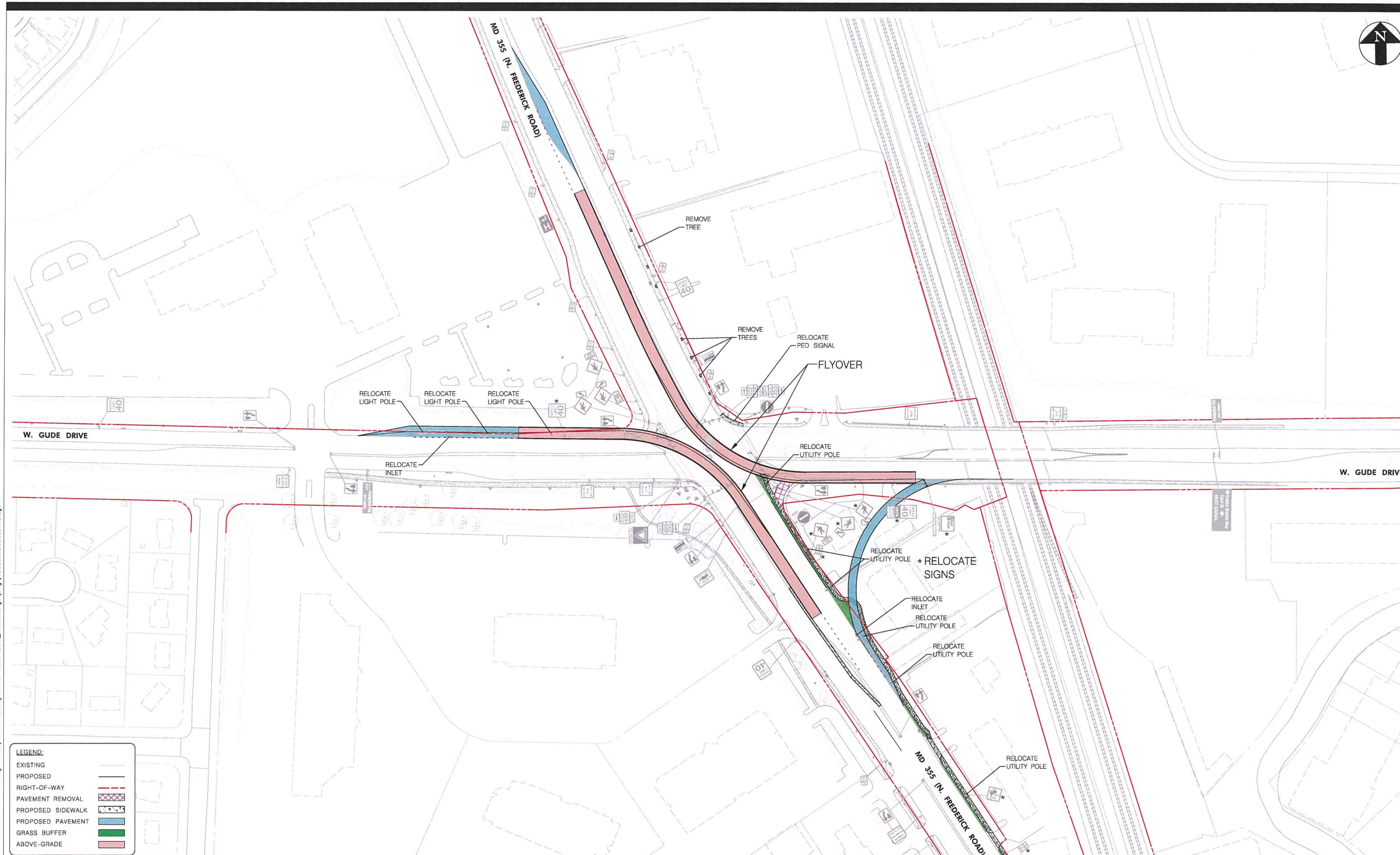
MD 355 (N. Frederick Road) at W. Gude Drive
Proposed Improvements: Above-Grade Option 4 – Overpass

80' 0 80' 160'
SCALE: 1" = 80'

OPERATOR: rckeller – PLOTTED: Tuesday, August 20, 2019 AT 01:23 PM
FILE NAME: \2015\43 MNCPPC Mont On-Call Planning Prime\Task 18 Shady Grove Vision Zero_Interchange\dwg\MD355andGudeDrive.dgn



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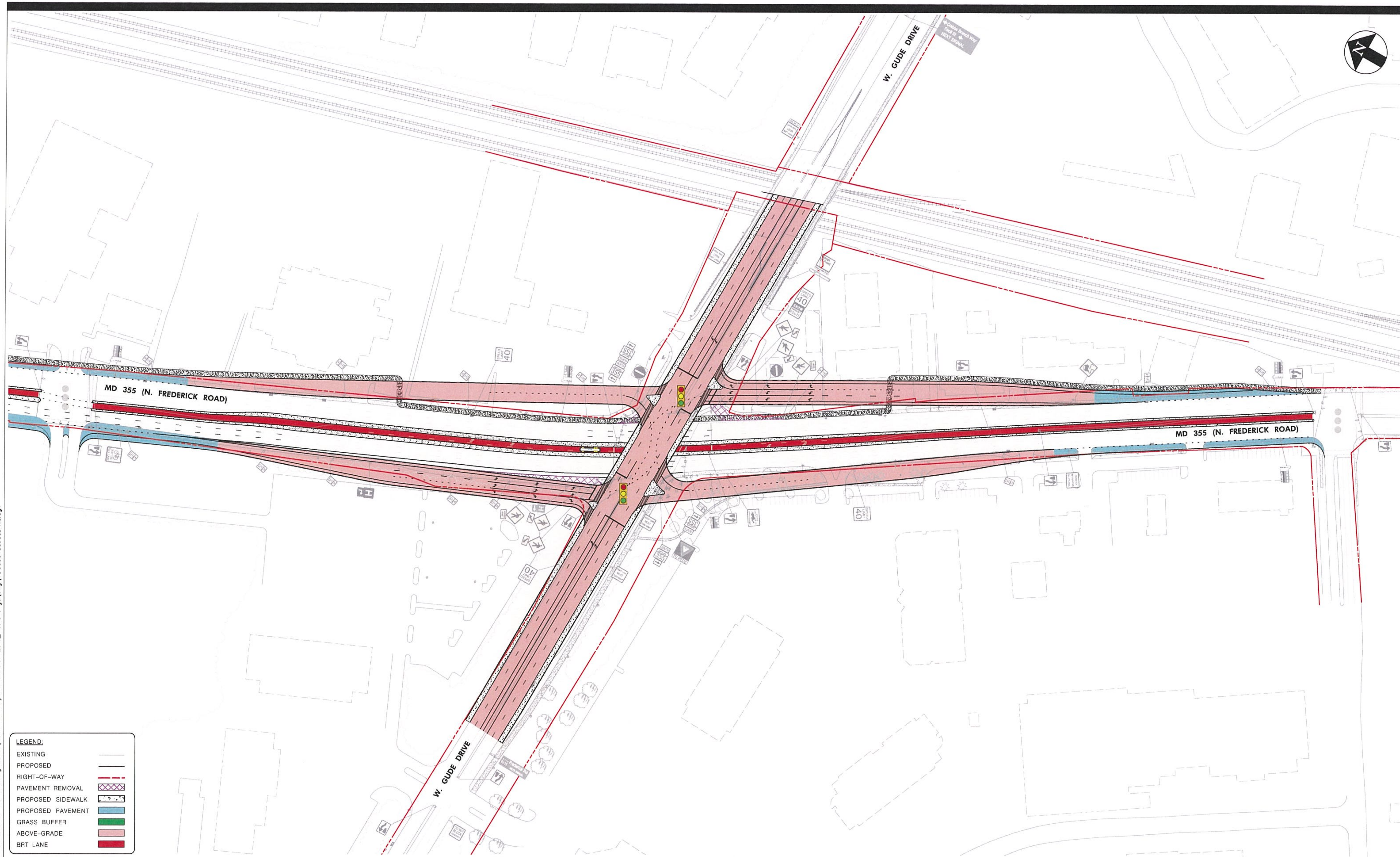
MD 355 (N. Frederick Road) at W. Gude Drive
Proposed Improvements: Above-Grade Option 5 – Left-Turn Flyover

80' 0 80' 160'
SCALE: 1" = 80'



MD 355 (N. Frederick Road) at W. Gude Drive

Proposed Improvements: Above-Grade Option 6 - Single Point Interchange

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OPERATORckeller - PLOTTED: Monday, September 30, 2019 AT 10:32 AM
FILE NAMER: \2015\43 MNCPPC Mont On-Call Planning Prime\Task 18 Shady Grove Vision Zero_Interchange\dwg\MD355andGudeDrive.dgn

5. Non-Auto Driver Mode Share (NADMS) Goals

The Draft Plan recommends supporting a 50 percent NADMS goal for residents living in the Metro Station Policy Area for all home-based work trips. The production side of the Department's Travel/4 Travel Demand network indicates that there is only a 6.6 percent difference between what would likely occur following build out in 2040 and the 50 percent goal. This is due to planned residential units' proximity to the high-quality transit coded in the Travel/4 model, including the existing WMATA Metrorail Red Line Metro Station, MD 355 Bus Rapid Transit Service, and the Corridor Cities Transitway.

Development will still be required to participate in the Greater Shady Grove Transportation Management District (TMD) and will be conditioned to meet the new regulations of approved Bill 36-18 for a "Project-based" TDM Plan. Because the Plan Area is currently within a "red" policy area, any project equal to or less than 40,000 square feet will be required to:

- Appoint a transportation coordinator;
- Notify the Montgomery County Department of Transportation (MCDOT) of project occupancy;
- Provide access to the project for distribution of Transportation Demand Management (TDM) materials, and;
- Display TDM related materials in a highly visible location.

Projects greater than 40,000 square feet in the Metro Station Policy Area will be required to:

- Develop and fund strategies to meet a NADMS goal;
- Conduct independent monitoring to determine compliance, and;
- Revise strategies and/or increase funding if compliance cannot be achieved within six years.

Parking strategies may be suggested and employed. The Planning Department can encourage Applicants to pursue such strategies in order to achieve the Plan's NADMS goals during the regulatory review process for new development.

Beyond the "red" Metro Station Policy Area, the Plan recommends a 35 percent NADMS goal for residents living within the Sector Plan area. Planning Department staff do not anticipate significant new residential projects beyond the Metro Station Policy Area; however, if such projects were to be realized, they would be subject to the thresholds and requirements of Bill 36-18 for properties in the orange tier. The provision of new transit options and pedestrian and bicycle facilities will improve non-auto access and encourage residents living within the existing single-family home communities to use alternate modes of transportation. Travel Demand Modeling efforts suggest that the 35 percent goal could be achieved.

On the attraction side, the model suggests that roughly 12.5 percent of commuters destined for the Plan Area commute by a mode other than car today. Because enhanced options will improve in the county at large, and because Bill 36-18 will require significantly more TDM agreements across the County, a NADMS target of 25 percent was used for modeling purposes. The notes for Table 12 show modeled NADMS production and attraction.

6. Infrastructure Prioritization Scheme Plan to Achieve (NADMS) Goals

Traffic congestion generally represents a state of equilibrium, where the supply of roadway facilities is completely used, and congestion has reached a point where user trips are deferred to different times, links, or modes in a transportation network. If widening projects provide more capacity, a facility is no longer in a state of equilibrium and the demand that had been deflected to other links and times shifts back to the widened facility, consuming the additional supply. Consumption of the new supply continues until equilibrium—in this case, a state of returned congestion—is restored. The "generated demand" that consumes new supply is often referred to as "induced demand."

The theory of induced demand is well documented in traffic research. Todd Litman of the Victoria Transport Policy Institute provides a sound overview with a citation list covering research over the last three decades.[4] Litman's literature review finds that induced demand reduces the benefits of roadway expansion and increases external costs.

The County currently promotes two policies which work against one another's goals. The County's desire for transportation demand management, supported by Planning Department generated NADMS goals, is diminished by its current Subdivision Staging Policy, which dictates that new development must provide additional vehicular capacity if proximate conditions are above "tolerable" levels of average intersection delay. Research suggests that when roadway capacity is increased, individuals who had previously deferred to other links, schedules, or modes with less impedance will consume the additional supply. Allowing vehicular mobility to maintain is competitiveness through the supply of additional roadway capacity reduces the likelihood that NADMS goals will be achieved.

For this reason, the *Shady Grove Minor Master Plan Amendment* supports the provision of alternative, non-vehicular mitigation when required of new development. In priority order, these include:

- Support for transit projects, including MD 355 BRT, the Corridor Cities Transitway, or other projects;
- Support for improvements that improve safety for non-motorists;
- Support for improvements that improve comfort or convenience for non-motorists, and;
- Support for roadway improvements that improve safety for drivers.

Each of these elements should be considered prior to the provision of an improvement that increases vehicular capacity.

7. Complete Streets Guide Typologies

Concurrent with the subject amendment, the Montgomery County Department of Transportation (MCDOT), the Department of Permitting Services (DPS), and Montgomery Planning initiated a joint project to develop a "Complete Streets Design Guide." The purpose of this document is to:

- To articulate a consistent, countywide vision for street design;
- Create a one-stop shop for all aspects of street design;
- Address best practices in fire access, stormwater management, use of different materials, and;
- Increase flexibility while maintaining minimum standards and continuous facilities.

[4] Litman,Todd. "Generated Traffic and Induced Travel: Implications for Transport Planning," March 2019.

The Guide will develop new street typologies, which are driven by the context of desired adjacent land uses and design rather than by function alone. Each street typology will have associated priorities and design parameters. Table 15 provides suggested typology classifications to consider for the Plan area once the Guide has been approved and adopted based on the draft parameters available at the time of this writing. This appendix excludes descriptions of the typologies and associated draft parameters to avoid confusion as the final document has not yet been released and may include minor changes.

Table 15 – Suggested Future Complete Street Typology Designations

Roadway	Limit 1	Limit 2	Proposed Complete Streets Designation
Proposed in Plan as Major Highways			
MD 355, Frederick Avenue	City of Gaithersburg City Limits (500' north of I-370)	Ridgemont Avenue	Boulevard
MD 355, Frederick Avenue	Ridgemont Avenue	Indianola Drive	Town Center Boulevard
MD 355, Frederick Avenue	Indianola Drive	Southern Plan Boundary	Boulevard
Gude Drive	City of Rockville Limits	Eastern Plan Boundary	Boulevard
Shady Grove Road*	Western Plan Boundary	I-370 Access Ramps	Boulevard
Shady Grove Road	I-370 Access Ramps	Midcounty Highway	Boulevard
Midcounty Highway	Goshen Road	Shady Grove Road	Major Highway
Metro Access Road	Intercounty Connector (MD 200)	Future WMATA Street (1,350' north of Redland Road)	Major Highway
Proposed in Plan as Arterials			
Crabbs Branch Way	Redland Road	Indianola Drive	Neighborhood Connector
Crabbs Branch Way	Indianola Drive	Gude Drive	Boulevard
Redland Road	Crabbs Branch Way	Needwood Road (northern access)	Neighborhood Connector
Proposed in Plan as Minor Arterials			
Redland Road	Needwood Road (northern access)	Muncaster Mill Road	Neighborhood Connector
Proposed in Plan as Business District Streets			
Redland Road	MD 355	Somerville Drive	Boulevard
Redland Road	Somerville Drive	Crabbs Branch Way	Neighborhood Connector
Crabbs Branch Way	Redland Road	Shady Grove Road	Town Center Boulevard

Roadway	Limit 1	Limit 2	Proposed Complete Streets Designation
Proposed in Plan as Business District Streets			
Crabbs Branch Way	Shady Grove Road	1000' north of I-370	Town Center Boulevard
Indianola Drive	MD 355	Crabbs Branch Way	Neighborhood Connector
King Farm Boulevard Extended	MD 355	Metro Station	Town Center Boulevard
Somerville Drive Extended	King Farm Boulevard Extended	Redland Road	Town Center Street
Somerville Drive	Redland Road	Paramount Drive	Town Center Street
Paramount Drive	MD 355	Somerville Drive	Town Center Street
Columbus Avenue Extended	Gramercy Boulevard	Redland Road	Town Center Street
Street A	Columbus Avenue Extended	Metro Access Road	Town Center Street
Metro South Neighborhood	MD 355	Somerville Drive	Town Center Street
Metro Access Road	Redland Road	Chieftan Avenue	Town Center Street
Proposed in Plan as Primary Residential Streets			
Crabbs Branch Way	1000' north of I-370	118' west of Castenea Lane	Neighborhood Connector
Indianola Drive	Crabbs Branch Way	Eastern Roadway Terminus-Gude Trail	Neighborhood Street
Monona Drive	Crabbs Branch Way	Indianola Drive	Neighborhood Street
Amity Drive	118' west of Castenea Lane	Washington Grove Lane	Neighborhood Connector
Needwood Road (near Blueberry Hill Local Park)	Redland Road	Blueberry Hill Local Park	Neighborhood Connector
Briardale Road	Shady Grove Road	1600' north of Shady Grove Road	Neighborhood Street
Miller Fall Road	Midcounty Highway	Shady Grove Middle School	Neighborhood Street
Epsilon Drive	Shady Grove Road	Amity Drive	Neighborhood Street
Proposed in Plan as Industrial Roads			
Oakmont Avenue	Northern Plan Boundary	Shady Grove Road	Industrial Street

8. Addendum – Updated Pedestrian Level of Comfort Analysis

The Pedestrian Level of Comfort, or "PLOC," analysis that was shared with the public during the planning process has since been updated to reflect the Department's new methodology. The new methodology breaks up facilities into seven different comfort levels, scored "1" (very comfortable) to "4" (unacceptable), including half scores (for example, "2.5" is somewhat comfortable). Facilities' scores are broken out by urban and non-urban contexts.

Factors impacting scoring include:

- Presence and width of buffering between the road and the facility, including landscaping, parking lanes, and separated bicycle facilities;
- Posted speed;
- Quality of crossing;
- Number of lanes crossed;
- Presence of protected pedestrian phases, leading pedestrian phases, or rapid flashing beacons;
- Lighting;
- American with Disabilities Act best practices, including:
    - Facility width
    - Presence of tripping hazards
    - Cross slope
    - Presence of obstructions
    - Presence and quality of detectable warning strips
    - Ramp quality
    - Presence of an accessible pushbutton

Figure 37 depicts the updated PLOC scores for the Plan Area. Figure 38 shows connectivity to WMATA's Shady Grove Metrorail Station and Figure 39 shows how connectivity is degraded due to lack of comfortable sidewalk facilities. The update largely impact crossing scores for Redland Road, Shady Grove Road, and Crabbs Branch Way. Connectivity to the Metro is greatly reduced if one assumes that pedestrians will only travel on comfortable segments. Based on the analysis, the only comfortable walks to metro are within 15 minutes. This is because of roadway crossing conditions in the Plan Area. Table 16 shows the number of dwelling units connected to the Metro Station.

Table 16 – Pedestrian Level of Comfort - Dwellings Comfortably Connected to Metro: May 2020

	Dwelling Units	Dwelling Units Connected via Comfortable Facilities	Percent Connected
15 Minute Walkshed	1432	748	52%
20 Minute Walkshed	2798	748	27%
25 Minute Walkshed	4270	748	18%
30 Minute Walkshed	5015	748	15%

Figure 37 – Updated Pedestrian Level of Comfort Analysis: May 2020

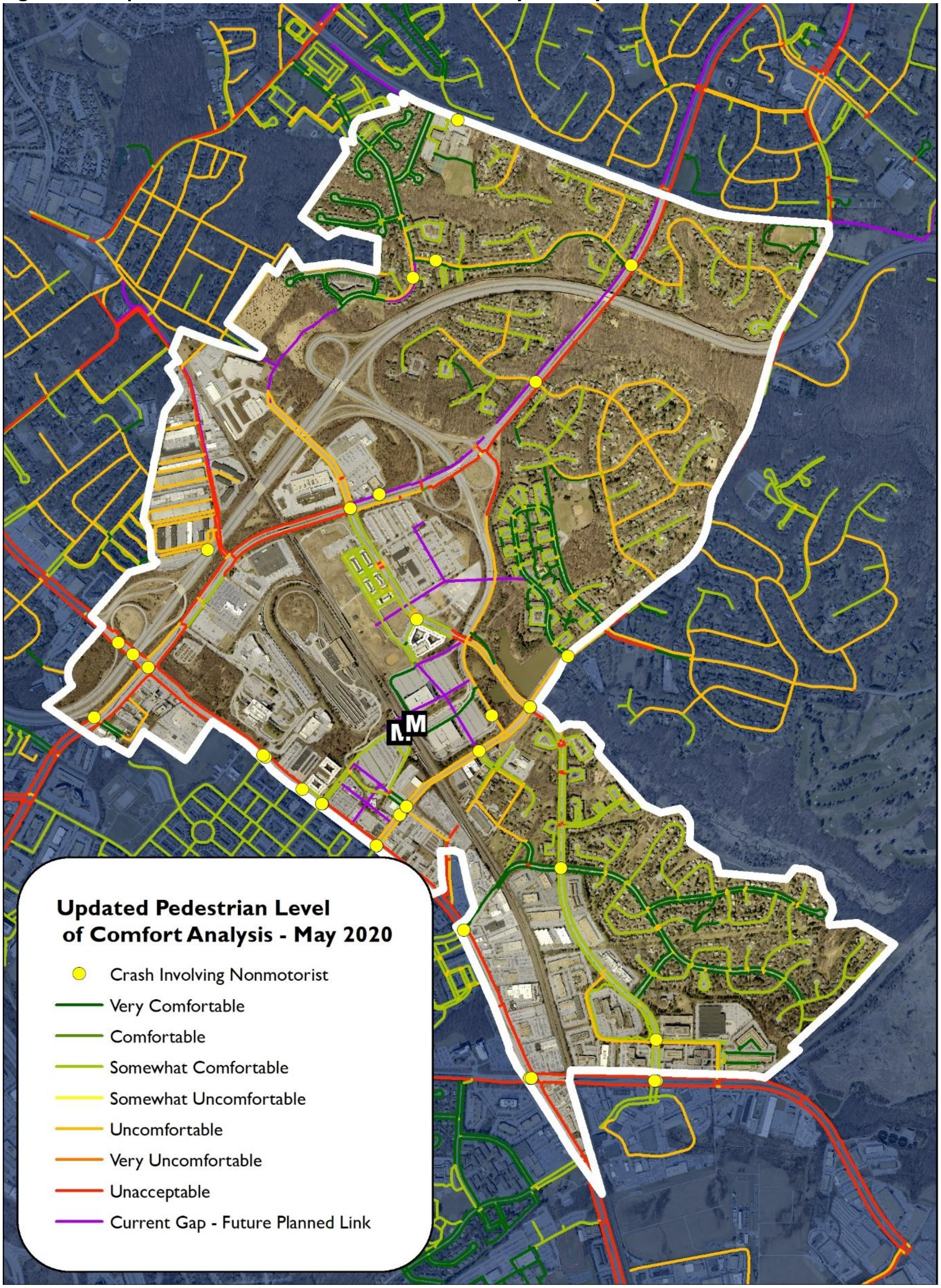

Figure 38 – Updated Pedestrian Connectivity to Metro: May 2020

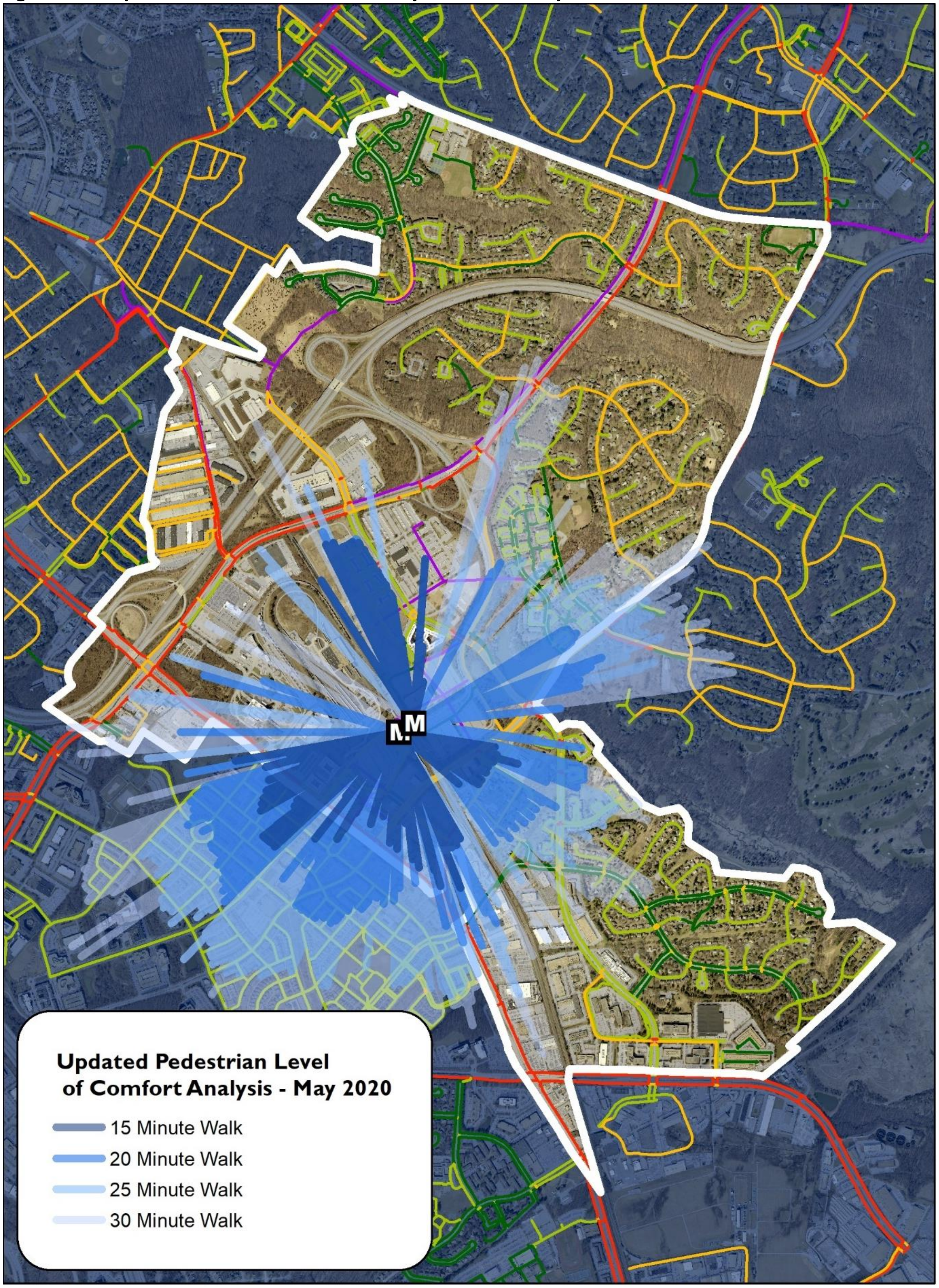

Figure 39 – Updated Pedestrian Connectivity to Metro on Comfortable Segments Only: May 2020