82 Hart Field Road Suite 105
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# Agenda

MPO Transportation Technical Advisory Committee Meeting
MPO Conference Room
Morgantown Airport Terminal
May 5, 2014
1:30 PM

1. Call To Order
2. Approval of Minutes
3. Transportation Improvement Program Amendments
4. Draft RFQ for I-79 Access Study
5. Presentation on Draft Green Bag Road-Kingwood Pike Intersection Study
6. Other Business
7. Meeting Adjournment

MMMPO
morgantown monongalia
metropolitan planning organization

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**Memorandum**

Date: April 28, 2014

To: Transportation Technical Advisory Committee Members

From: Bill Austin, AICP BA

Subject: May 5, 2014 TTAC Agenda

Please find below a short description of the action items to be considered at the May 5, TTAC Meeting to be held at the MPO Office in the Conference Room at 1:30 PM.

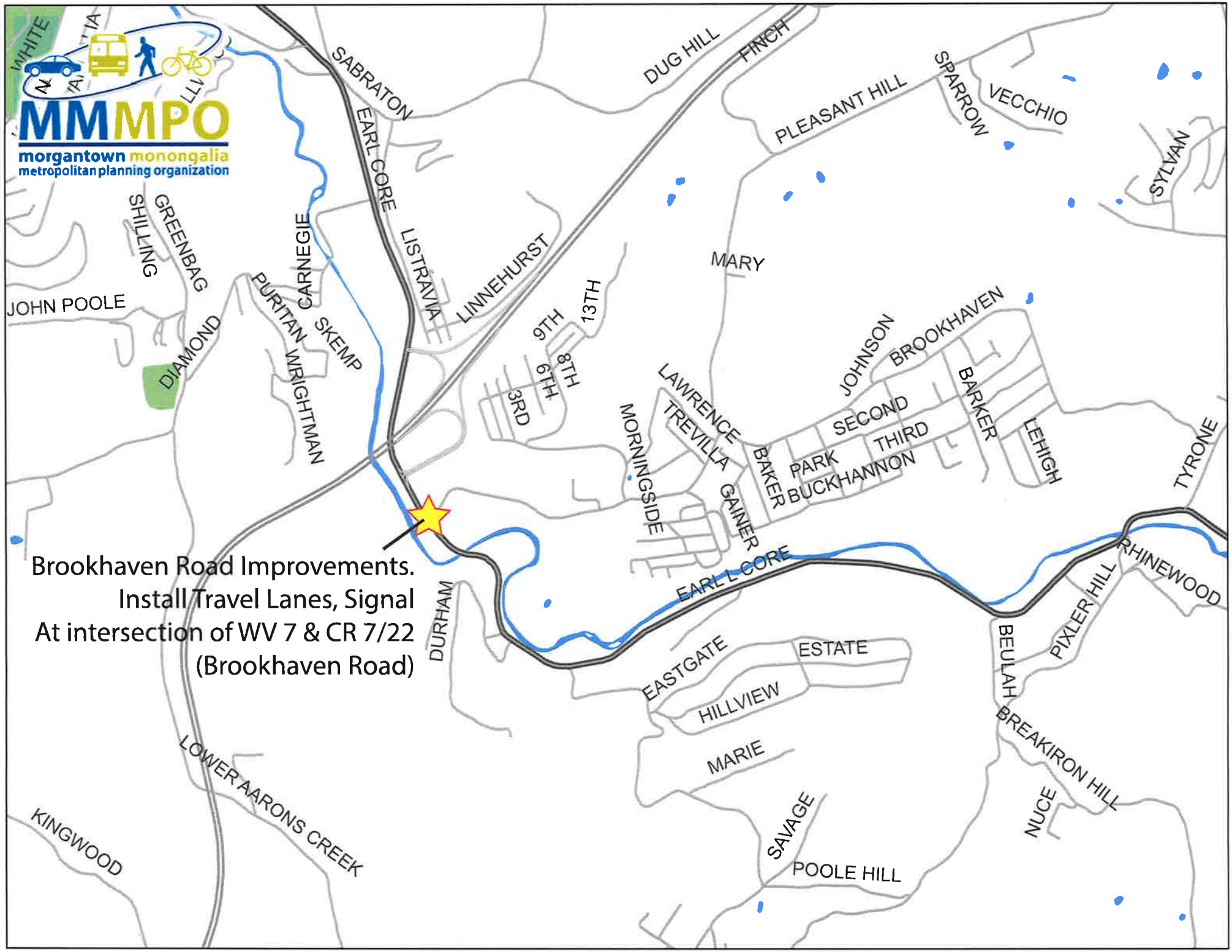
**-Transportation Improvement Program Amendments**-Please note that the West Virginia Department of Transportation has requested two TIP Amendments in addition to the removal of the Monongahela Boulevard center turn lane project. Please note that at the March Meeting the Policy Board held off on removing that project pending discussions with WVDOH on how to revive it. MPO Staff has been working with WVDOH and WVU on this issue. The two amendments WVDOH is requesting are for the WV 7 turning lane and signalization project discussed at the last TTAC meeting, WVDOH has determined that the correct location of that project is at Brookhaven Road. The attached map shows the correct location. WVDOH is also requesting that the TIP be amended by removing the Engineering and Right of Way phases associated with the Monfayette Expressway Park and Ride. The work associated with this funding has already been accomplished as part of a different project.

Mountain Line is requesting that the TIP be amended to reflect changes in the structure of the funding but not the ultimate total funding of the agency.

Please find on the following pages descriptions of TIP Amendments requested by Mountain Line Transit and the WVDOT Division of Highway.

# West Virginia Department of Transportation Division of Highways Proposed TIP Amendments

| | PROJECT NAME/TYPE/LOCATION | STATUS | PROJECT NUMBERS | | PHASE | FUNDING | PHASE COST* IN FEDERAL FY | | TOTA |
|---|---|---|---|---|---|---|---|---|---|
| | | | STATE | FEDERAL | | SOURCE | 2014 | 2015 | COS |
| 1 | Brookhaven Road Improvements | Add new project | U331-7-036.20 00 | CMAQ0007262D | ENG | CMAQ | $ 10,000 | | $ 10,000 |
| | Install Travel Lanes, Signal | | | | ROW | CMAQ | $ 15,000 | | $ 15,000 |
| | At intersection of WV 7 & CR 7/22 | | | | CON | CMAQ | | $ 475,000 | $ 475,000 |
| | (Brookhaven Road) | | | | | | | | $ 500,000 |
| 2 | Mon/Fayette Park and Ride | Cancel - phases | U331-88/1 00000 00 | CMAQ0881001D | ENG | CMAQ | $ 160,000 | | $ 160,000 |
| | Construct Park & Ride | work performed | | | ROW | CMAQ | $ 5,000 | | $ 5,000 |
| | Near CR 88/1 | under different | | | | | | | |
| | | project | | | | | | | $ 165,000 |


MMMPO
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Brookhaven Road Improvements.
Install Travel Lanes, Signal
At intersection of WV 7 & CR 7/22
(Brookhaven Road)
SABRATON
EARL CORE
DUG HILL
FINCH
PLEASANT HILL
SPARROW
VECCHIO
SYLVAN
SHILLING
GREENBAG
CARNEGIE
LISTRAVIA
LINNEHURST
MARY
JOHN POOLE
DIAMOND
PURITAN
WRIGHTMAN
SKEMP
9TH
13TH
8TH
6TH
3RD
LAWRENCE
TREVILLA
MORNINGSIDE
JOHNSON
BROOKHAVEN
SECOND
THIRD
PARK
BUCKHANNON
BAKER
GAINER
BARKER
LEHIGH
TYRONE
EARL L CORE
RHINEWOOD
PIXLER HILL
BEULAH
BREAKIRON HILL
NUCE
DURHAM
EASTGATE
ESTATE
HILLVIEW
MARIE
SAVAGE
POOLE HILL
LOWER AARONS CREEK
KINGWOOD

**Mountain Line Transit**
**Increase Total Section 5307 Federal Funding***

| FY 2013 Fed. | FY 2014 Fed. | FY 2015 Fed. | FY 2016 Fed. | FY 2017 Fed. |
|---|---|---|---|---|
| Current $1.5279 million | Current $1.5279 million | Current $1.5279 million | Current $1.5279 million | Current $1.5279 million |
| Proposed $1.571 million | Proposed $1.571 million | Proposed $1.571 million | Proposed $1.571 million | $1.571 million |

**Increase Section 5307 Safety and Security Federal Funding***

| FY 2013 Fed. | FY 2014 Fed. | FY 2015 Fed. | FY 2016 Fed. | FY 2017 Fed. |
|---|---|---|---|---|
| Current $15,500 | Current $15,500 | Current $15,500 | Current $15,500 | Current $15,500 |
| Proposed $16,000 | Proposed $16,000 | Proposed $16,000 | Proposed $16,000 | Proposed $16,000 |

*These funding categories require a 50% local match which is programmed by Mountain Line

**Increase Section 5339 Bus and Bus Facility Formula Federal Funding****

| FY 2013 Fed. | FY 2014 Fed. | FY 2015 Fed. | FY 2016 Fed. | FY 2017, Fed. |
|---|---|---|---|---|
| Current TIP $125,000 | Current TIP $125,000 | Current TIP $125,000 | Current TIP $125,000 | Current TIP $125,000 |
| Proposed $131,000 | Proposed $131,000 | Proposed $131,000 | Proposed $131,000 | Proposed $131,000 |

**MOUNTAIN LINE TRANSIT**
**Revise Section 5307 Mobility Manager Federal Funding****

| FY 2014 Fed. | FY 2015 Fed. | FY 2016 Fed. |
|---|---|---|
| Current TIP<br>$50,000 | Current TIP<br>$50,000 | Current TIP<br>$50,000 |
| Proposed<br>$150,000 | Proposed<br>$0 | Proposed<br>$0 |

**Revise Section 5307 New Fit and Senior Mons Federal Funding****

| FY 2014 Fed. | FY 2015 Fed. | FY 2016 Fed. |
|---|---|---|
| Current TIP<br>$50,000 | Current TIP<br>$50,000 | Current TIP<br>$30,000 |
| Proposed<br>$130,000 | Proposed<br>$0 | Proposed<br>$0 |

**Draft RFQ for I-79 Access Study-**Please find enclosed with your agenda packet a draft Request for Qualifications for the I-79 Access Study. This Study is recommended in the MPO's 2140 Long Range Transportation Plan. As recommended in the LRTP the Study is to review proposed locations for a new bridge over the Monongahela River. MPO and WVDOH staff have discussed the project and determined that the most useful format for the Study would be to revisit the purpose and need identified for the project LRTP to determine if a new river crossing is the appropriate direction for the area. If it is found that the project purpose and need is appropriate this work should be able to feed directly into the environmental process. If the TTAC and the Citizens Advisory Committee are comfortable with this draft we will submit it to the MPO Policy Board with contractual language for it's release. If the Committee's recommend additional work we will bring a revised version back at the June meetings. It is requested that at a minimum the TTAC designate three members to work with the MPO Director on the Consultant selection team as required by the MPO's RFP Policy.

**Draft Green Bag Road/Kingwood Pike Intersection Study**-Please find enclosed for your review a draft operational study performed on the intersection of Green Bag Road and Kingwood Pike. This intersection is part of a larger corridor identified as a Tier One Priority in the MPO's Long Range Transportation Plan. MPO staff selected this intersection for study due to the easily identified congestion in the area and the relatively simple operation of the intersection. This made it appropriate for Staff's first in-house study while also addressing a portion of an important corridor for consideration. Staff is requesting that the TTAC review the methodology used as well as the information provided in the draft report to ascertain the appropriateness of the format and detail of the Study as well as the recommendations made in the Study.

MPO Staff also requests that the TTAC provide a recommendation on how MPO Staff should evaluate the recommendations of this and future studies. MPO Staff''s preliminary recommendation from this Study is to recommend the immediate implementation of Alternative IIa to provide an adequate level of service now and in the immediate future with plans to upgrade the intersection to alternative I before 2040. We would appreciate any guidance the TTAC may be able to provide in this area.

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# MINUTES

MPO Transportation Technical Advisory Committee Meeting
Morgantown Airport Terminal Building 1st Floor
Morgantown Monongalia MPO Conference Room
March 11, 2014
1:30 PM

## Members Present

Damien Davis-City of Morgantown, Terry Hough-City of Morgantown, Richard Wood-Monongalia County, Bill Austin-MMMPO, Elwood Penn-WVDOH, Fouad Shoukry-WVDOH, Arlie Forman-WVU, Brian Carr-WVDOH, Chris Fletcher-City of Morgantown, Kevin Burgess-FHWA

## Others Present

Jing Zhang-MMMPO

## Call to Order

Bill Austin called the meeting to order at 1:38 PM.

## Approval of the Minutes

After the introductions Mr. Austin noted that the Minutes of the January meeting had been included in the agenda packet. He noted that the year of the meeting needed to be changed and then asked for any corrections the Committee members might have to the Minutes. There being no corrections Mr. Austin then called for a motion to approve the Minutes. Mr. Wood moved to approve the minutes; seconded by Mr. Penn. The motion was unanimously approved.

## Transportation Improvement Program Amendments

Mr. Austin introduced the proposed amendments to the TIP. Mr. Austin noted that the most unusual TIP amendment was the removal of the Project to install a center turn lane on Monongahela Boulevard. Mr. Austin asked if the Division of Highways would please explain why this project was being removed. Mr. Carr stated that he was not certain of the reason. Mr.

Fletcher noted that $1.3 million was a lot of money for the area to lose. Mr. Shoukry stated that he was unaware of the reason for the withdrawal of the funding but he feels this is a worthwhile project. Ms. Hough stated that a possible reason for the withdrawal of the project is the cost associated with the need to accommodate pedestrians within the area. She also stated another possible reason that the funding for the project might have been removed was the WVU Athletic Departments concern about the potential loss of parking associated with it.

Mr. Austin then introduced the remainder of the highway projects for consideration by the TTAC. Mr. Austin noted that there is a project for a design study of the intersection of WV 7 and US 19 in Pursglove, Mr. Austin stated that there had been a fatality at this intersection last year. Mr. Shoukry asked exactly what is meant by a design study. Mr. Carr was not exactly sure what is meant by this term but he would follow up on it.

Mr. Austin then noted that there is a proposed project to realign the intersection of Beechurst Avenue and Campus drive and to potentially make it a four legged intersection. Mr. Austin noted that this project is in agreement with LRTP's recommendation to improve the Beechurst corridor.

After a short discussion Mr. Austin then introduced the proposed amendment for the addition of a turn lane in the installation of a signal at the intersection of WV7 at Brookhaven Road, In reviewing the mapping provided by the MPO based on information from WVDOH, it was determined by the TTAC that the subject project is actually proposed to take place at the intersection of Tyrone Road and WV 7.

Mr. Austin then introduced Mountain Lines requested TIP Amendments to add back most of the funding for the Senior Mons Nutrition Program service and the Mobility Manager. Austin noted that these amendments added back $280,000 of the $300,000 that was removed from Mountain Lines budget with the last TIP Amendments. He explained that these amendments are due to WVDOT stipulating that Section 5307 funds can be used for these projects which was unclear at the time of the previous TIP Amendments.

After a short discussion Mr. Fletcher moved to recommend approval of the proposed TIP amendments to the MPO Policy Board with the stipulation that Mr. Austin relay the suspected reasons for the loss of the Monongahela Boulevard Project to the Policy Board. The motion was seconded by Ms, Hough. The motion was unanimously approved.

**Draft Morgantown Monongalia County Bicycle Plan**

Mr. Austin then introduced the Draft Morgantown Monongalia County Bicycle Plan. He stated that with his assistance Mr. Zhang and Mr. Davis have been working with a steering committee to develop an Urban Area Bicycle Plan. He noted that the draft Bicycle Route Map had been presented to the TTAC and the MPO at the last meeting. Since that time the Steering Committee had held a public meeting and sought comments on the Plan on the internet and from members of

the Greater Morgantown Bicycle Board. He stated that this Plan has been designed for ease of implementation at a low cost.

Mr. Shoukry asked for clarification on the type of information that would be available for DOH as they considered improvements to the area. Mr. Zhang stated that there is documentation of the recommendations for these facilities on the corridor level that will be shared in the final report. Mr. Zhang noted that the information provided on the mapping also identifies locations where it may be necessary to purchase right of way to implement the Plan. He noted that there are only 3 locations where this may be necessary.

Mr. Fletcher noted that funding is limited for these types of improvements and he would like to make sure that the City Manager is aware of these efforts. Mr. Austin stated that he had forwarded the Route Map that was shared with the TTAC and the Policy Board to the City Manager and that he would forward the draft Plan to the City Manager as well.

Ms. Hough expressed concern about the cost of implementing the plan and the maintenance of the proposed facilities. Mr. Davis stated that the Steering Committee had be very mindful of this issue and that the designated proposed facilities consisted primarily of striping and signage. Mr. Austin noted that the Steering Committee's top 5 priorities were estimated to cost less than $100,000.

After a more discussion Mr. Fletcher moved to recommend approval of the draft Bicycle Plan to the MPO Policy Board. The motion was seconded by Mr. Wood. Ms. Hough commented that she was relying on Mr. Davis' recommendation in this matter. Without further comment Mr. Fletcher's motion was unanimously approved.

**Downtown Operations Study**

After the conclusion of the discussion of the draft Bicycle Plan Mr. Austin introduced the Downtown Operations Study. He stated that it had been hoped that Dr. Nichols of the Rahall Institute would have the preliminary findings documentation available for this meeting. He will be making a presentation on those findings at the Policy Board meeting. He stated that those findings should be available prior to the end of the week and that he will share them with the MPO's Committees prior to the Policy Board meeting.

**Traffic Count Locations**

Mr. Austin then noted that the counts for the MPO's Annual traffic count would be taken in April on the 9th and 10th.. The TTAC had been provided with a map of proposed count locations to be added to the Program and that he would appreciate the Committee's review and comments on the proposed new locations. He noted that this item is clearly a technical item that would not need to be addressed by the Policy Board. Ms. Hough noted that the only count location she could see a problem with was the North Avenue location. Her concern with this location is that

North Avenue is experiencing physical problems and that she did not know if the counters would be affected by work that may need to be done to the road. Mr. Austin said that the MPO would take this location off of the list until the road is in better condition. Ms. Hough asked that the MPO remind the City and the University of the traffic count dates so that the counters would not be impacted by street sweepers. Mr. Austin stated that he would make sure to notify these agencies prior to the counts.

**Status of the Van Pool Program**

Mr. Austin informed the TTAC that the MPO is now subsidizing two van pools and that Ms. LaNeve, Mountain Lines Mobility Coordinator is working to recruit additional van pools. He stated that there had been some questions from FTA about the CMAQ grant for the Project since until recently very little of the funding had been spent. He noted that Mr. Bruffy had responded to the inquiry and that since the project is now moving forward it is not anticipated that this funding is in jeopardy.

**Other Business**

Mr. Austin opened the floor for other business the group might bring forward. Mr. Fletcher asked DOH how he should respond to groups who asked if they could plant flowers or other plants in the roundabout. Mr. Shoukry stated that these groups could be referred to him.

After that discussion. Mr. Austin stated that he had asked Mr. Carr to update the MPO on the status of several projects, the Patteson+1 Project, the Van Voorhis Project, the West Run Widening Project, the Collins Ferry roundabout study and the Green Bag Road/WV 7 Intersection Improvement Project. Mr. Carr stated that the Green Bag Road/WV7 Study has been given to a consulting firm. He also noted that the West Run Project may be ready for letting as early as this fall. The other projects are waiting on the new Division Design Engineer to get in place before they can move forward.

**Adjournment**

There being no further business the meeting adjourned at 3:15 PM.

# Request for Qualifications for Consulting Firms

# To Perform Work for the Morgantown Monongalia Metropolitan Planning Organization

This Request for Qualifications is subject to the Morgantown Monongalia Metropolitan Planning Organizations Request for Proposal Process adopted in August of 2012 and which is available on the MPO's website www.plantogether.org

**Purpose of Request for Qualifications**-This RFQ is to identify qualified bidders to conduct complex planning tasks on behalf of the Morgantown Monongalia Metropolitan Planning Organization. The purpose of these tasks will be to expand on the recommendations of the most recent update of the MPO's long range transportation plan, in particular the recommendation related to the construction of a facility or facilities to provide additional access for the area's urban core to I-79 and the area west of the Monongahela River. It is anticipated that if justified, this Study will provide the proposed transportation improvement project with a Project Purpose and Need Statement, preliminary public involvement and analysis that may be used as part of a Planning and Environmental Linkage document as specified by WVDOH Policy. It is anticipated that if a Project recommendation comes out of the proposed Study this Study will be the first stage of a comprehensive corridor study. The second phase would be performed by WVDOH. The Consultant selected for this project will be eligible for the second phase of the Study if it is determined that it should move forward. It is possible that this phase of the Study would need to be completed within one year of the notice to proceed.

**Study Technical Elements-**It is anticipated that the Study will consist of a variety of technical and public involvement tasks including but not limited to the following:

-Upgrading the MPO's TransCad Model with significantly enhanced data and appropriate network coding (anticipated to be minimal) to provide more sensitivity for corridor analysis and to provide an enhanced interface for the use of the model by MPO staff.

-Evaluation of the need for additional access as described in the MPO's 2040 LRTP.

If the need for additional access is confirmed utilizing the enhanced model then work will proceed to identify a project purpose and need statement for use in the Project development process and a preliminary evaluation of corridors or strategies that may address the project purpose and need. At a minimum it is anticipated that this work will include the following:

-Analysis of the corridors identified in the MPO's 2040 Long Range Transportation Plan ability to address the identified purpose and need of the Project. The 2040 Long Range Transportation Plan identifies three locations for a potential facility with ancillary streets to provide this access. The three locations for potentially crossing the Monongahela River are in the vicinity of 8th Street in Morgantown, the WVU Coliseum, and a proposed extension of West Run Road in Monongalia County.

-Identification of additional corridors and alternative strategies that may address the purpose and need identified for the Project.

-Screening level evaluation of the identified corridors and strategies impact on the community and the environment work to include but not be limited to:

> -Identification of potential environmental impacts including wetlands, endangered species, archaeological sites, public properties etc.

-Identification of potential socio-economic impacts of potential alternatives including but not limited to potential land use changes, natural environment issues and environmental justice issues.

-Necessary ancillary improvements to the surface street network resulting from the identified potential alternatives

**Public Involvement**-It is anticipated that the development of a Project Purpose and Need statement as well as the evaluation of proposed strategies and corridors will require significant public involvement to be used as an important part of any Project evaluation criteria. At a minimum proposers should anticipate gathering input from the MPO's stakeholders including the public and elected officials from the area's local governments as well as holding a significant number of public meetings to discuss corridors. It is also anticipated that the project will have a web presence to present information and to solicit input. It is anticipated that any final report developed will be available for review by the MPO's Committee's and that there will be a presentation to the MPO Policy Board by the selected consultant.

**Study Evaluation Criteria**-The evaluation criteria for each alternative in the Study may include but not be limited to:

-Addresses the 2040 LRTP Goals and Objectives and identified transportation needs

-Addresses the Comprehensive Plan Goals and objectives for each community impacted

-Social and economic impacts

-Environmental impacts

-Cost benefit analysis

-Public evaluation of each alternative

-Additional criteria specified by the Steering Committee

The results of this analysis will be presented in a matrix summarizing the results for each alternative

**Consultant Selection Criteria**-It is anticipated that the following criteria will be used to select the consultant for this Project:

-Technical Capability-The selected consultant will have a demonstrated knowledge of TransCad and data collection techniques sufficient to update the MPO's model in a short time frame and within reasonable cost constraints. The selected consultant will also have extensive experience in using GIS data collection techniques to identify and quantify potential environmental and socio-economic impacts in a quick and cost effective manner. The selected consultant will also be familiar with appropriate format for sharing this data with the appropriate resource agencies.

-Public Involvement-The selected consultant will have the capability to present the proposed alternatives in an understandable, concise, and accurate manner while still identifying the significant aspects of each alternative. The proposals will include significant non-public meeting outreach to the community for the conduct of an inclusive conversation about the proposed alternatives while still maintaining a cost effective approach to the project.

-Consultant availability to work with staff and the public throughout the project.

-Consultant experience with comparable projects.


# GREENBAG RD AND DORSEY AVE INTERSECTION STUDY

APRIL, 2014

*(Draft)*

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# LIST OF FIGURES

# 1.0 Study Purpose

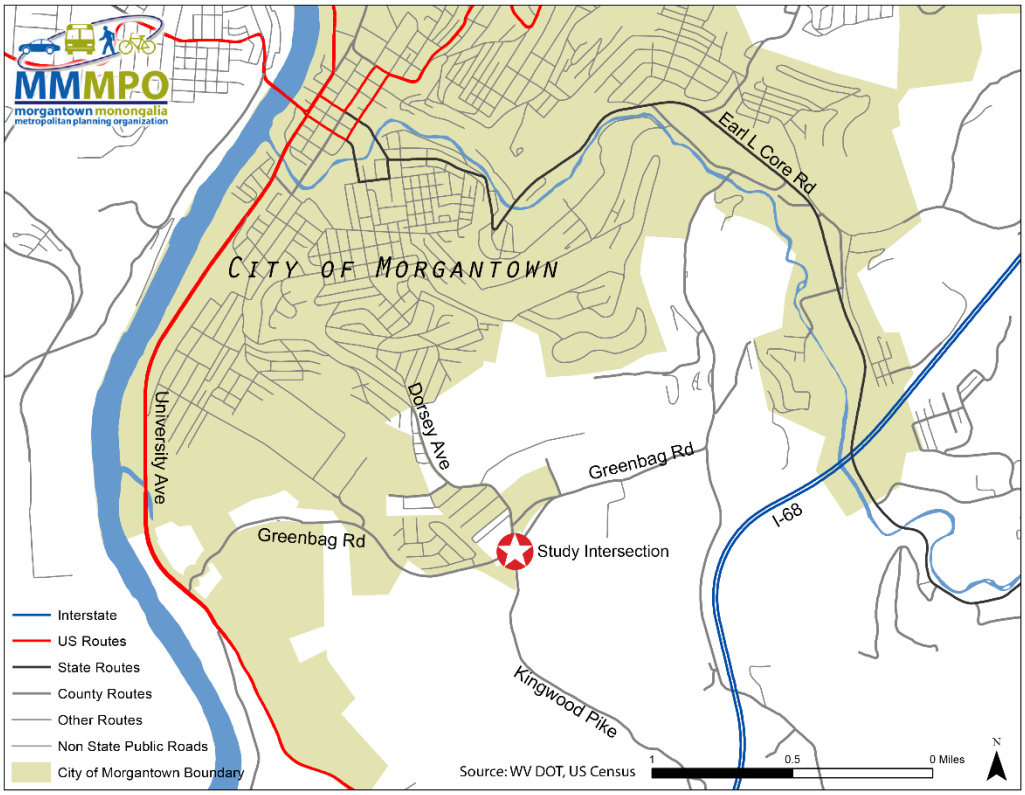
The purpose of this study is to understand the existing condition of Greenbag Rd and Dorsey Ave/Kingwood Pike intersection and to make preliminary recommendations to improve its safety and operational performance. It is also intended to establish a standard analytical procedure for similar studies to be conducted by MPO staff.

This study was prepared by MPO staff as a project of the MMMPO Unified Planning Work Program FY 2013-2014. This intersection was identified as a priority safety improvement location in the 2040 MMMPO Long Range Transportation Plan (LRTP), and was included in the Greenbag Road Improvements Project, a tier 1 project recommended in the LRTP.

# 2.0 Description of Location

The subject intersection is located at CR 875 (Greenbag Rd) and CR 81 (Dorsey Ave/Kingwood Pike) in Monongalia County, WV. Greenbag Rd is a minor arterial, two-lane facility that provides an important south-west connection in the southern Morgantown area linking US 119 (University Ave) and WV 7 (Earl L Core Road). Dorsey Ave/Kingwood Pike is a minor arterial, two-lane facility through the First Ward area and into the southeast end of the county. The project location is shown in Figure 1.

**FIGURE 1 PROJECT LOCATION**



# 3.0 EXISTING CONDITIONS

This section provides information that characterize the subject intersection. It includes review of geometric conditions, crash history, traffic operational status and other intersection related features. These key components form the basis for assessing the current physical and operating conditions of the subject intersection.

## 3.1 GEOMETRY & TOPOGRAPHY

The dimensions and topography include lane width, street width, turning radius, intersection length, and locations of utility/signal light poles, which are shown in Figure 2 and summarized in Table 1.

Geometric data was collected by using the Pictometry Aerial Map and Pictometry distance-measuring tool embedded in the ESRI Arch Map; topographic data came from 2 feet contour mappings from the Monongalia County GIS Database. Although every effort has been made to provide accurate geometric information for the intersection, the accuracy of the data used in this analysis cannot be guaranteed.

**TABLE 1 INTERSECTION DIMENSION SUMMARY**

| | Southwest Leg | Northeast Leg | North Leg | South Leg |
|---|---|---|---|---|
| Approching lane width | 12’5” | 9’2” | 9’10” | 9’5” |
| Pavement width (edge to edge) | 25’ | 21’9” | 20’10” | 20’9” |
| Right turn radius | 41’10” | 22’7” | 56’5” | 58’9” |
| Through movement travel length | 147’2” | 147’2” | 168’4” | 168’4” |
| Stop line offset | 72’3” | 43’10” | 75’10” | 70’7” |

Following characteristics of the intersection have been identified:

- **The Roadways intersect at skewed angels, which decrease the intersection’s safety and efficiency.** The skewed angle of this intersection results in 1) Longer traveling distance for vehicles entering the intersection, and therefore an increased time of exposure to the cross-street traffic; 2) limited vision for entering vehicles to observe opposing and crossing traffic; 3) the difficulty of aligning vehicles entering the cross street to make a right or left turn; and 4) acute-angle radius requiring large vehicles to encroach beyond their intended right of way to accomplish a turning movement.

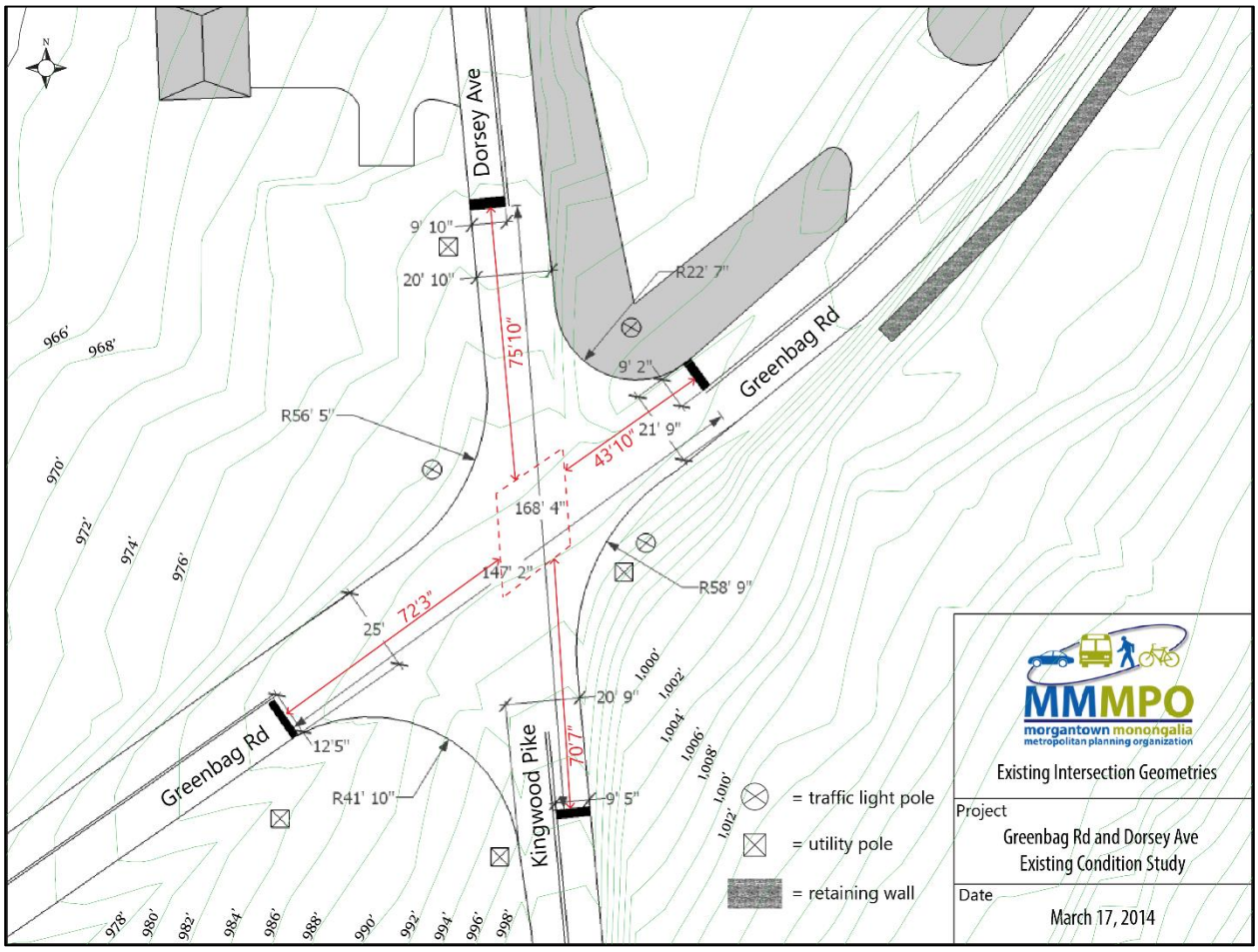
- **The slopes of the intersection reduces its safety and efficiency.** The slope of the road increases when going southbound from Dorsey Ave to Kingwood Pike and when going northeast bound on Greenbag Rd. This obscures vision for vehicles entering the intersection, requiring a longer start up and lost time for southbound and northeast bound vehicles.

- **Narrow lane width reduces intersection’s capacity.** The width of three of the approaching lanes at the intersection are under 10 feet, except for the southwest leg. This reduces the maximum rate at which vehicles can pass through the intersection under prevailing conditions.

- **Small turning radiuses make some turning movements difficult for large vehicles.** The small inside turning radii and design turning radii resulting from the skewed angle and slopes at this intersection make it difficult for large vehicles making turning movements. Large vehicles observed at the intersection during the field traffic count include Mountain Line Transit Authority buses, large school bus (S-BUS-12), interstate semitrailer (WB-20), and intermediate semitrailer (WB-12). Those vehicles have wider and longer wheelbases, which result in them requiring greater minimum turning radii than do passenger

vehicles. The southwest bound right turn, southbound left turn, northbound left turn, and northeast bound right turn are all difficulte movements.

**FIGURE 2 GEOMETRIC DIMENSIONS AND TOPOGRAPHY**




## 3.2 Lane Designation and Signal Timing

The intersecting roads are both two-lanes with each approaching lane designated as a shared left-turn, through, and right-turn lane. Left turns operate under permissive only mode, which requires left-turning drivers to yield to a conflicting vehicle before completing the turn, that is, a green arrow for left turn traffic is never provided. The efficiency of this mode is dependent on the availability of gaps in the conflicting streams through which the turn can be safely completed[1].

The signal timing of the intersection is uncoordinated and is operated by pretimed control in which the cycle length, phase plan, and phase times are preset to repeat continuously. The southwest bound and northeast bound movements are allocated with 45 seconds green time and the southbound and northbound movements 35 seconds.

[1] Federal Highway administration, *Traffic Signal Timing Manual*, 2008, P 4-8

Figure 3 illustrates lane designation, speed limits and timing phrase. Figure 4 and 5 show the current signal timing plan. Data are summarized in Table 2. The intersection's operational status is discussed in 3.10 Traffic Operation.

**FIGURE 3 INTERSECTION AERIAL PHOTOGRAPH**


**FIGURE 4 RING-AND-BARRIER DIAGRAM**

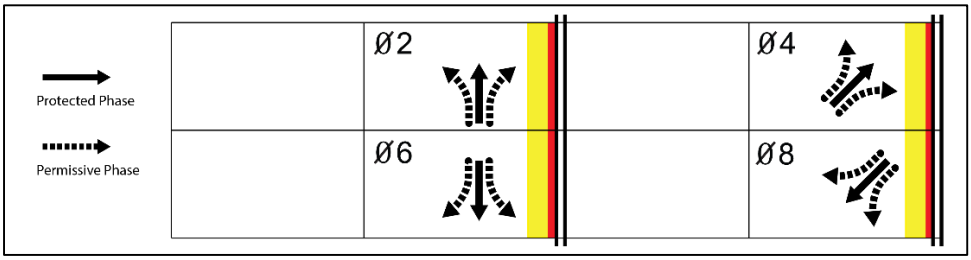



**FIGURE 5 SPLITS AND PHASES DIAGRAM**

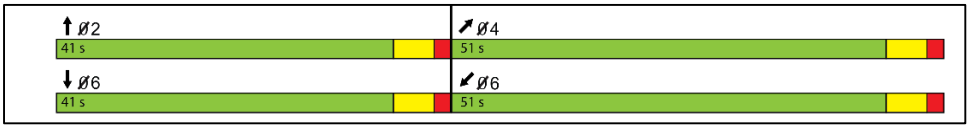



**TABLE 2 SIGNAL TIMING SUMMARY**

| | Approaching Speed Limits | Phase Number | Effective Green Time | Yellow Time | All Red Time | Left-turn Mode |
|---|---|---|---|---|---|---|
| Northbound | 45 MPH | 2 | 35 s | 4 s | 2 s | Permissive |
| Southbound | 35 MPH | 6 | 35 s | 4 s | 2 s | Permissive |
| Northeast Bound | 40 MPH | 4 | 45 s | 4 s | 2 s | Permissive |
| Southwest Bound | 40 MPH | 8 | 45 s | 4 s | 2 s | Permissive |

## 3.5 LAND USE PATTERN

The intersection is located outside of the City of Morgantown boundary, but it is included in the city's comprehensive plan for extended study and land management purposes. Currently, there is a one-floor business building located on the northeast corner of the intersection.

## 3.6 PEDESTRIAN AND BICYCLIST SAFETY ASSESSMENT

This study uses both field assessment and the Pedestrian and Bicyclist Intersection Safety Indices (Ped ISI and Bike ISI) to assess the pedestrian and bicyclist safety at the subject intersection. The field assessment was conducted during the traffic count period and following characteristics was observed.

- **No pedestrians or bicyclist were observed during the field study period.** The lack of pedestrian and bicyclist traffic at this intersection may be largely because of the existing built environment of the surrounding area. It may be also because of the existence of alternative routes that divert any possible pedestrian and bicyclist traffic traveling in this area. Those routes include Luckey Ln and Richard Ave.
- **Some facilities beneficial to pedestrians and bicyclists are not provided.** Such facilities include, but not limited to, curb, wide shoulder, sidewalk pedestrian or bicyclist signal phase, crosswalk, and appropriate bicycle signage.
- **Uneven road surface constitute a hazard for bicyclists crossing this intersection.** Uneven surface exists in the center of the intersection, poses a potential hazard for bicyclists, especially when they travel through this intersection without any appropriate awareness or warning.

The Indices assign the subject intersection with values between 1 (safest) and 6 (least safe), which are produced by using method provided by Pedestrian and Bicyclist Intersection Safety Indices: User Guide[1]. Each leg of an intersection may have different characteristics affecting pedestrian or bicyclist safety; therefore the tools are intended to provide an evaluation of the safety of an individual crossing (Ped ISI) or approach leg (Bike ISI) rather than evaluating the intersection as a whole.

The Ped ISI and Bike ISI for the subject intersection are shown in Table 3 and Table 4[2].

**TABLE 3 PEDESTRIAN SAFETY INDEX**

| Intersection Leg | Ped ISI Value |
|---|---|
| North | 1.847 |
| South | 2.015 |
| Northeast | 1.955 |
| Southwest | 1.979 |

**TABLE 4 BICYCLIST SAFETY INDEX**

| Intersection Leg | Bike ISI Value |
|---|---|
| North | TH 3.413 |
| | RT 1.484 |
| | LT 2.495 |
| Northeast | TH 3.389 |
| | RT 1.646 |
| | LT 2.645 |
| South | TH 3.413 |
| | RT 1.484 |
| | LT 2.495 |
| Southwest | TH 3.389 |
| | RT 1.646 |
| | LT 2.645 |

[1] Detailed description of the method is provided in Appendix B Technical Support Document.
[2] ADT volume is estimated by using the data from nearby count stations in the 2013 MMMPO Traffic Count Report.

## 3.8 TRANSIT LEVEL OF SERVICE

This study uses the fixed-route transit service measures[1] to access the transit level of service for the subject intersection. The intersection has one bus stop served by Orange Line Route 4 and Mountain Heights Route 14, which are operated by the Mountain Line Transit Authority.

Service frequency determines how many times an hour a user has access to the transit mode, assuming that transit service is provided within acceptable walking distance and at the times the user wishes to travel. Service frequency LOS is determined by destination from a given transit stop. The service frequency LOS to major destinations from the stop at this intersection is summarized in Table 5.

**TABLE 5 TRANSIT SERVICE FREQUENCY LOS**

| Destination from the intersection | Ave. Headway (min) | LOS |
|---|---|---|
| Morgantown Downtown/Bus Depot | 31-60 | E |
| Westover Terminal | 31-60 | E |
| WVU Evansdale Campus | 31-60 | E |
| Mountaineer Mall | >60 | F |

LOS E is service once per hour, which corresponds to the minimum service frequency applied when determining hours of service LOS. LOS F suggests service at frequencies greater than 1 hour, entailing highly creative planning or considerable wasted time on the part of passengers.

The passenger load LOS reflect the comfort level of the on-board vehicle portion of a transit trip. Based on field observation, the passenger load LOS for the stop at the intersection is at LOS A, suggesting passengers are able to spread out and can use empty seats to store parcels and bags.

## 3.9 CRASH ANALYSIS

This part provides an analysis of the characteristics of crashes that occurred at the subject intersection. Crash data used in this crash analysis are from the WV DOT Crash Database between 2009 and 2011, which was geocoded by MPO staff in 2013. Findings are summarized in Table 6 and 7.

**TABLE 6 CRASH FREQUENCY AND RATE**

| Year | Crash Frequency | Number of vehicle involved | Injury[2] | Crash Rate[3] | State Average[4] |
|---|---|---|---|---|---|
| 2009 | 3 | 5 | 3 | 521 | 380 (non- intersection) |
| 2010 | 3 | 2 | 0 | | |
| 2011 | 2 | 4 | 0 | | |

**TABLE 7 CRASH COLLISION TYPE**

| Collision Type | Frequency |
|---|---|
| Rear End | 4 |
| Single Vehicle Crash | 2 |
| Right Angle | 2 |

[1] As provided by Transit Capacity and Quality of service Manual, Transportation Research Board

[2] No fatal crash reported during the study time period.

[3] Per hundred million entering vehicles. The ADT volume is estimated by compiling the peak hour ratio from the nearby count stations of the 2013 traffic report and the data from the field count. The crash rate should not be interpreted rigidly.

[4] Based on the state average crash rate for county route; - 2003 West Virginia Crash Data

## 3.10 TRAFFIC OPERATION

This section assesses the current operational status of the subject intersection by using three types of methods, which are the Quick Estimation Method (QEM), the Automobile Method, and the Intersection Capacity Utilization (ICU) Method. The characteristics of each method are summarized in Table 8.

**TABLE 8 TRAFFIC OPERATION ANALYSIS METHOD DESCRIPTION**

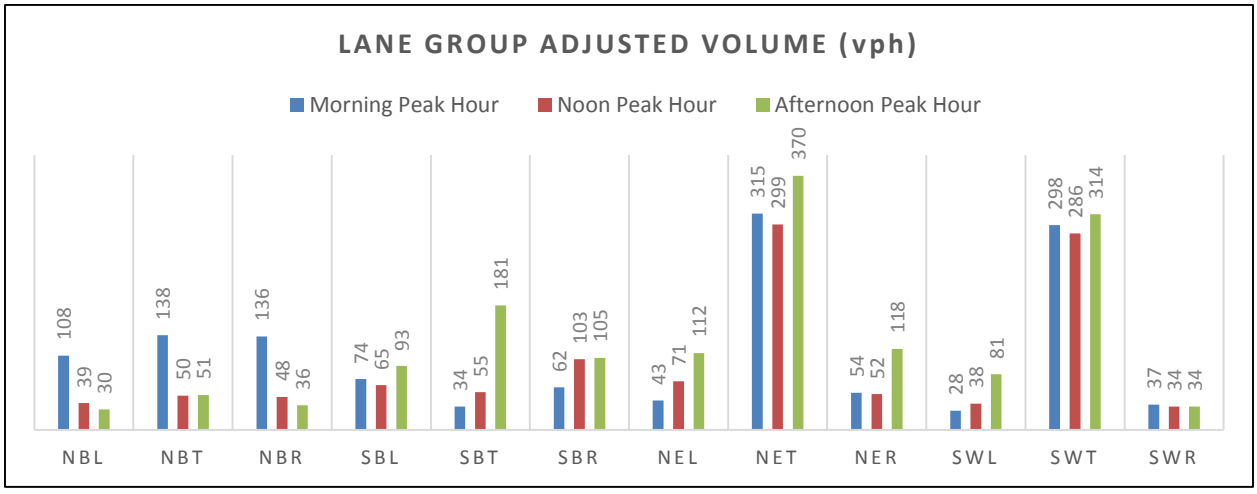
| Method | Source | Application | LOS Focus | Process |
|---|---|---|---|---|
| Quick Estimation Method[1] | Highway Capacity Manual 2010 | -- Preliminary left-turn treatment analysis | Delay | Manual |
| Automobile Method | Highway Capacity Manual 2010 | -- Lane Group Adjusted Volume<br>-- Control Delay<br>-- Volume-to-Capacity Ratio<br>-- Level of Service (LOS) | Delay | Synchro |
| Intersection Capacity Utilization Method | Trafficware© | | Capacity | Synchro |

Traffic count data used in this analysis came from field counts conducted by MPO staff. The traffic count report presenting the raw traffic counts is provided in Appendix A. The complete result and detailed calculations for this analysis are discussed in Appendix B Technical Support Document.

The adjusted volume for each lane group (Table 9 and Figure 7) and the key indices of operational status of the subject intersection (Table 10, 11 and 12) are presented. The lane group adjusted volume is used to estimate the demand volume under prevailing condition. As the subject intersection involves shared left-turn operations, the effect of permissive left-turn is considered in the computation process of the adjusted volume. The indices include Volume-to-Capacity Ratio, Control Delay, and Level of Service.

No protected left turn is recommended for any approach of the subject intersection based on the preliminary left-turn treatment analysis by the QEM[2].

**FIGURE 6 LANE GROUP ADJUSTED VOLUME**




[1] The QEM is a simplified method for evaluating the performance of a signalized intersection at planning level. Comparing this with the operational level of analyses, only approximate results are desired from this method.
[2] The Left-turn treatment check provided in the QEM should not be used as the sole basis for determining the need for a left-turn phase.

**TABLE 9 ADJUSTED FLOW RATE**

| Lane Group | NBL | NBT | NBR | SBL | SBT | SBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Morning Peak Hour | 108 | 138 | 136 | 74 | 34 | 62 | 43 | 315 | 54 | 28 | 298 | 37 |
| Noon Peak Hour | 39 | 50 | 48 | 65 | 55 | 103 | 71 | 299 | 52 | 38 | 286 | 34 |
| Afternoon Peak Hour | 30 | 51 | 36 | 93 | 181 | 105 | 112 | 370 | 118 | 81 | 314 | 34 |

**TABLE 10 TRAFFIC OPERATION ANALYSIS SUMMARY BY QUICK ESTIMATION METHOD**

| Lane | NB | | | SB | | | NEB | | | SWB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Criteria | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS |
| Morning Peak Hour | 0.54 | 26.7 | C | 0.36 | 22.8 | C | 0.60 | 21.5 | C | 0.53 | 19.1 | B |
| Noon Peak Hour | 0.24 | 20.6 | C | 0.42 | 23.8 | C | 0.67 | 23.4 | C | 0.53 | 19.3 | B |
| Afternoon Peak Hour | 0.18 | 19.8 | B | 0.69 | 32.1 | D | 1.00 | 92 | F | 0.66 | 22.6 | C |

**TABLE 11 TRAFFIC OPERATION ANALYSIS SUMMARY BY AUTOMOBILE METHOD**

| Lane | NB | | | SB | | | NEB | | | SWB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Criteria | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS |
| Morning Peak Hour | 0.72 | 33.9 | C | 0.43 | 25.0 | C | 0.56 | 19.8 | B | 0.50 | 18.5 | B |
| Noon Peak Hour | 0.26 | 20.8 | C | 0.41 | 23.4 | C | 0.60 | 21.0 | C | 0.50 | 18.5 | B |
| Afternoon Peak Hour | 0.25 | 20.6 | C | 0.68 | 31.0 | C | 1.12 | 101.4 | F | 0.85 | 36.6 | D |

**TABLE 12 TRAFFIC OPERATION ANALYSIS SUMMARY BY INTERSECTION CAPACITY UTILIZATION METHOD**

| Lane | NB | | | SB | | | NEB | | | SWB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Criteria | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS |
| Morning Peak Hour | 0.85 | 43.0 | D | 0.45 | 21.3 | C | 0.61 | 21.3 | C | 0.57 | 20.7 | C |
| Noon Peak Hour | 0.30 | 16.9 | B | 0.48 | 20.3 | C | 0.66 | 23.3 | C | 0.58 | 21.1 | C |
| Afternoon Peak Hour | 0.26 | 16.6 | B | 0.82 | 40.7 | D | 1.00 | 62.1 | E | 0.81 | 33.9 | C |

The following concerns were identified, based on the traffic operation analyses and/or field observations.

- **Excessive delay on the northeast bound approach during the afternoon peak hour, as evidenced by its LOS F in two analysis methods.** This was likely caused by the effect of left-turning vehicles waiting to turn through a gap in the opposing traffic stream and blocking the through/right turn vehicles behind them, as Figure 7 shows that during the afternoon peak hour, there were 112 vehicles attempting to turn left on the northeast bound approach and 314 vehicle for through movement in the opposing lane. Observed delay ranged from 62.1 seconds to 101.4 seconds based the analysis.

- **High volume and low LOS occurred during the afternoon peak hour, except for the north bound approach, as evidenced by the LOS ranging from C to F during that time.** This was likely caused by the increased demand left-turns on both northeast bound and southwest bound approaches and by the relatively shorter green time allocated to the south bound traffic. It should be noted that The peak hour factor for the southbound traffic during the afternoon peak hour is 0.84, suggesting a high degree of traffic demand fluctuation in that hour, that is, a potentially higher degree of congestion for a peak 15-minutes flow rate in that hour.

- **Long northbound approach delay during the morning peak hour, as evidenced by its LOS C/D during that time.** This was likely caused by the high demand at that approach in that hour and the relatively short green time allocated to the north bound traffic at that time. Observed delay ranged from 26.7 seconds to 43.0 seconds, and occasionally one green cycle failed to clear the queue on that approach.

# 4.0 FUTURE CONDITIONS

The section provides information on the forecasted operational status of the intersection in 2020 and 2040. An average annual growth rate of 1.03%[1] has been used, and other variables, such as lane capacity, peak hour factor, and signal timing plan, remain unchanged.

The method of Intersection Capacity Utilization is used for this analysis. Forecasting details are provided in Appendix B Technical Support Document. Table 13 and 14 show the forecasted results in 2020 and 2040.

It can be found that

- In 2020, the northbound approach will operate at LOS D in the morning peak hour, and in 2040, it will operate at LOS F.
- In 2020, three approaches of the intersection will operate from LOS D to LOS F, and in 2040, they will all operate at LOS F.

**TABLE 13 2020 INTERSECTION OPERATIONAL STATUS PROJECTION**

| Lane | NB | | | SB | | | NEB | | | SWB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Criteria | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS |
| Morning Peak Hour | 0.91 | 51.2 | D | 0.50 | 22.9 | C | 0.65 | 22.7 | C | 0.61 | 21.8 | C |
| Noon Peak Hour | 0.31 | 16.3 | B | 0.51 | 20.7 | C | 0.78 | 29.7 | C | 0.62 | 22.3 | C |
| Afternoon Peak Hour | 0.25 | 15.1 | B | 0.85 | 43.7 | D | 1.29 | 168.0 | F | 1.01 | 70.0 | E |

**TABLE 14 2040 INTERSECTION OPERATIONAL STATUS PROJECTION**

| Lane | NB | | | SB | | | NEB | | | SWB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Criteria | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS | V/C Ratio | Delay (s) | LOS |
| Morning Peak Hour | 1.14 | 116.6 | F | 0.68 | 32.4 | C | 0.81 | 31.1 | C | 0.76 | 28.4 | C |
| Noon Peak Hour | 0.39 | 18.9 | B | 0.63 | 25.6 | C | 1.00 | 61.7 | E | 0.78 | 30.5 | C |
| Afternoon Peak Hour | 0.33 | 17.4 | B | 1.05 | 84.6 | F | 1.69 | 338.5 | F | 1.40 | 216.6 | F |

[1] The average annual growth rate is provided by the WVDOH District Office.

# 5.0 ALTERNATIVES STUDY

Four alternatives to improve the safety and operational performance of the intersection were analyzed. These alternatives are summarized in Table 15 and illustrated through Figure 7 to Figure 10.

**TABLE 15 DESCRIPTION OF ALTERNATIVES**

| | Geometry | Signal Timing |
|---|---|---|
| Alternative I | Add exclusive left turn lane on northeast bound and southwest bound approaches. | Add protected-permissive left turn phase for two exclusive left turn lanes and optimize cycle length. |
| Alternative II-a | Add exclusive turn lane on northeast bound approach. | Add protected-permissive left turn phase for one exclusive left turn lane and optimize cycle length. |
| Alternative II-b | Add exclusive turn lane on northeast bound approach. | Keep current signal timing pattern and optimize existing cycle length. |
| Alternative III | Unchanged. | Keep current signal timing pattern and optimize existing cycle length. |

**FIGURE 7 ALTERNATIVE I**

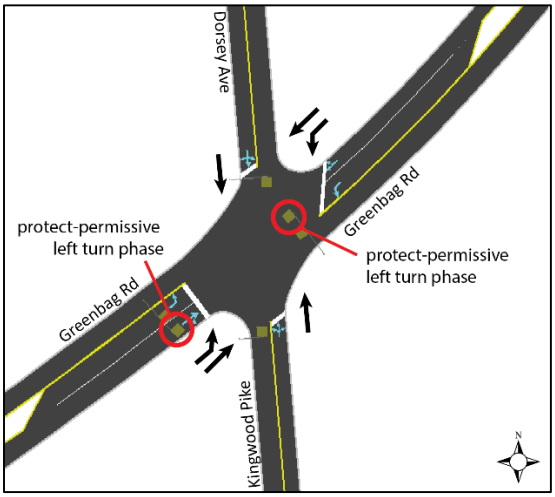



**FIGURE 8 ALTERNATIVE II-A**

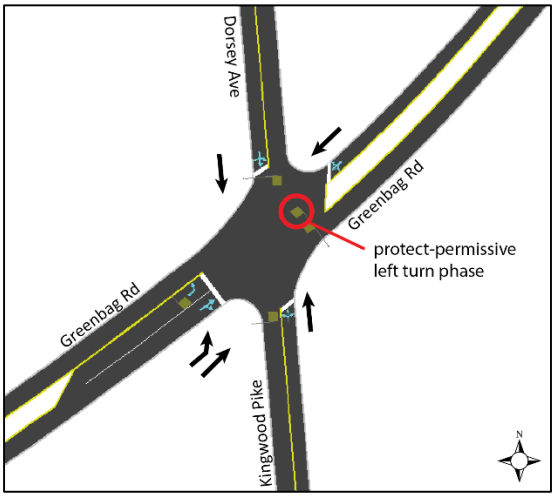



**FIGURE 9 ALTERNATIVE II-B**

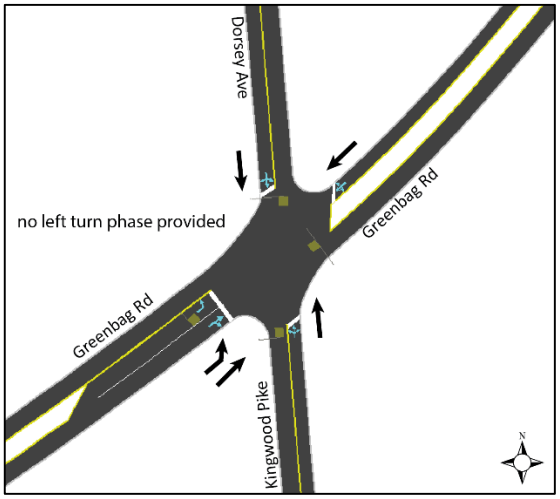
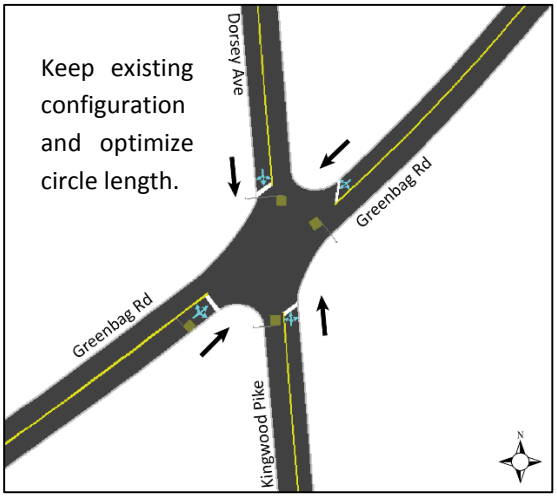



**FIGURE 10 ALTERNATIVE III**



## 5.1 SAFETY ANALYSIS

Safety implications of proposed alternatives for motor vehicles, pedestrians, and bicycles were studied based on methods provided by the FHWA, which include the Interactive Highway Safety Design Model (IHSDM), the Crash Modification Factors Clearinghouse (CMF), and the Pedestrian/Bicycle Intersection Safety Indices (ISI). Existing traffic volume and pattern are used in the evaluation process.

With respect to motor vehicle safety, both the IHSDM and the CMF indicate that the Alternative I is the safest among all alternatives, followed by the Alternative II-a. Table X summaries the IHSDM and the CMF analysis.

**TABLE 16 ALTERNATIVE SAFETY EVALUATION FOR MOTOR VEHICLES**

| | Crash Prediction Evaluation (2014-2020)[1] | | Crash Reduction Factor[2, 3] |
|---|---|---|---|
| | Expected No. of crashes | Expected Crashes Rate (crashes/mi veh) | |
| Alternative I | 13.7 | 1.96 | 42 |
| Alternative II-a | 15.3 | 2.19 | 24 |
| Alternative II-b | 15.5 | 2.22 | 21 |
| Alternative III | 17.2 | 2.46 | N/A |

With respect to pedestrian safety, the Ped ISI show that there is no significant change for pedestrian safety under the proposed alternatives.

With respect to bicycle safety, the Bike ISI shows that, compared with existing conditions, there is no significant change for bicycle safety under the proposed alternatives, except for bicyclists making left turn from the north leg and the south leg. The movements with decreased of safety are highlighted in red in Table 17.

**TABLE 17 ALTERNATIVE SAFETY EVALUATION FOR BICYCLES**

| | Pedestrian Intersection Safety Index | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Intersection Leg** | **North (Dorsey)** | | | **South (Kingwood)** | | | **Northeast (Greenbag)** | | | **Southeast (Greenbag)** | | |
| **Movement** | **LT** | **TH** | **RT** | **LT** | **TH** | **RT** | **LT** | **TH** | **RT** | **LT** | **TH** | **RT** |
| Alternative I | 2.9 | 3.4 | 1.4 | 2.9 | 3.4 | 1.4 | 2.6 | 3.3 | 1.6 | 2.6 | 3.3 | 1.6 |
| Alternative II-a | 2.4 | 3.4 | 1.4 | 2.9 | 3.4 | 1.4 | 2.6 | 3.3 | 1.6 | 2.6 | 3.3 | 1.6 |
| Alternative II-b | 2.4 | 3.4 | 1.4 | 2.9 | 3.4 | 1.4 | 2.6 | 3.3 | 1.6 | 2.6 | 3.3 | 1.6 |
| Alternative III | 2.4 | 3.4 | 1.4 | 2.4 | 3.4 | 1.4 | 2.6 | 3.3 | 1.6 | 2.6 | 3.3 | 1.6 |

[1] Based on the FHWA Interactive Highway Safety Design Model (IHSDM) 2013.
[2] Based on the data from the Crash Modification Factors Clearinghouse, which is funded by the FHWA and maintained by the University of North Carolina Highway Safety Research Center.
[3] This value indicates a decrease in crashes.

## 5.2 OPERATIONAL ANALYSIS

The operational analysis uses the Intersection Capacity Utilization method and current afternoon peak hour volume to assess the proposed alternatives. Average annual growth rate of 1.03% is used to forecast 2020 and 2040 conditions. Synchro 8 was used in the computation process.

Table 18 summarizes the LOS, the signal delay, and the capacity utilization associated with each alternative at intersection level. Table 19 shows the LOS and the signal delay of two legs on Greenbag Rd. The LOS and the signal delay for each intersection leg are shown through Figure 12 to Figure 30. It is assumed that signal phasing is optimized based on projected volume.

This is a planning level study and is not a substitute for sound engineering judgment.

**TABLE 18 ALTERNATIVE OPERATIONAL EVALUATION BY INTERSECTION**

| | Intersection LOS | | | Intersection Signal Delay (s) | | | Intersection Capacity Utilization | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2014 | 2020 | 2040 | 2014 | 2020 | 2040 | 2014 | 2020 | 2040 |
| Alternative I | C | D | E | 31.5 | 37.1 | 75.0 | 69.1% | 72.6% | 86.4% |
| Alternative II-a | C | D | F | 30.8 | 40.6 | 119.2 | 90.5% | 95.3% | 114.2% |
| Alternative II-b | C | D | F | 28.2 | 35.1 | 119.7 | 90.5% | 95.3% | 114.2% |
| Alternative III | D | D | F | 39.6 | 51.7 | 138.1 | 80.9% | 85.4% | 102.9% |
| No action | D | F | F | 45.3 | 103.9 | 227.6 | 84.3% | 88.8% | 106.2% |

From Table 18, it can be found that

- Alternative I provides the overall most efficient operation in 2014-2040 time frame.
- Alternative II-b provides the most efficient operation in 2014-2020 time frame.
- By optimizing existing signal timing, the Alternative III decreases the signal delay by 5.7 seconds in 2014, 52.2 seconds in 2020, and 89.5 in 2040.

**TABLE 19 ALTERNATIVE OPERATIONAL EVALUATION ON GREENBAG RD**

| | Greenbag Rd Approach Delay and Level of Service | | | | | | |
|---|---|---|---|---|---|---|---|
| | Northeast Bound (to Sabraton) | | | Southwest Bound (to Mountaineer Mall) | | | Total |
| | 2014 | 2020 | 2040 | 2014 | 2020 | 2040 | |
| Alternative I | 35.6 (D)[1] | 43.3 (D) | 100.3 (F) | 20.8(C) | 22.9 (C) | 30.5 (C) | 254.3 |
| Alternative II-a | 17.2 (B) | 16.2 (B) | 25.1 (C) | 42.5 (D) | 57.5 (E) | 244.7 (F) | 403.2 |
| Alternative II-b | 19.1 (B) | 19.7 (B) | 30.8 (C) | 40.7 (D) | 51.6 (D) | 270.7 (F) | 432.6 |
| Alternative III | 43.3 (D) | 54.7 (D) | 185.3 (F) | 19.3 (B) | 23.4 (C) | 74.9 (E) | 400.9 |
| No action | 62.1 (E) | 168.0 (F) | 338.5 (F) | 33.9 (C) | 70.0 (E) | 216.6 (F) | 889.1 |

From Table 19, it can be found that

- Alternative I favors the southwest bound traffic and has the least amount of total delay in the analysis period.
- Alternative II-a and II-b favor the northeast bound traffic and keep the LOS of this approach at C in 2040
- Alternative III favors the southwest bound traffic and keeps the LOS of this approach at E in 2040.

[1] Where 35.6 = approach delay in seconds; (D) = approach LOS

## Alternative I

The Alternative I recommends adding exclusive left turn lane on the northeast leg and the southwest leg and adding protected-permissive left turn phase for the two exclusive left turn lanes. Operational statuses and suggested signal phasing plan are summarized through Figure 11 to Figure 15.

**FIGURE 11 ALTERNATIVE I SIGNAL PHASE**

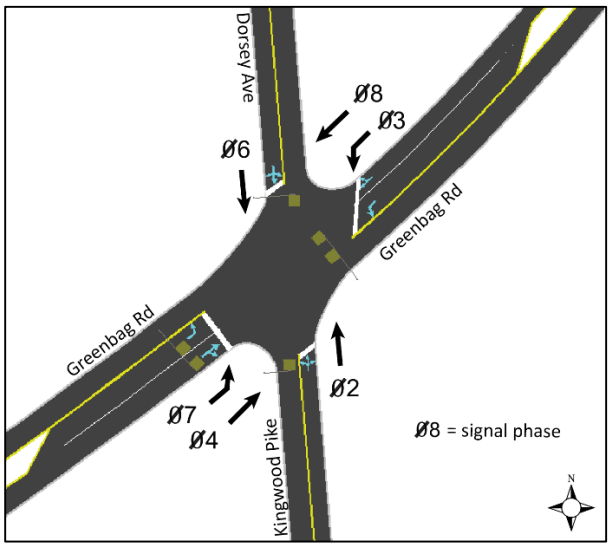



**FIGURE 12 ALTERNATIVE I EXISTING CONDITION SCENARIO**

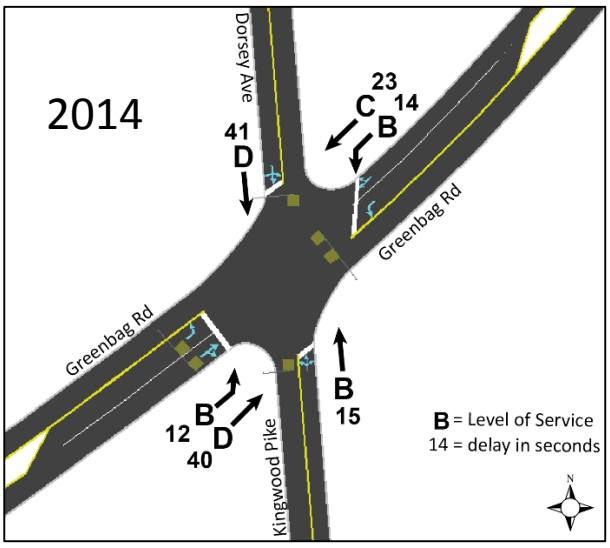



**FIGURE 13 ALTERNATIVE I 2020 CONDITION SCENARIO**

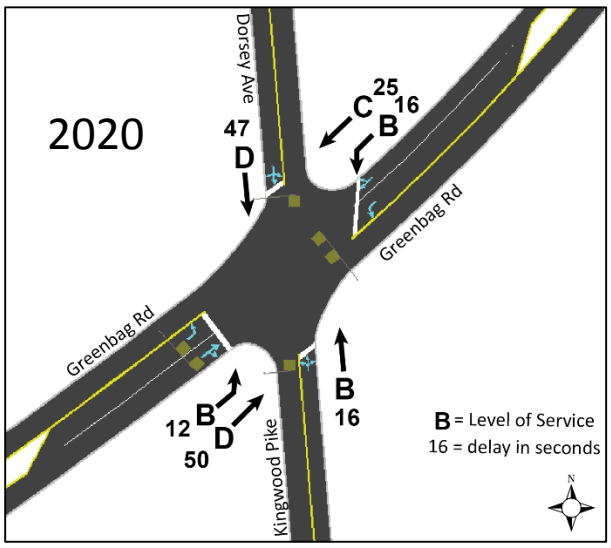
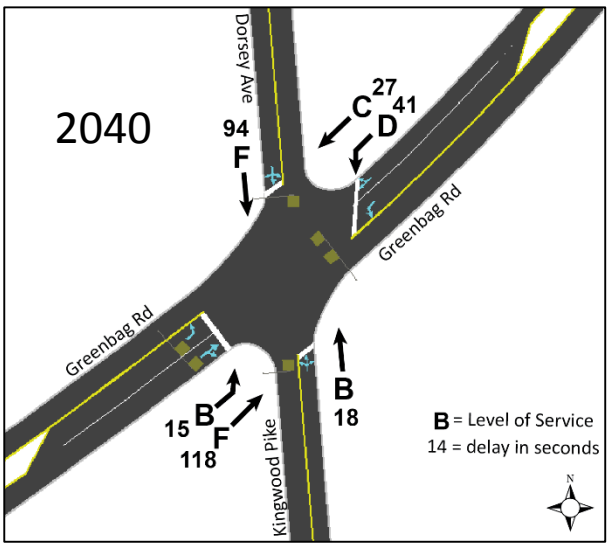



**FIGURE 14 ALTERNATIVE I 2040 CONDITION SCENARIO**



## Alternative II-a

Alternative II-a recommends adding exclusive left turn lane on the southwest leg and adding protected-permissive left turn phase for that left turn lane. Operational statuses and suggested signal phasing plan are summarized through Figure 16 to Figure 20.

**FIGURE 15 ALTERNATIVE II-A SIGNAL PHASE**

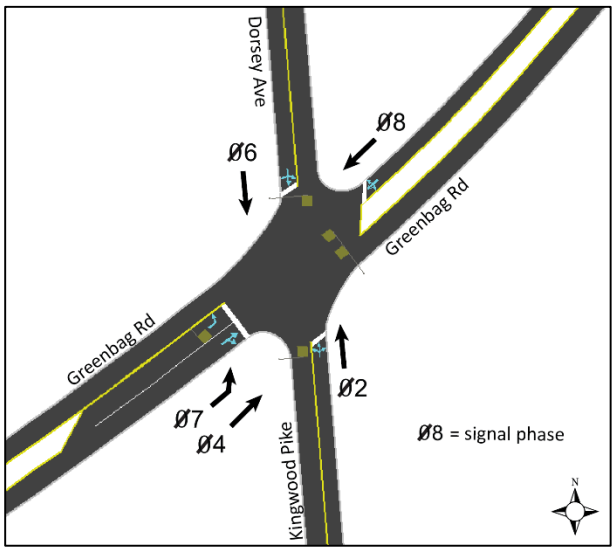



**FIGURE 16 ALTERNATIVE II-A EXISTING CONDITION SCENARIO**

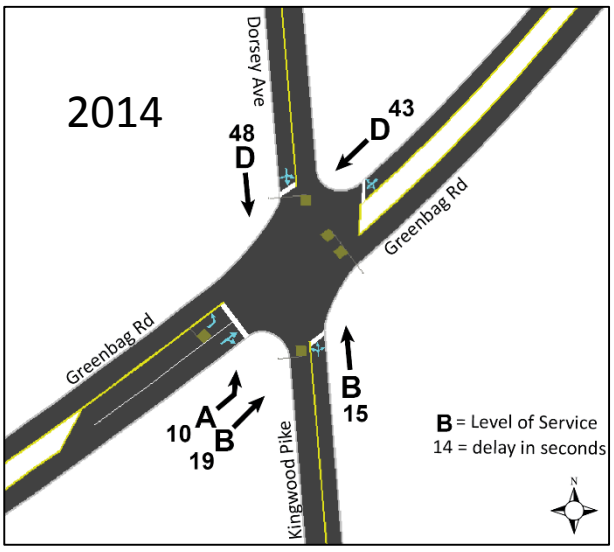



**FIGURE 17 ALTERNATIVE II-A 2020 CONDITION SCENARIO**

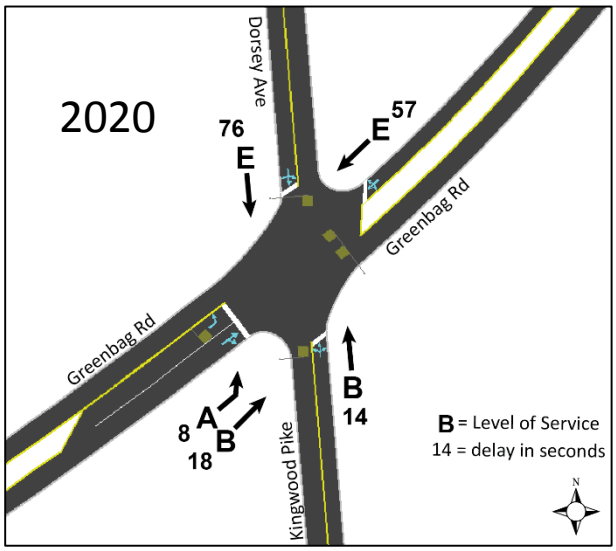
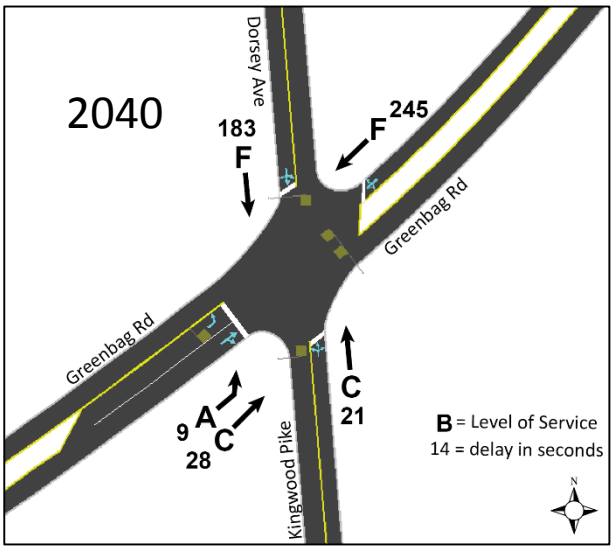



**FIGURE 18 ALTERNATIVE II-A 2040 CONDITION SCENARIO**



## Alternative II-b

The Alternative II-a recommends adding an exclusive left turn lane on the southwest leg and optimizing existing cycle length based on existing traffic pattern; it does not recommend adding protected-permissive left turn phase for the proposed exclusive left turn lane. Operational statuses and suggested signal phasing plan are summarized through Figure 21 to Figure 25.

**FIGURE 19 ALTERNATIVE II-B SIGNAL PHASE**

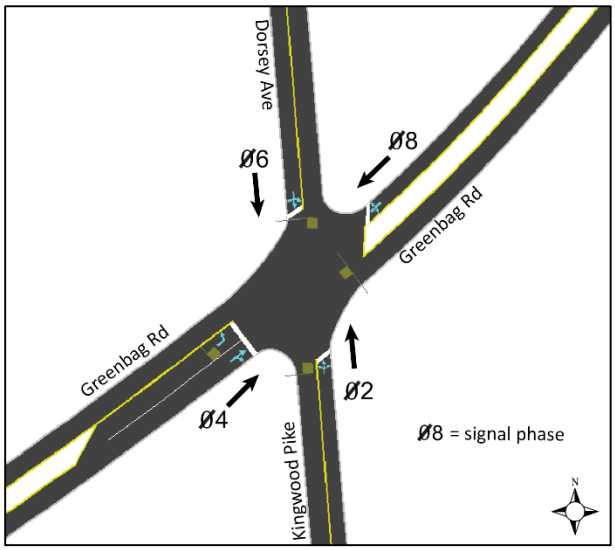



**FIGURE 20 ALTERNATIVE II-B EXISTING CONDITION SCENARIO**

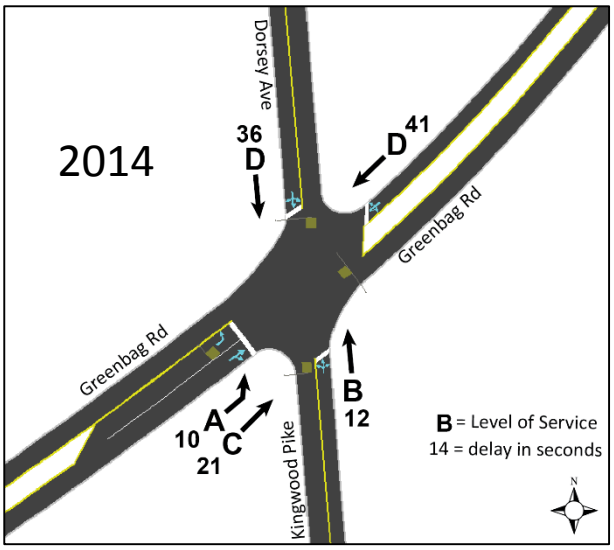



**FIGURE 21 ALTERNATIVE II-B 2020 CONDITION SCENARIO**

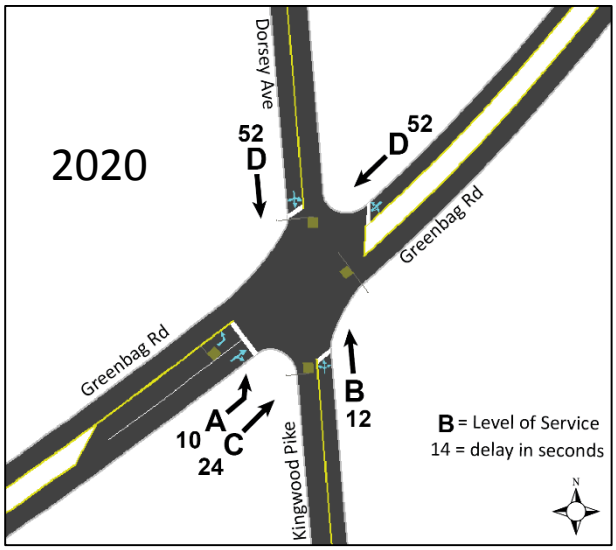
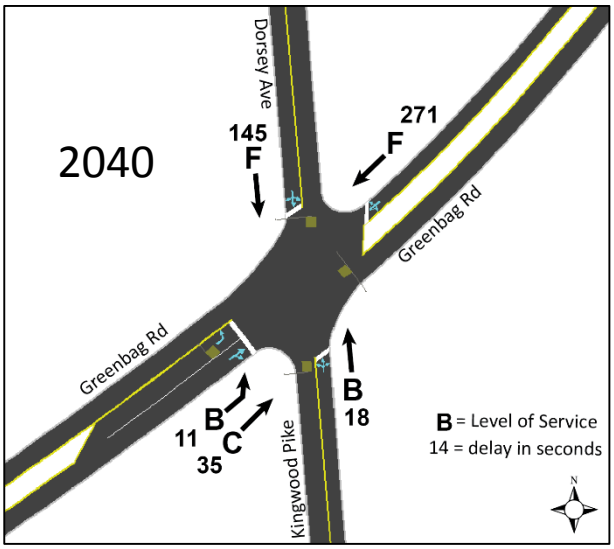



**FIGURE 22 ALTERNATIVE II-B 2040 CONDITION SCENARIO**



## Alternative III

The Alternative III recommends optimizing the cycle length based on existing traffic pattern. Operational statuses and suggested signal phasing plan are summarized through Figure 26 to Figure 30.

**FIGURE 23 ALTERNATIVE III SIGNAL PHASE**

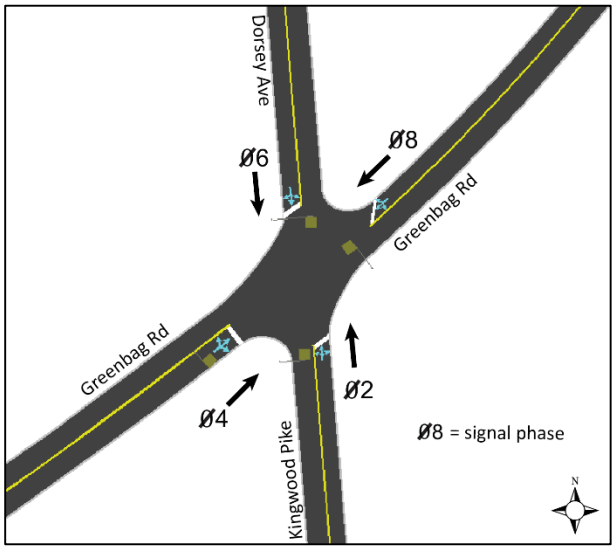



**FIGURE 24 ALTERNATIVE III EXISTING CONDITION SCENARIO**

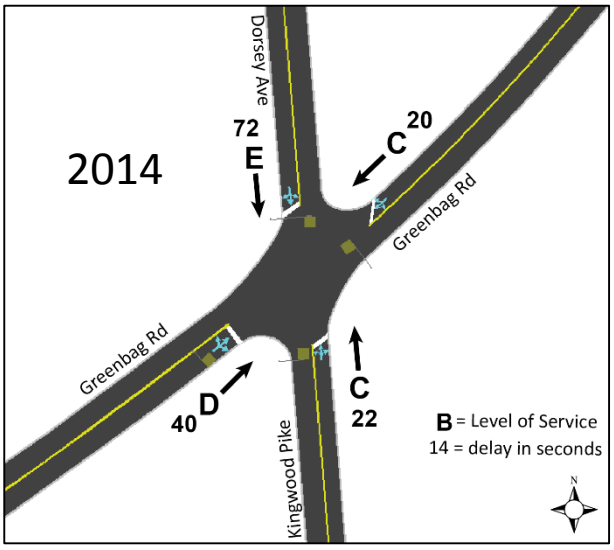



**FIGURE 25 ALTERNATIVE III 2020 CONDITION SCENARIO**

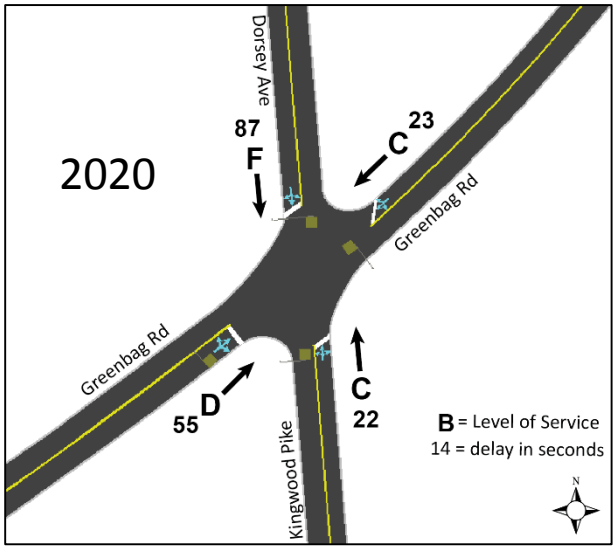
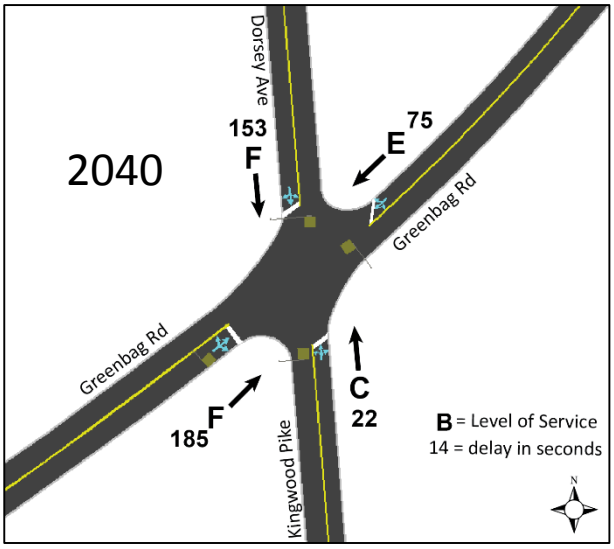



**FIGURE 26 ALTERNATIVE III 2040 CONDITION SCENARIO**



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