I-375 DYNAMIC TRAFFIC ASSIGNMENT MODEL METHODOLOGY AND ASSUMPTIONS

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SEMCOG

MDOT
Michigan Department of Transportation

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1 Executive Summary

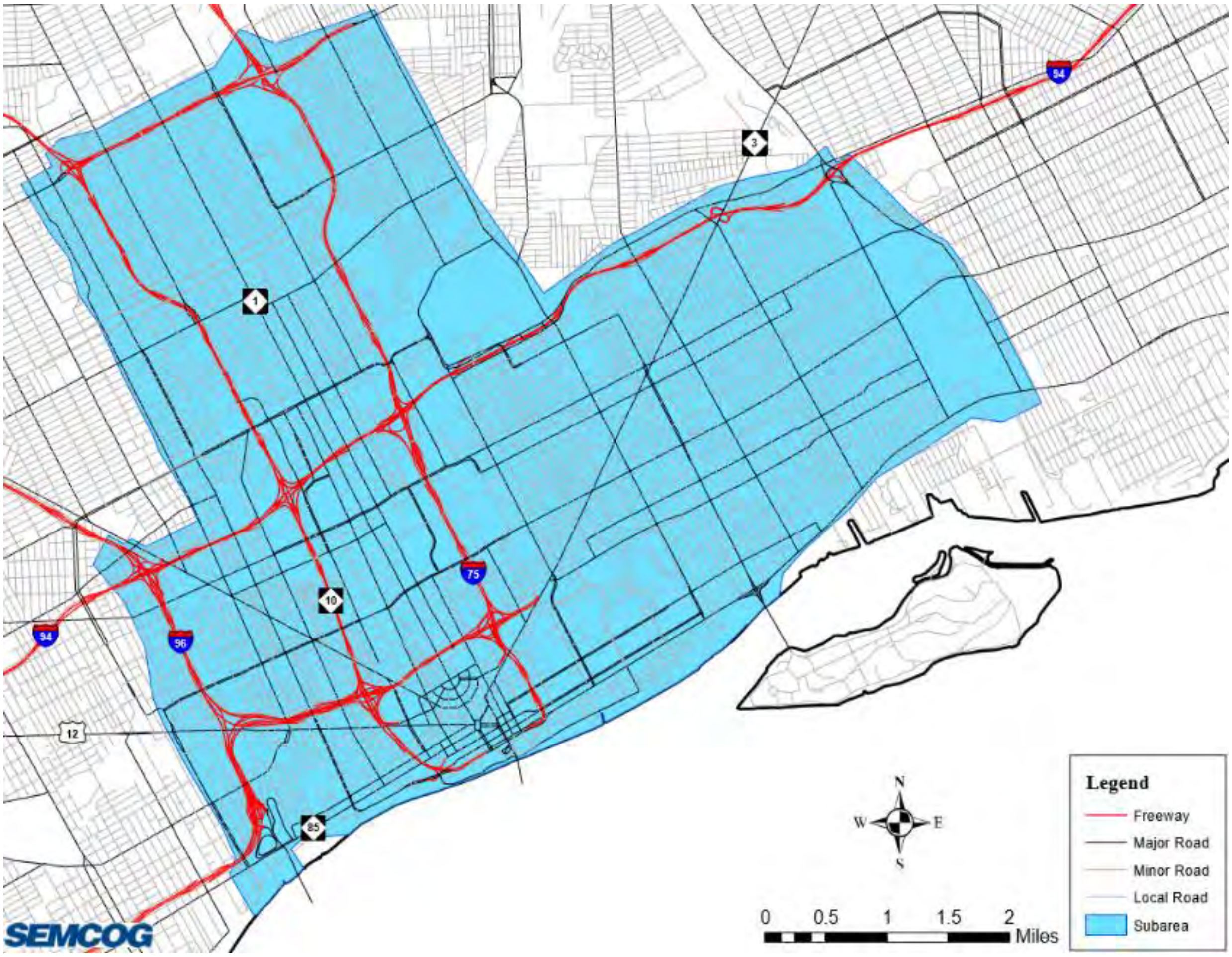
In the spring of 2018, as part of MDOT's I-375 technical team, the Southeastern Michigan Council of Governments (SEMCOG) reviewed initial microsimulation modeling results for the conversion to a boulevard. The microsimulation model did not allow for sufficient traffic diversion to the local network where excess capacity could provide relief. In order to better assess the diversion and inform the micro-model, the project team ran two additional models, the SEMCOG macro-level regional travel demand forecast model and the SEMCOG Dynamic Traffic Assignment (DTA) model for the subarea impacted by the conversion. The results showed significant diversion and resulted in adding over 30 additional intersections to an expanded study area analysis. Below is a brief summary of the background of the project, the development of the model, as well as some results. Following that is a more detailed description.

1.1 Background

In mid-2018, SEMCOG created a mesoscopic dynamic traffic assignment model of downtown Detroit and immediate area to evaluate the impacts of converting I-375 from a freeway to a boulevard. A mesoscopic model is a type of model that provides more detailed vehicular information with more refined results than a macroscopic travel demand model and allows evaluation of a bigger subarea than a microscopic model. This is the first time that SEMCOG has utilized this type of model and did so due to the complexity of the project.

The SEMCOG macroscopic travel demand model was utilized early-on in the project and found that impacts from the conversion would be expected not only within downtown Detroit, but also potentially as far north as M-8 and east to Connor. A microscopic VISSIM model was created for the project, which included the I-375 freeways and service drives from just north of I-75 to south of Jefferson Avenue and also included one roadway just east of I-375. The purpose of the mesoscopic model was to better understand diversion and resulting impacts that the conversion would have on the greater study area at a more refined detail than the SEMCOG macroscopic travel demand model. Figure 1 illustrates the study area for the mesoscopic DTA model.

Figure 1. DTA Study Area



1.2 Model Development

The DTA model study area is approximately 33 square miles, includes 2,900 network links and 679 actuated signals and used the DynusT platform. There were 331 traffic count locations and 156 AM and PM peak hour turning movement counts that were used to develop the 48 ½-hour trip matrices to create a 24-hour model. The basis of the DTA model trip matrices were from the five different time period trip matrices from the 2015 SEMCOG regional travel demand model. The same traffic count locations utilized to create the trip matrices were also used to calibrate the DTA model. Travel time information was also obtained for 9 roadways within the subarea and included I-75, M-10, I-94, Gratiot Avenue, Michigan Avenue, and others. Approximately four months of historical travel time information was utilized to determine an average travel time and speed for each roadway. However, after further review of the historical speed data, it was found that the speeds were highly variable, and it was difficult to calibrate the DTA model to both speeds and volume, particularly for the major arterials. Given that the volumes were more reliable than the speeds, and that changing the speed flow curves did little to help with calibration of the major arterials, the speeds along the major arterials were increased to improve traffic volume matching. The resulting model had R^2 values of 0.95 for the daily model, 0.90 for the AM peak period, and 0.92 for the PM peak period for the traffic volumes. A 2045 DTA model was also created based on growth expected within the regional travel demand model. There was a nine-percent increase in trips in the study area from 2015 to 2045.

It should be noted that the purpose of the DTA model was to determine the approximate impact and diversion that the conversion of I-375 from a freeway to a boulevard would have on adjacent and regional roadways. Having all three levels of model results (macro, meso, and micro) provides a robust estimate of the likely impacts of the conversion from freeway to a boulevard.

1.3 Model Results

The model was coded with the conversion of I-375 from a freeway to a boulevard. Some roadways were also changed from one-way roadways to two-way roadways, including:

- Southbound I-375 Service Drive between Clinton Street and Jefferson Avenue
- Northbound I-375 Service Drive between Monroe Avenue and Antietam Avenue
- Beaubien Street between Madison Avenue and Lafayette Avenue
- Lafayette Avenue /Bates Street between Farmer Street and Beaubien Street
- Macomb Street between Brush Street and Southbound I-375 Service Drive
- St. Antoine Street between Lafayette Avenue and Madison Avenue
- Brush Street between Congress Street and Madison Avenue

All these roadways are currently one-way. Beaubien Street, Lafayette Avenue/Bates Street, Macomb Street, St. Antoine Street, and Brush Street were coded as a two-way two-lane roadway with a speed of 20mph. Most of these roadways are narrow in nature and would likely still retain parking on one side which would result in a lower speed. Monroe Avenue was reduced from two lanes eastbound to one lane eastbound with turn lanes at the I-375 boulevard. The I-375 boulevard was coded with either three- to four-lanes, with turn bays where indicated by the study team and a speed of 35mph. Appendix A has an illustration of the Preferred Alternative.

The results of the 2045 model found that there was diversion from the I-375 corridor to other roadways. The I-375 corridor is defined as the I-375 freeway, service drives, and any ramps connecting to the I-375 freeway. The corridor also includes the conversion of the I-375 freeway to the boulevard. Below is a summary of the expected changes.

- Volumes on I-75 will decrease by around 20%
- Volumes along the I-375 corridor will decrease by up to 50%
- Volumes on Gratiot Avenue will decrease north of the Gratiot Connector and increase south of Gratiot Avenue
- Volumes along Clinton Street will increase
- Volumes along Monroe Street and Macomb Street will decrease

- Volumes will tend to increase along Lafayette Avenue, Larned Street, and Congress Street
- Volumes along WB Jefferson Avenue west of I-375 may increase
- Volumes along the NB I-375 Service Drive / New Road will increase
- Volumes along Brush Street will increase
- Volumes along Rivard Street, St. Aubin Street and Antietam Avenue east of Rivard Street will not change significantly
- No roadways are near or over capacity before or after the conversion, except for the New Local Road north of Clinton Street, which is close to capacity but not over

The 2045 analysis found that the I-94 and I-375 projects would be complementary projects, meaning that the removal of I-375 would not negatively impact I-94, but that the widening of I-94 helps with traffic diversions due to the removal of I-375.

As a result of this analysis, the study team will analyze approximately 30 additional signalized intersections outside of the VISSIM microsimulation study area. This includes Gratiot Avenue/Randolph Street south of Antietam Avenue, Mack Avenue east of I-75, Congress Street within downtown Detroit, Brush Street and Beaubien Street. Refer to the *I-375 Expanded Study Area Analysis (June, 2020)* for more information on the additional analysis.

2 Project Background

In 2015, the Michigan Department of Transportation (MDOT) and the City of Detroit started a journey to review various roadway alternatives for I-375 within downtown Detroit. This section of freeway was opened to traffic on June 12, 1964, and is a spur off of I-75 into downtown Detroit to the south. The spur is approximately 1.25 miles in length and has six bridges of local roadways that go over the freeway. The impetus for the study really began with the deterioration of the bridges and the need for replacement. Given the somewhat low volumes of the freeway section, the question was raised whether the freeway needed to be a freeway at all, especially in a downtown setting. Figure 2 illustrates the location of the freeway, along with freeway and ramp volumes taken in 2017.

Figure 2. Study Area

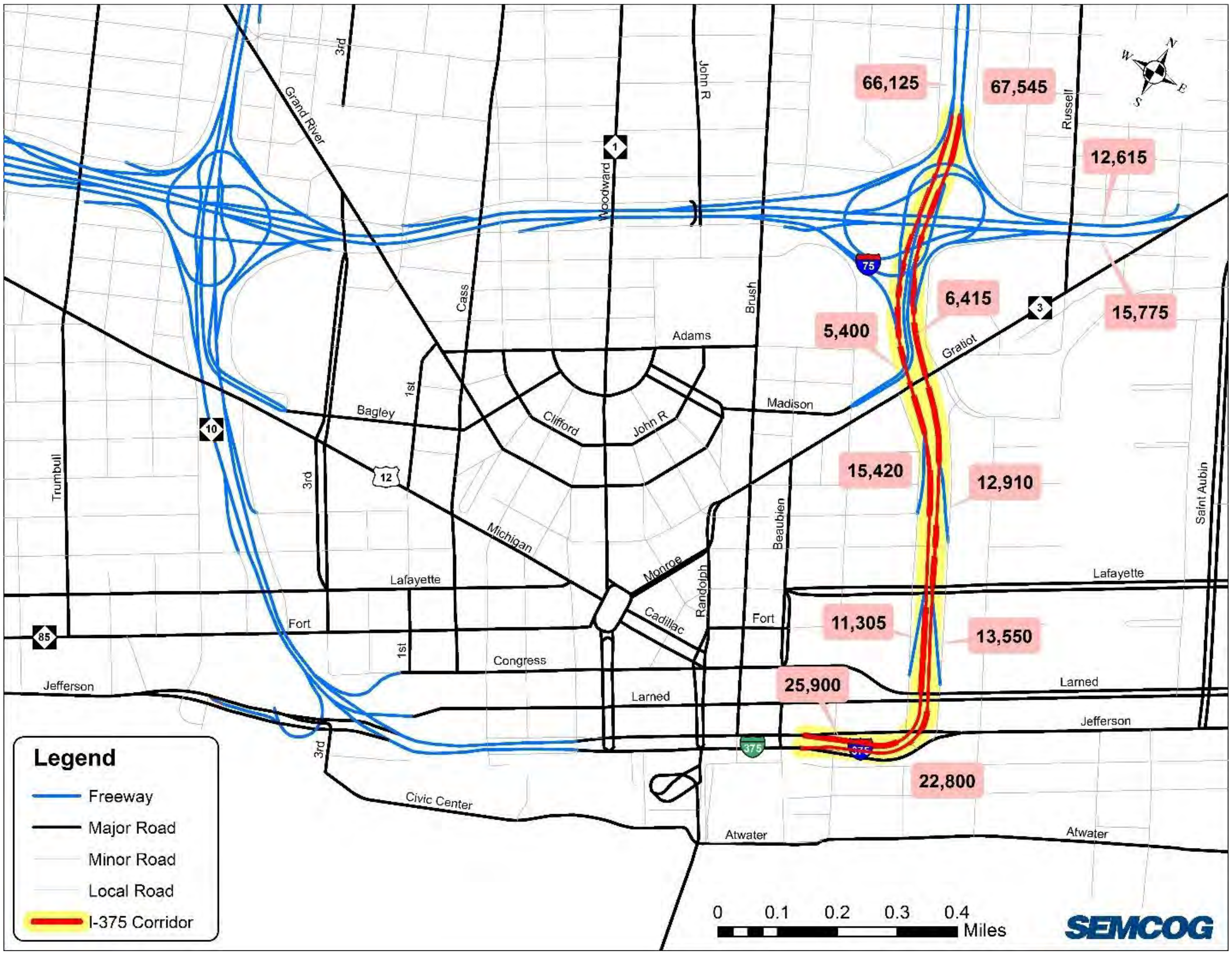
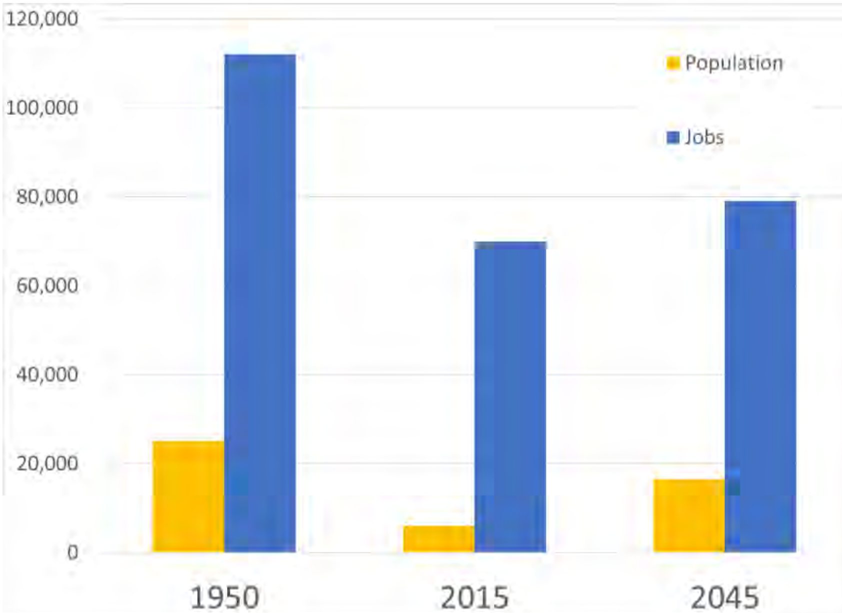


Figure 3. Downtown Population and Employment



When I-375 was built, Downtown Detroit was booming, and population and employment were growing. Roadways were being built and widened to accommodate this explosive growth. However, since that time, population within the City has since declined and by the year 2045, Downtown will still not be at population and employment levels seen in the 1950's. The roadways within downtown and surrounding areas have not changed significantly and many operating under capacity. Figure 3 illustrates the change in population and jobs in Downtown from 1950, 2015 and expected for 2045.

Traffic volumes along I-375 just south of I-75 in 2016 were approximately 114,000 vehicles per day and is expected to grow by 25-percent by the year 2040. However, traffic volumes at Jefferson Avenue, at the southern end/beginning of the spur, is approximately 48,000 vehicles per day. There are two ramps between the beginning and the end, which both carry approximately 11,000 to 16,000 vehicles per day (vpd). The ramps to and from Madison Avenue carry approximately 5,000 to 7,000 vehicles per day. The Gratiot Connector, which connects I-75 to Gratiot Avenue, carries approximately 30,000 vehicles per day. The majority of roadways within the I-375 corridor area and downtown Detroit are operating under capacity.

The removal of a freeway and its conversion to a boulevard can obviously have some diversion of traffic to other roadways. In addition to this potential change, the City of Detroit conducted a Downtown Mobility Study which recommended the conversion of several one-way streets to two-way streets near the vicinity of the I-375 corridor. These streets include Macomb Street, Monroe Avenue, Beaubien Street, and Brush Street. These are highlighted in the above figure. It should also be noted that the Downtown Mobility Study has not been finalized or adopted and should be considered draft.

3 DTA Model Development Background

Early in the project, a microsimulation VISSIM model was created for the I-375 study which included a base year and a future 2040 year. The VISSIM model included I-75, I-375, Rivard Street to the east, and the local roadways that intersect I-375. The VISSIM model also included the potential extension of I-375 to the south. The Southeast Michigan Council of Governments (SEMCOG) travel demand forecasting model was utilized to determine future year growth rates as well as the potential diversion of traffic with the new alignment.

The SEMCOG model is a 24-hour model that is broken into five time periods: AM peak period, mid-day period, PM peak period, evening, and overnight. The AM peak period is a 2.5-hour model and the PM peak period is a 3.5-hour model.

In the spring of 2018, as part of MDOT's I-375 technical team, SEMCOG reviewed initial microsimulation VISSIM modeling results for the conversion to a boulevard. While the results seemed reasonable for the volume of traffic, it was determined that it is not logical to assume all of the traffic would remain in the I-375 corridor since downtown Detroit has excess roadway capacity on most of its network. Yet, the initial I-375 corridor level microsimulation did not allow for sufficient diversion to the network.

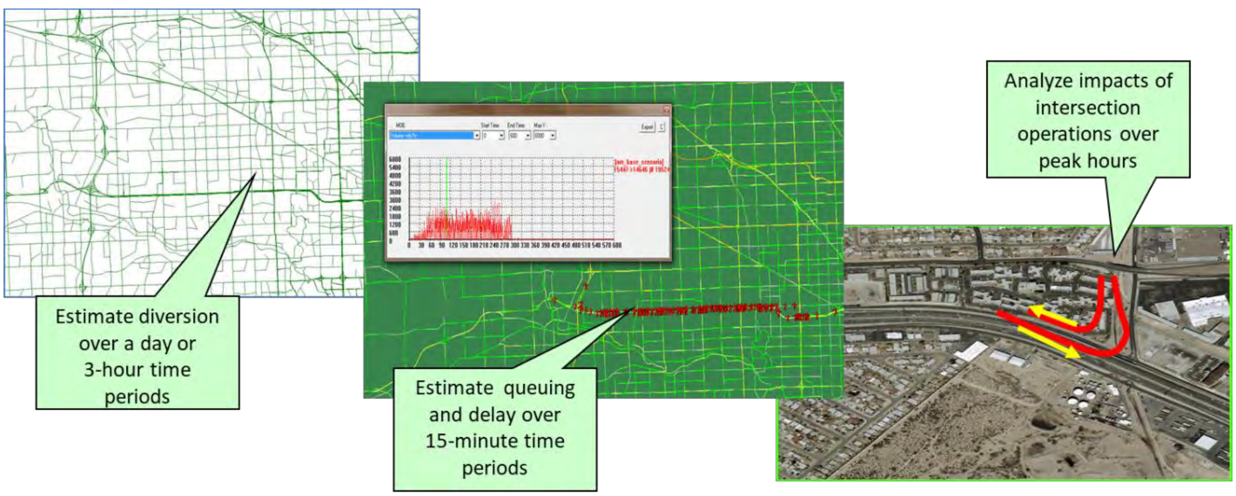
As indicated earlier, in order to assess the potential diversion, the SEMCOG macro-model was run with a conversion of I-375 to a boulevard. As expected, the model showed diversion to other roadways in the network, resulting in better traffic flows on the new boulevard. However, the macromodel does not sufficiently account for operational aspects such as signal timing and turn movements. The team agreed that the best way to substantiate and refine the macromodel results would be with a mesoscopic dynamic traffic assignment (DTA) model, and output from the mesoscopic model could be used as a reference for I-375 corridor level microsimulation. Both MDOT and SEMCOG were developing DTAs at the regional level, but neither had been fully calibrated and, thus, not available for use.

At this same time, SEMCOG, MDOT and the City of Detroit were developing a downtown transportation study that was looking at how to best utilize the city's transportation network. Part of that effort recommended some one- to two-way conversions to open the grid more and provide better accessibility. This includes roadways that access I-375. For the downtown study to be effective, it needed to better account for the impact of the I-375 conversion.

Due to the conversion of a freeway to a boulevard as part of the project, and based on stakeholder feedback, SEMCOG suggested that a subarea mesoscopic dynamic traffic assignment model be developed for the project. There are three different types of transportation models: microscopic, mesoscopic, and macroscopic. The different levels vary by the amount of information that goes into the model and also comes out of the model. They also differ by the way they model traffic behavior, either individualistic/stochastic or as a group/static. Microscopic models are typically very detailed and model individual vehicles and its reaction to the environment. Those models also contain very detailed information, such as length of turn lanes, detailed signal timings, and turning movement volumes. Macroscopic models are typically less detailed and model groups of origins and destinations. The models contain the number of lanes on a roadway, speed limits, and functional class. Microscopic models are for smaller study areas and macroscopic models are for regional areas and states.

Mesoscopic models are a variety of models that are between a microscopic model and macroscopic model and can contain a lot more information that what is in a macroscopic model or a little more information than a macroscopic model. Typically, they contain less than what is in a microscopic model. For example, origin and destination matrices are typically still used as an input into the mesoscopic model and then converted to a trip table of individual vehicles within the network. However, individual vehicles are then typically placed into "groups" of vehicles within the assignment of the network. This allows a larger subarea than a microscopic model but also more granularity than a macroscopic model.

Figure 4. Macro, Meso, and Micro Models



Actuated signal timing was utilized in the model instead of the pre-timed signal timings that are actually in the field. Through consultation with the developers of DynusT, it was suggested to utilize actuated signal timings within the subarea given the conversion of the freeway to a boulevard. The actuated signal timings would better respond to the fluctuations in traffic flow from the conversion.

Calibration of the model was focused on better matching the traffic volumes over the speed information, but speed was a consideration. There was more emphasis to match the volumes better within the I-375 corridor in order to better replicate actual pattern reflective of traffic volumes. Some of the traffic volume information that was used in the development of the DTA model was also used in the VISSIM microsimulation model. Due to this focused effort, the calibrated DTA model will not only provide better information on the diversion of traffic throughout the day due to the conversion of I-375, but also which roadways should be analyzed further due to the expected diversion.

As a result of these multiple studies that were occurring simultaneously, SEMCOG agreed to expedite the development of the mesoscopic DTA model for the area impacted by the I-375 conversion, which includes downtown Detroit. The SEMCOG macromodel was used to define the subarea and SEMCOG completed the development of the mesoscopic DTA model in July 2018 with refinements made in October 2018 based on comments from FHWA.

4 Subarea Determination

The first step in developing the DTA mesoscopic model was to determine a subarea from the regional macromodel. The SEMCOG 2040 regional model was used to capture the traffic growth. The new I-375 boulevard was coded into the 2040 model and then compared with the No-Build alternative. The maps below illustrate the roadways that had a change in traffic volumes larger than 100 vehicles during the AM or PM peak hours or greater than 10 percent of the total volume.

Figure 5. AM Peak Period Regional Macromodel Diversion

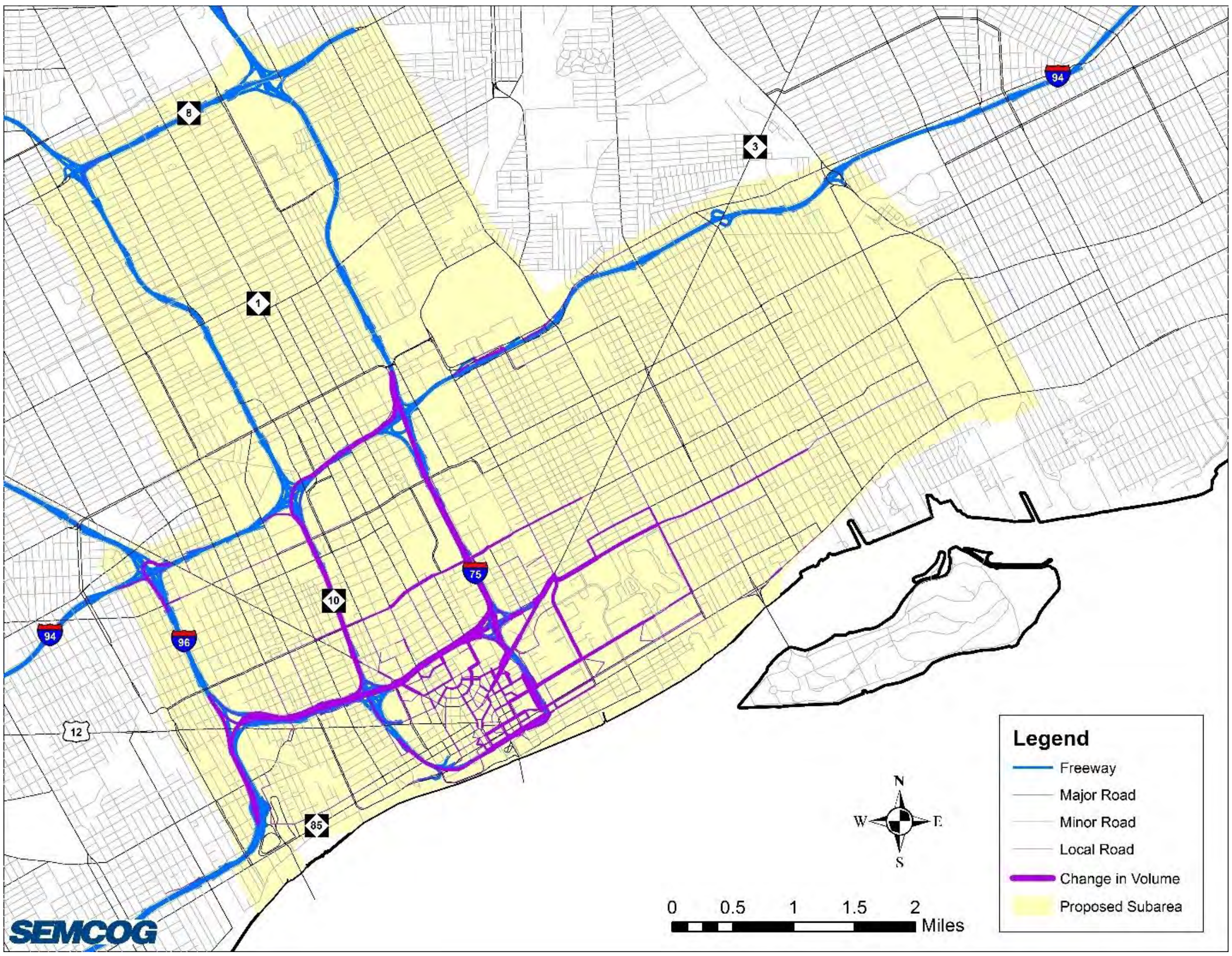
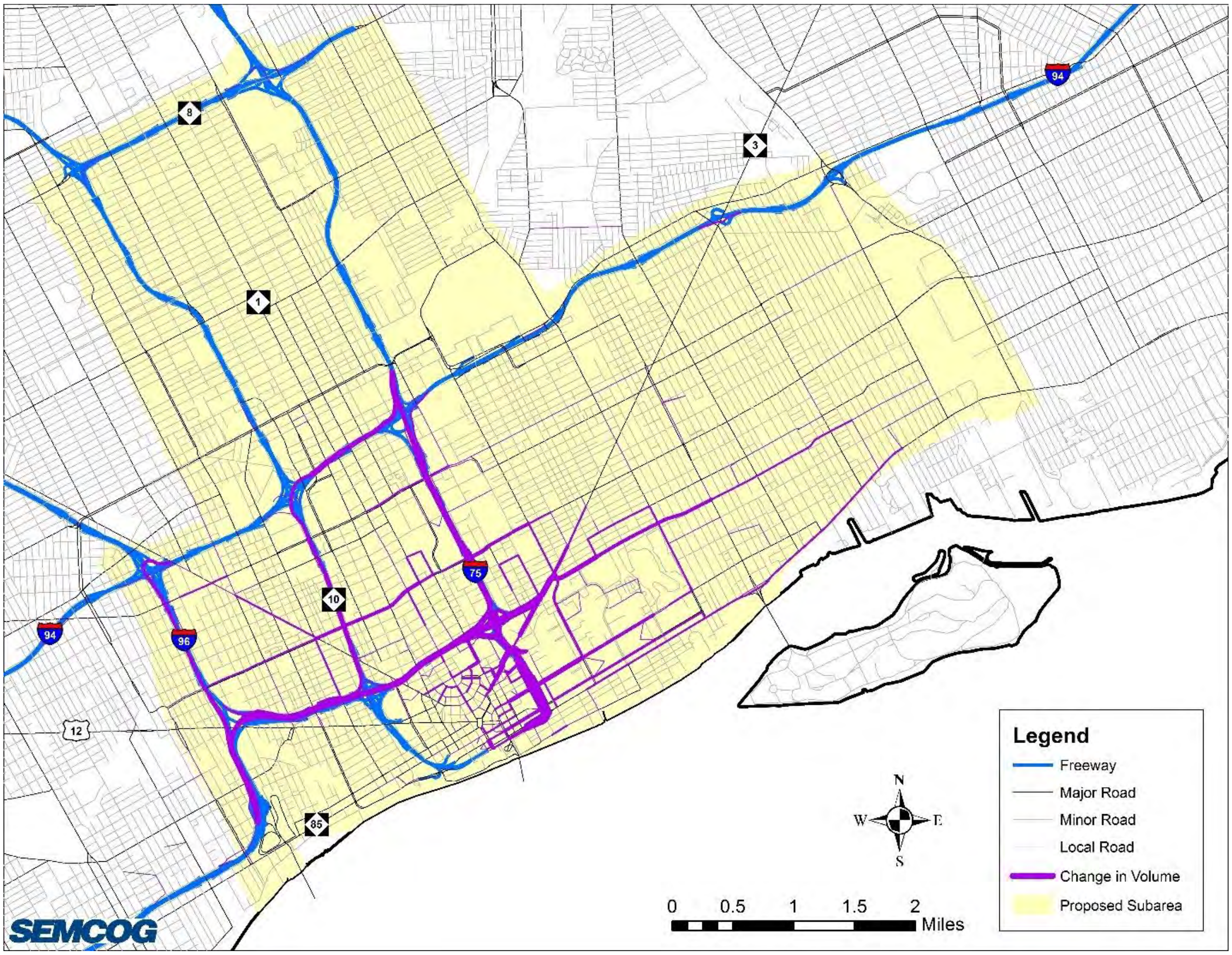


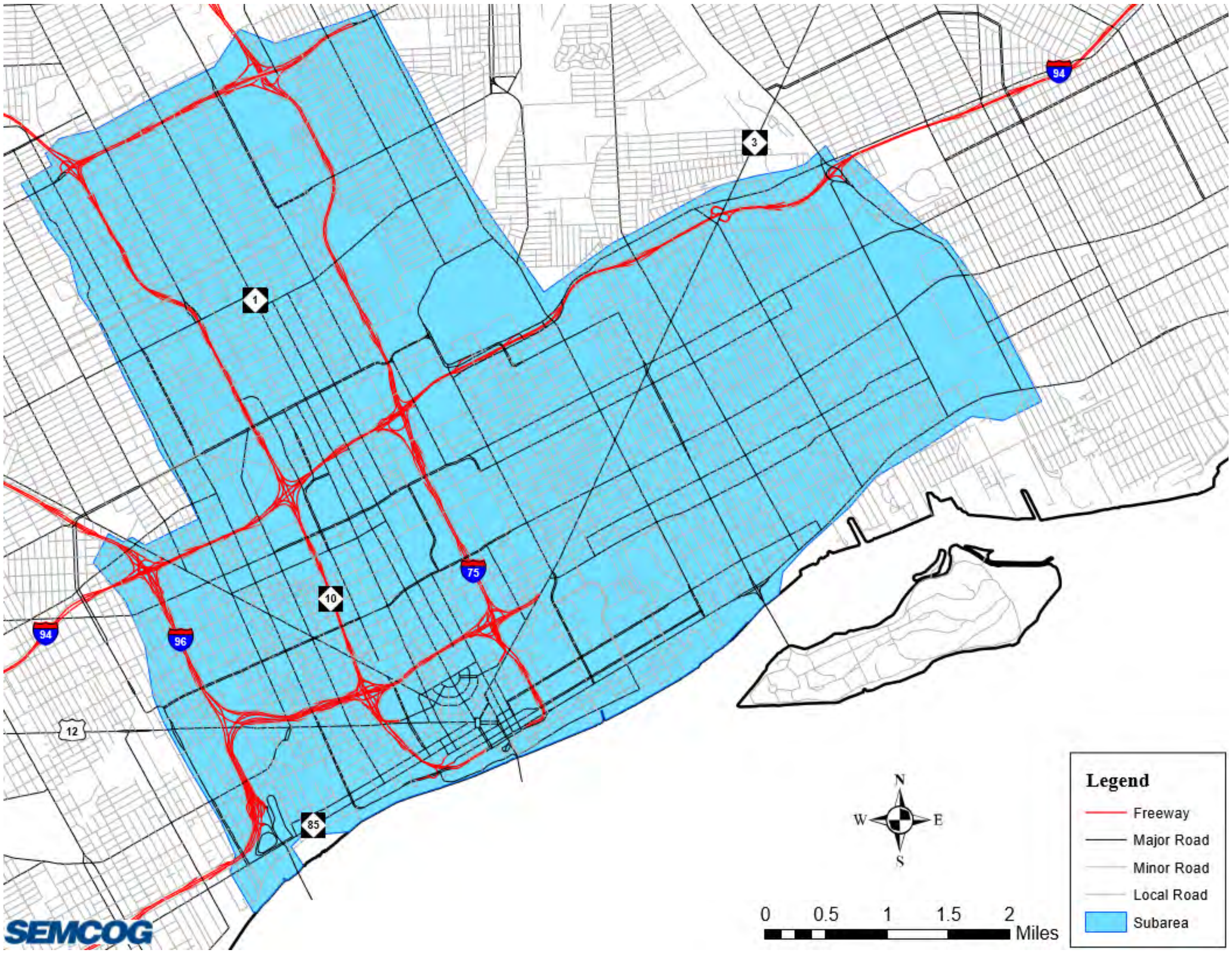
Figure 6. PM Peak Period Regional Macromodel Diversion



As shown in the two figures, the majority of the diversion occurred from I-75 to M-10 via I-94. However, the current configuration of the interchanges of I-94 at I-75 and M-10 do not allow for this movement to easily occur. Currently, the ramps at I-94 and M-10 are left-sided ramps and the distance between the two interchanges is not conducive for this movement. There is a long-term widening project for I-94 where the freeway will be widened by one lane in each direction and the M-10 interchange will be changed from left-sided ramps to right-sided ramps. This was already coded in the 2040 model. Even if these ramps were still left-sided, the travel demand forecasting model would still allow this movement to occur because the model doesn't take into account weaving and queuing. This is one of the cons of macroscopic models that can be addressed with mesoscopic and microscopic models. So, those that are aware of traffic patterns along the I-94 corridor and the region know that if a traveler wants to get from I-75 to M-10, the other option is to take M-8 to the north. As a result, the subarea included the M-8 freeway to the north to capture this potential diversion from I-75 to M-10. Two other areas that saw some volume differences included Vernor Highway to the east of downtown and Mack

Avenue just north of downtown. This diversion tended to end near Connor Avenue to the east. Therefore, the subarea was widened to include Conner Avenue to the east. There was also some diversion from I-96 and I-94 area. As such, the subarea included the area west to I-96. Figure 7 illustrates the subarea that was used for the project.

Figure 7. Location of Subarea



5 Development of the Model

DynusT was utilized as the mesoscopic model for this project. DynuStudio was used as the graphical user interface (GUI) to assist in developing the network and convert output from DynusT.

DynusT consists of iterative interactions between its two main modules – traffic simulation and traffic assignment. Vehicles are created and loaded into the network based on their respective origins and follow a specific route based on their intended destinations. The large-scale simulation of network-wide traffic is accomplished through a mesoscopic simulation approach that omits inter-vehicle car-following details while maintaining realistic macroscopic traffic properties (i.e. speed, density and flow). More specifically, the traffic simulation is based on the Anisotropic Mesoscopic Simulation (AMS) model that simulates the movement of individual vehicles according to the principle that a vehicle's speed adjustment is influenced by the traffic conditions in front of the vehicle. In other words, at each simulation interval, a vehicle's speed is determined by the speed-density curve, and the density is defined as the number of vehicles per mile per lane with a limited distance, called the speed-influencing region (SIR), downstream of the vehicle (Chiu et al. 2010).

The DynusT model utilizes some of the same characteristics of the regional travel demand model, including speed, number of lanes, and functional type. The model also uses saturation flow rate and traffic flow models (speed-density curves). The number of functional types is somewhat limited though and only include freeway, ramps, and arterials.

6 Network Development

The SEMCOG 2015 subarea network file was converted from a TransCAD network to a shapefile. That shapefile was then read into DynuStudio and converted into the DynusT network file format. The following information was transferred from the TransCAD network file to the DynusT file:

1. Length of Roadway
2. Number of Lanes
3. Link Type (Freeway, On-ramp, Off-Ramp, Arterial)
4. Speed

There were approximately 2,900 links that were included in the network. The subarea size was approximately 33 square miles. Table 1 summarizes the types of links within the subarea network, as well as the number of links for each type and the number of miles.

Table 1. Network Characteristics

Facility Type	Number of Links	Length (miles)
Interstate Freeway (I-75, I-375, I-94, I-96)	146	41.7
Other Freeway (M-10, M-8)	83	21.2
Major Arterials (Gratiot, Woodward, Jefferson)	609	71.6
Minor Arterials (Larned, Lafayette, Beaubien)	828	102.3
Collectors (Rivard, Larned, Monroe)	970	113.8
Ramps	242	45
Collector-Distributor System	8	1.9
Total	2,886	397.5

Approximately 242.5 miles of this network are considered one-way links, which includes roadways such as freeways, ramps, and other one-way roadways. The remaining 155 miles are two-way links, such as Woodward Avenue or Gratiot Avenue.

Saturation flow rate was then assigned to each roadway based on type of roadway. Table 2 summarizes the saturation flow rate of most roadways within the network.

Table 2. Saturation Flow Rates

Roadway Type	Saturation Flow Rate
Freeways	2,200 vehicles per hour per lane
Major Arterials	1,500 vehicles per hour per lane
Minor Arterials	1,800 vehicles per hour per lane
Collectors	1,300 vehicles per hour per lane

Left-turn and right-turn bays were added for those intersections within the downtown Detroit area, but not outside of downtown Detroit in the interest of saving time and the limited amount of diversion that is expected outside of the downtown area.

SEMCOG maintains a GIS database with the locations of most signalized intersections. This information was utilized to determine location of signalized intersections within the subarea. DynusT allows different types of intersection controls, which included no control, two-way stop, four-way stop, pretimed signals, and actuated signals. There were approximately 679 intersections within the model that were considered signalized. This includes double and quadruple intersections where there is technically one signal controller but multiple physical intersections.

Since there is no easy interface to read in signal timings from either Synchro or any other software, each signal was coded as an actuated signal with a minimum green time of 20 seconds and a maximum green time of 60 seconds for each phase. Most intersections were set to a standard two-phase signal.

7 Traffic Count Development

Traffic count information was utilized in the development of the origin-destination matrices, as well as the calibration and validation of the DynusT model. SEMCOG obtains traffic counts from the Michigan Department of Transportation, other agencies within southeast Michigan, as well as counts that have been taken by SEMCOG. A traffic count database has been developed which contains a variety of counts and can be matched to links within the SEMCOG TransCAD network. These counts range from 24-hour permanent traffic recorders (PTRs), spot roadway counts, and turning movement counts. Some of the counts are broken into 15-minute time periods, while other counts are hour based. Within the study area, there were 330 directional counts that were utilized for the study. Table 3 summarizes counts by facility type, the total number of counts, and the total volume.

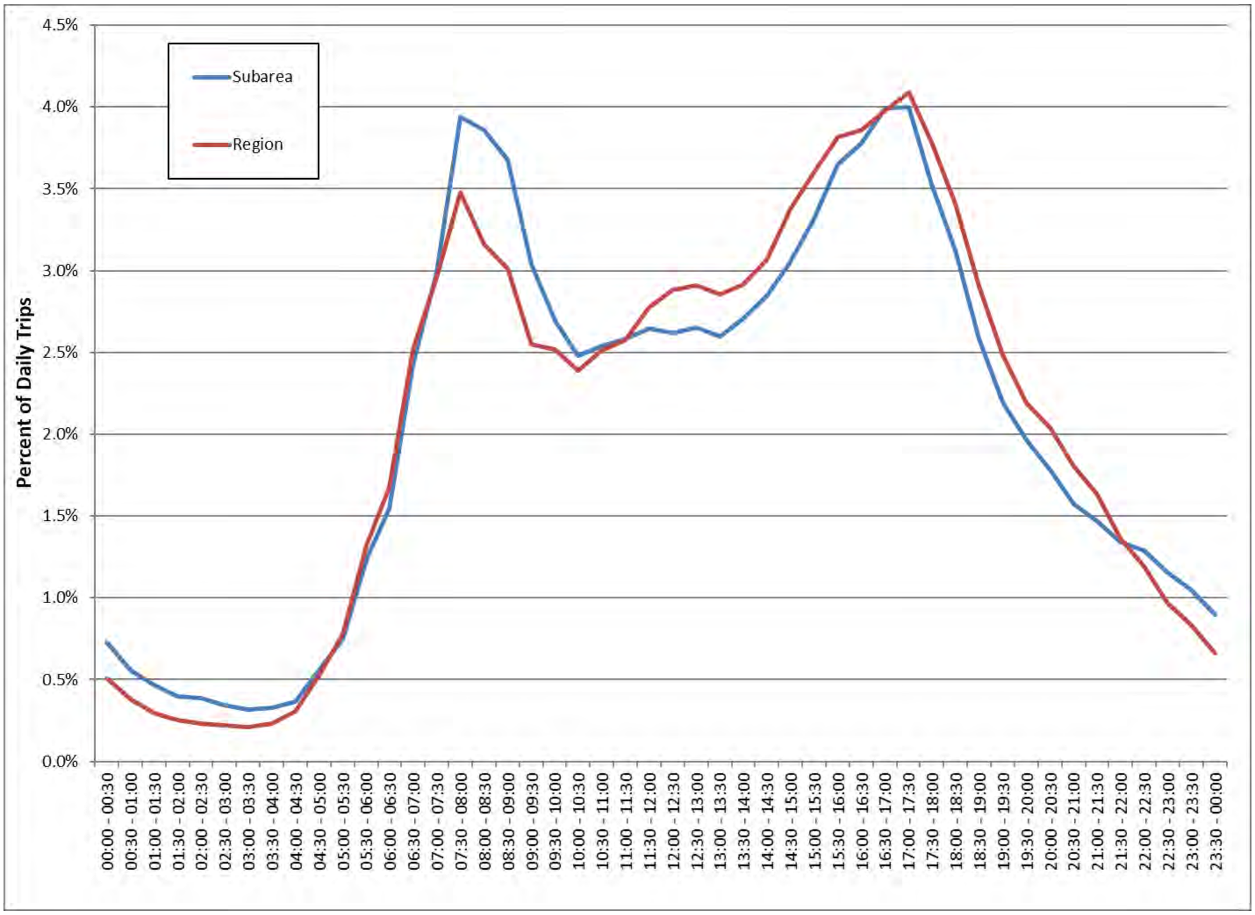
Table 3. Traffic Counts

Facility Type	Number of Counts	Total Daily Volume
Interstate Freeway (I-75, I-375, I-94, I-96)	9	586,900
Other Freeway (M-10, M-8)	9	360,706
Major Arterials (Gratiot, Woodward, Jefferson)	84	725,755
Minor Arterials and Collectors (Larned, Lafayette, Beaubien)	80	210,557
Ramps	145	1,213,427
Collector-Distributor System	3	41,906
Total	330	3,139,251

Of the 330 count locations, 235 locations (71%) had 15-minute counts while the remaining 95 locations (29%) had hourly counts. The counts were taken between 2014 and 2016 and were mainly spot counts that were not factored in any way. All the counts were reviewed and verified as part of the development of the latest version of the 2015 SEMCOG regional travel demand forecasting model.

Using the 15-minute counts within the study area, diurnal (time-of-day) factors were developed for half-hour increments. These diurnal factors were also compared to the regional factors and it was found that the factors were significantly different within the study area compared to the region. There was a much higher AM peak pattern within the study area, which coincides with a higher level of work trips compared to other types of trips. Figure 8 illustrates the subarea and regional diurnal factors.

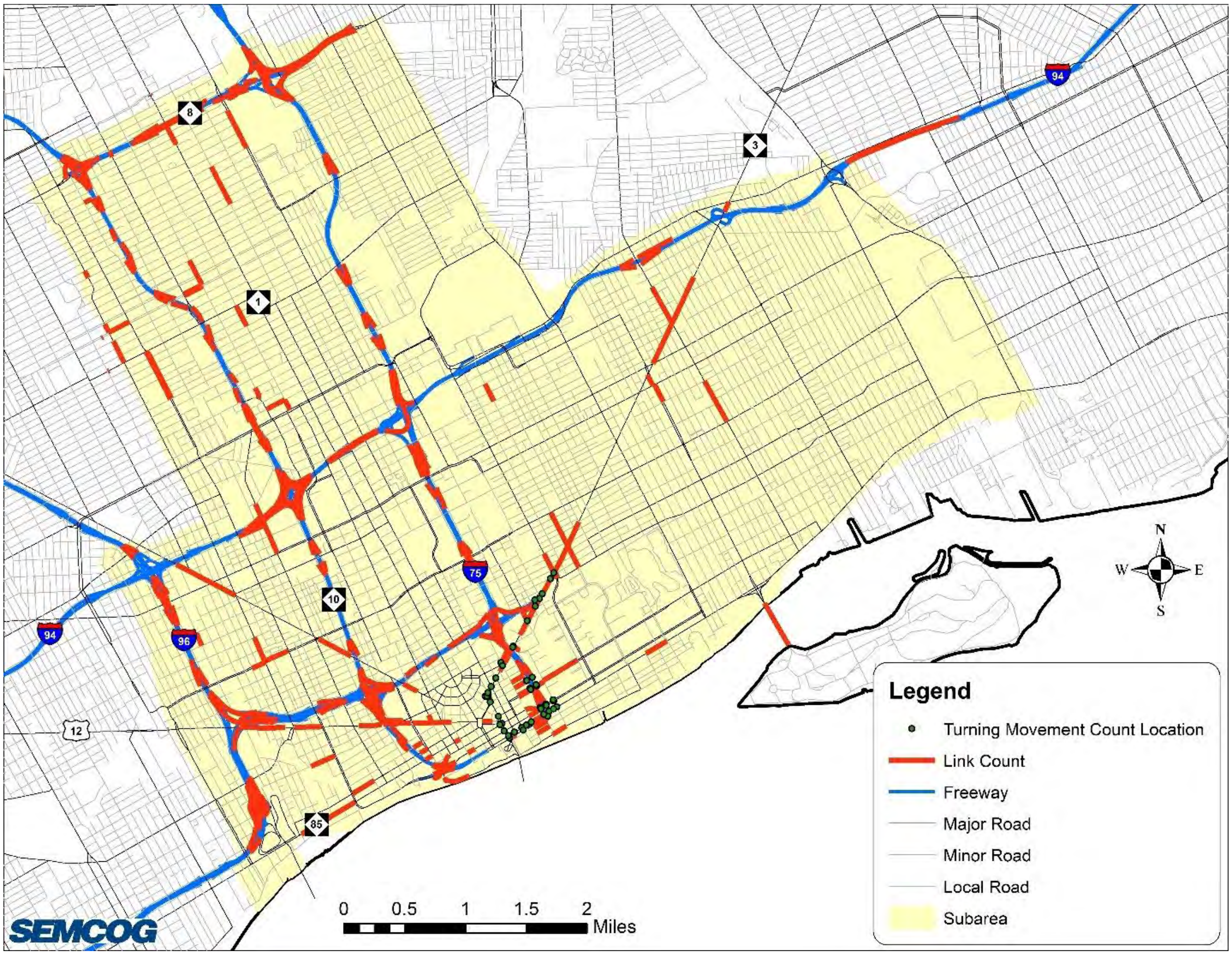
Figure 8. Regional and Subarea Time of Day Factors



The AM peak hour is from 7:30 AM to 8:30 AM and the PM peak hour is from 4:30 PM to 5:30 PM. Using the half-hour diurnal factors within the study area, the 95 locations that had hourly counts were divided into half-hour counts for use in the development of the OD trip matrices and the calibration/validation of the DTA model.

Figure 9 illustrates the locations of the counts within the study area.

Figure 9. Traffic Count Locations



8 Origin-Destination (OD) Matrix Development

As indicated earlier, the SEMCOG regional travel demand model is a 24-hour model that is broken into five time periods: AM peak period, mid-day period, PM peak period, evening, and overnight. The AM peak period is a 2.5-hour model and the PM peak period is a 3.5-hour model.

There are two different methods that could be used in development OD matrices within DynuStudio/DynusT. The first is to read in a peak period OD matrix into DynuStudio, enter the diurnal factors for the period, and then have DynuStudio create a demand matrix that is divided. The other option is to manually create the OD matrices through an OD matrix estimation process that is available through TransCAD which also uses the diurnal factors, but then adjusts the matrices based on available traffic counts. Given the relatively small study area, the number of traffic counts, and the sensitivity of the project, it was decided to use the OD matrix estimation process in the hope that the results would be more accurate.

The first step in this process was to run the 2015 regional demand forecasting model and extract a subarea OD matrix. The regional model has 2,899 traffic analysis zones (TAZs). The number of TAZs within the subarea was 239, which included 144 internal TAZs and 95 external TAZs. Of the 95 external TAZs, 13 were original to the regional model and 82 were created. This subarea extraction process created five separate subarea matrices with 239 zones. There were six different vehicle types within each matrix. The six different matrices were combined into two matrices, one car matrix and one truck matrix. The car matrices contained the SOV, HOV2, HOV3, and Light Truck. The truck matrices contained the Medium Truck and Heavy Truck Matrices. Those two matrices were then combined into one vehicle matrix to perform the Origin-Destination Matrix Estimation (ODME) process since the counts were total vehicle counts.

Table 4. Subarea Trips before ODME

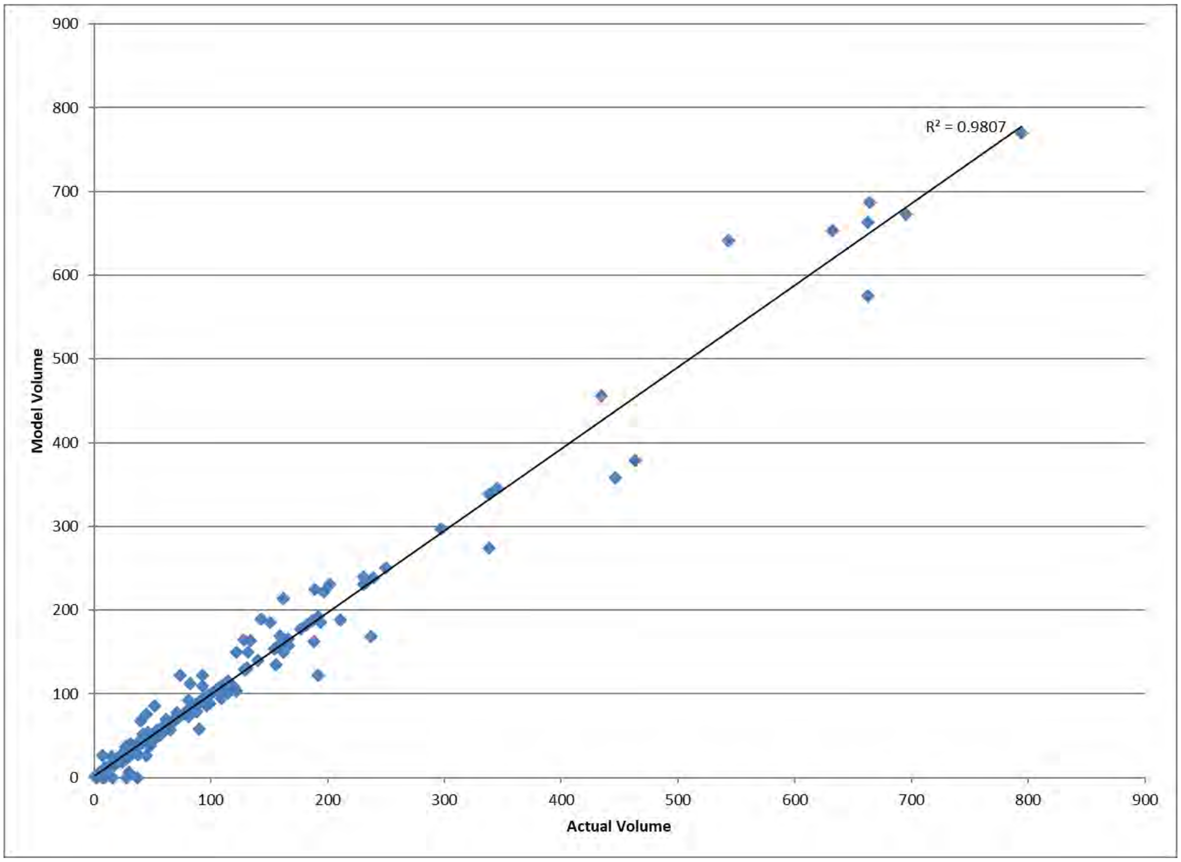
Type	AM Peak Period	Mid-Day Period	PM Peak Period	Evening Period	Night-time Period	Total
SOV	132,638	209,031	257,957	131,984	88,792	820,402 (64%)
HOV2	32,991	55,674	75,257	38,664	20,868	223,454 (17%)
HOV3	11,962	11,067	28,166	7,953	4,071	63,219 (5%)
Light Truck	10,199	63,518	16,109	3,778	3,615	97,219 (8%)
Medium Truck	6,080	30,024	7,345	1,620	1,584	46,653 (3%)
Heavy Truck	4,578	21,318	5,564	2,085	2,020	35,565 (3%)
Total	198,448	390,632	390,398	186,084	120,950	1,286,512

Once the subarea matrices were extracted, they were divided into half hour matrices utilizing the diurnal factors that were developed from the traffic counts. The approximate length of trip within the study area is typically less than a half hour, given that that study area is somewhat small.

Once the 48 separate trip matrices were created, the OD matrix estimation process was conducted. As indicated earlier, there were approximately 331 traffic count locations that were utilized. In addition, there were 156 turning movement counts that were utilized around the I-375 study area for the AM and PM peak hours only. These were also included and were obtained in 2017. These were hourly counts that were divided into half-hour counts based on the diurnal factors. The ODME process used a maximum number of iterations equal to 200 and a convergence of 0.0001, with the new TransCAD NCFW user equilibrium assignment method.

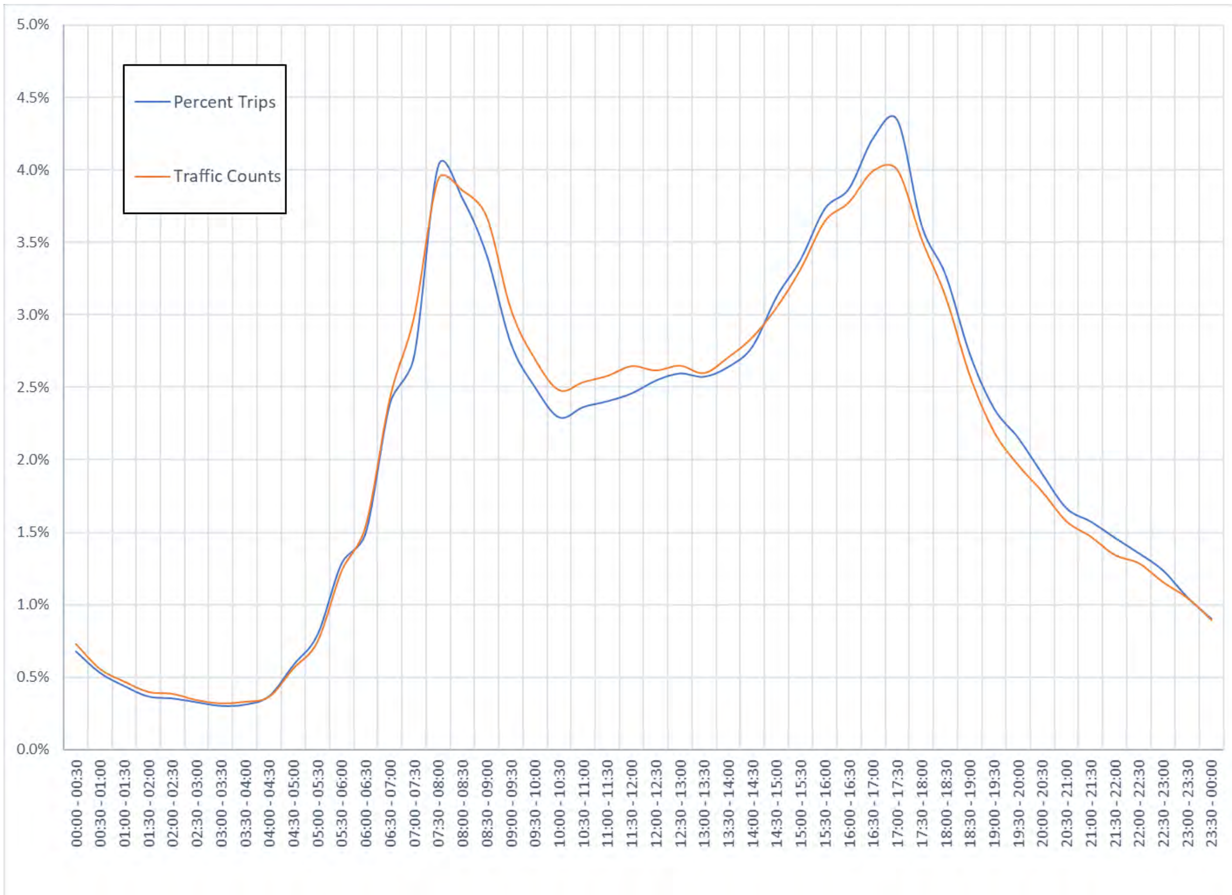
Figure 10 illustrates the actual versus estimated model volumes for one of the time periods. The R^2 value from this run was 0.98, which means that the modeled volumes were fairly close to actual volumes. Having an R^2 of 1.0 is perfect. There was still some variability of the model, which is expected.

Figure 10. Example of ODME Results



The total number of trips after the OD matrix estimation process was 1,250,145, which was approximately 3.9% less trips than the original number of trips. Figure 11 illustrates the percentage of trips during each of the 48 time periods.

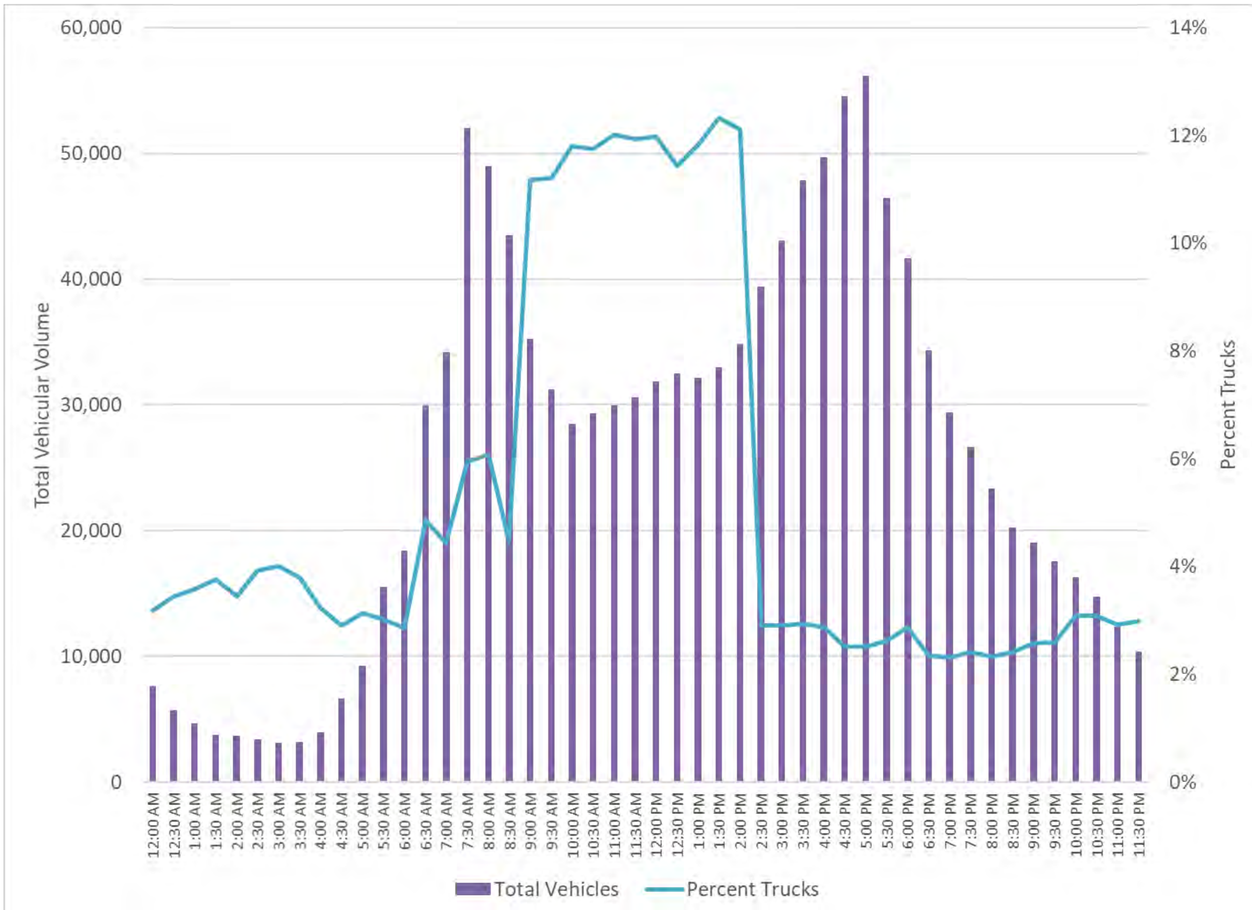
Figure 11. Traffic Counts compared to Subarea Trips



The trip matrices had a higher percentage of trips during the PM peak hour than the traffic counts but had a difference of 0.3% during one half hour time period. Given the amount of counts within the study area, as well as around I-375, the ODME process did a good job of adjusting the subarea trip matrices to better match traffic conditions.

Once the ODME process was finalized for the total vehicle matrices, they were split into car matrices and truck matrices again based on the percentages from the original matrices. Figure 12 summarizes the number of total vehicles and the percent trucks for each of the 48 time periods. As shown in the figure, the percentage of trucks for most of the time varies between two-percent to six-percent, except during the mid-day. The times between 9:00 AM to 2:30 PM, the percentage of trucks increase to between 11-percent to 12-percent. This is consistent with the regional travel demand model.

Figure 12. Total Vehicles and Percent Trucks by Time of Day



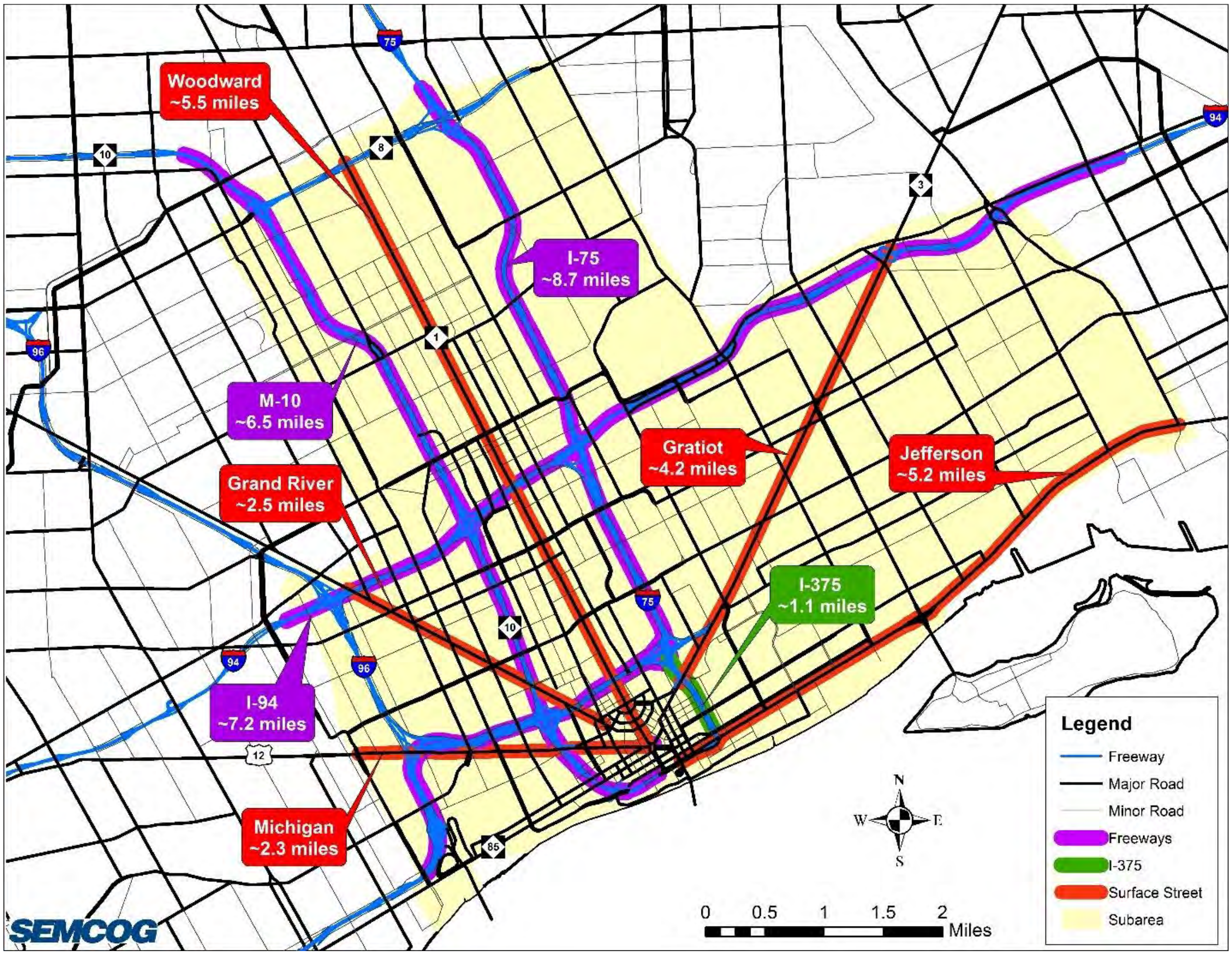
9 Travel Time Development

In addition to utilizing traffic volumes, travel times were used for freeways and major arterials within the subarea. These travel times were obtained from the Regional Integrated Transportation Information System (RITIS). This tool utilizes archived speed and travel time information from the National Highway System and goes back to the year 2011. It utilized probe data from mobile devices and GPS systems from personal and commercial vehicles that have travelled along various roadways. There were 18 roadways that were downloaded from RITIS and included data from a Tuesday, Wednesday, and Thursday in the months of April, May, June, September, and October in 2015. These months were chosen since the original base year of the regional model was 2015 and these were the months were there were likely to have no snow events and school was still in session. RITIS has a confidence level associated with the dataset, and a high confidence was chosen for the dataset, which means that it is based on real-time data for each specific segment. The data was then averaged to represent one "average travel day" to determine a total travel time along each roadway. The length of the roadway segment was also downloaded and used to determine an average speed. The travel times and speeds were broken down into 15-minute time segments to be used during the calibration and validation of the DTA model. Table 5 summarizes the roadway segments that were downloaded and summarized as well as distance, average speed, minimum and maximum speeds. Figure 13 illustrates the locations of these travel time segments.

Table 5. Travel Time Segments

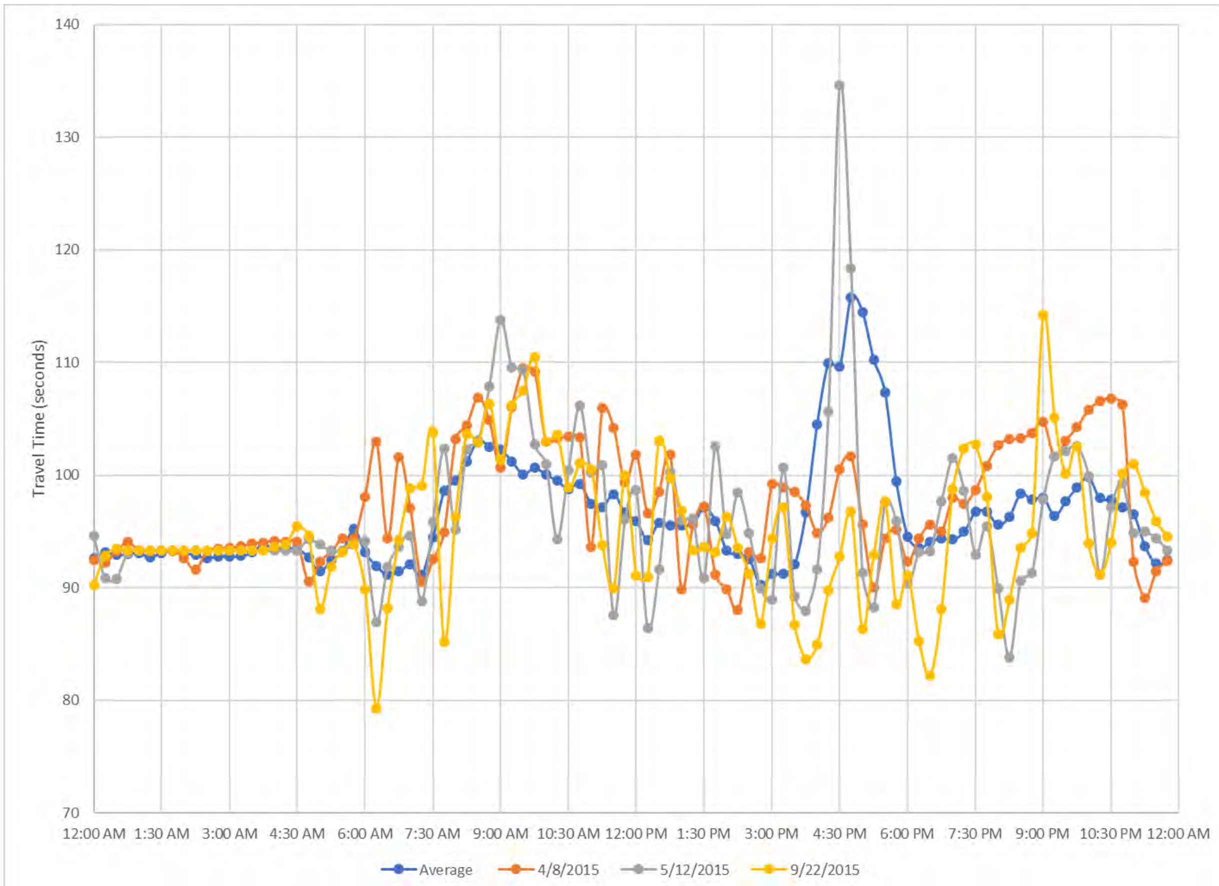
Roadway Segment	Description	Distance (miles)	Minimum Speed	Average Speed	Maximum Speed
Northbound I-75	Grand Blvd to M-8	8.77	38.9	53.0	58.3
Southbound I-75	M-8 to Grand Blvd	8.68	40.2	55.1	61.1
Northbound M-10	Jefferson to M-8	6.8	37.2	52.5	56.7
Southbound M-10	M-8 to Jefferson	6.14	42.6	54.1	57.9
Eastbound I-94	Grand Blvd to Conner Ave	7.26	19.9	45.9	58.6
Westbound I-94	Conner Ave to Grand Blvd	7.19	34.8	50.1	59.8
Northbound I-375	Jefferson to I-75	1.1	34.2	41.1	43.9
Southbound I-375	I-75 to Jefferson	1.25	26.7	41.3	46.5
Northbound Gratiot	I-375 to French Road	4.4	23.0	26.3	30.1
Southbound Gratiot	I-94 to I-375	4.06	24.4	27.7	32.5
Eastbound Jefferson	M-1 to Conner Ave	5.2	23.0	26.4	31.0
Westbound Jefferson	Conner Ave to M-1	5.2	22.5	25.9	30.9
Eastbound Michigan	Grand Blvd to M-1	2.4	18.3	21.0	25.9
Westbound Michigan	Cass to Grand Blvd	2.27	20.1	22.9	27.4
Southbound Woodward	M-8 to Campus Martius	5.55	17.3	20.1	25.2
Northbound Woodward	Campus Martius to M-8	5.55	17.1	19.7	24.7
Eastbound Grand River	I-94 to Cass	2.47	21.4	23.9	28.4
Westbound Grand River	Cass to I-94	2.47	20.3	23.7	28.7

Figure 13. Locations of Travel Time Segments



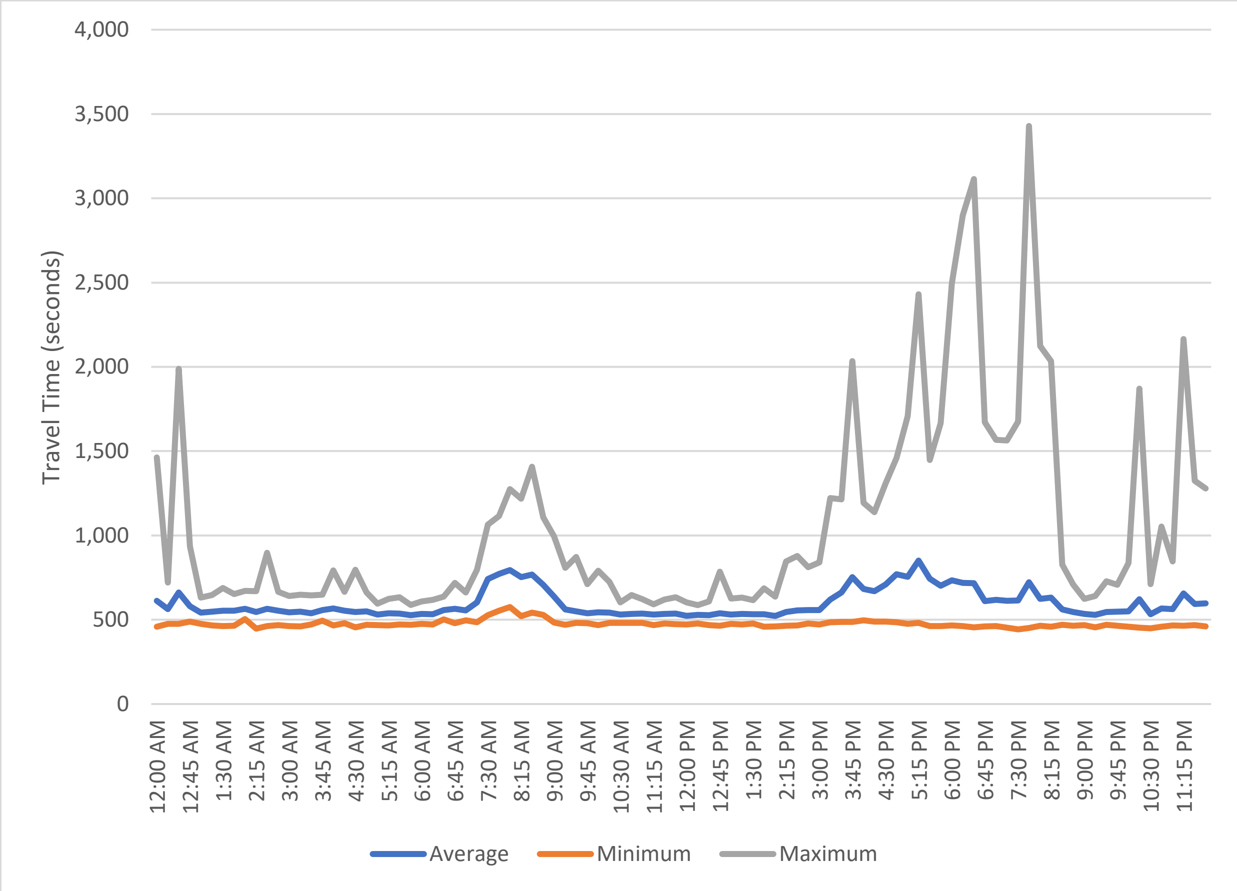
A table and graphs were developed for each of the 18 roadways segment that illustrates the variation of speed throughout the day. Figure 14 illustrates the average travel time chart for northbound I-375, as well as variation of speeds on several different days.

Figure 14. Northbound I-375 Travel Time



While this only illustrates one corridor out of the 18 corridors, this illustrates the high variability in travel time not only along I-375, but this is indicative of travel time data for all corridors. It is also dependent on the number of device users along the corridor and during each segment. Figure 15 illustrates the theoretical minimum and maximum travel times along northbound I-75. This was basically done by determining the minimum travel time on a particular day and then maximum travel time on a different day and summarizing those.

Figure 15. Northbound I-75 Travel Time



This figure illustrates the highly variable data within the dataset, which may or may not be indicative of the actual travel time variability along the corridor. This is why the data is averaged over several days/months to remove the variability. However, it should also be noted that high variability does exist and can make it difficult to calibrate a model that may be using traffic volumes collected from one or two days.

10 Model Calibration

The DTA model was calibrated using traffic volumes with less emphasis on travel time. DynusT does not utilize a model penalty for distance and runs iteratively until each vehicle within the network has obtained the shortest travel time within the convergence criteria. The convergence criteria for this model was set at 5%, meaning that when a repeated travel time for the entire model is within 5%, the model is considered converged. There were two vehicle classes utilized in the model, one for cars and one for trucks. The value of time for the car vehicle class was $10 per hour and the value of time for the truck vehicle class was $30 per hour, though did not impact any of the decision making in the model.

Given the nature of the project, a conversion of a freeway to a boulevard, more confidence was given to traffic volumes than the travel time information. There were several factors that were used to calibrate the model. The first was saturation flow rate, the second was speeds along the corridor, and the third was the speed-flow curves within DynusT. Originally two different speed-flow curves were utilized in the calibration, one for freeways and one for non-freeways. In addition, all roadway segments had a saturation flow rate equal to 1,800 vehicles per hour per lane (vphpl). This was quickly adjusted to the values that are shown in Table 2. It was found that minor arterials had too much traffic while the major arterials did not have enough traffic. In addition, the saturation flow rate of freeways was increased to 2,200 vphpl since the AM and PM peak period volumes were not high enough and there was too much variability in speeds along the freeway. As a result, another speed-flow curve was added to the model, one for freeways, one for major roadways, and one for minor roadways.

Even after a third speed-flow curve was added to the model, there still was not enough volume along the major arterials, which includes Gratiot Avenue, Woodward Avenue, Michigan Avenue, Jefferson Avenue, and Grand River Avenue. Since the saturation flow rate was already set at 1,800 vphpl, the speeds were increased. This resulted in better traffic volume matching for the major arterials with less volumes on the freeways and the minor arterials. Table 6 illustrates the volume comparisons between a run without the speed adjustment on the major roadways and another run with the speed adjustment.

Table 6. Early Traffic Volume Calibration Comparisons

Facility Type	Actual Daily Volumes	Model Volumes Without Major Road Speed Adjustment	Model Volumes With Major Road Speed Adjustment
Interstate Freeways	586,900	586,180 (0%)	583,308 (-1%)
Other Freeway	360,706	353,904 (-2%)	351,841 (-3%)
Major Arterials	725,755	557,643 (-30%)	667,223 (-9%)
Minor Arterials / Collectors	210,557	233,215 (11%)	223,223 (6%)
Ramps	1,213,427	1,299,479 (7%)	1,261,292 (4%)
Collector-Distributor System	41,906	40,523 (-3%)	41,813 (0%)
Total	3,139,251	3,070,944 (-2%)	3,128,710 (0%)

As shown in the chart, adding the speed adjustment greatly improved the number of vehicles that utilized the major roadways with some decrease along the freeway system. There was some decrease of vehicles utilizing the minor arterials. The speed flow curves were adjusted until the model volumes for each category were within 10-percent of the actual volume. Table 7 summarizes volume and speed comparisons on a daily basis. Appendix B to this report has speed charts for each of the 18 roadways.

Table 7. Final Run (#14) Traffic Volume Calibration Comparisons

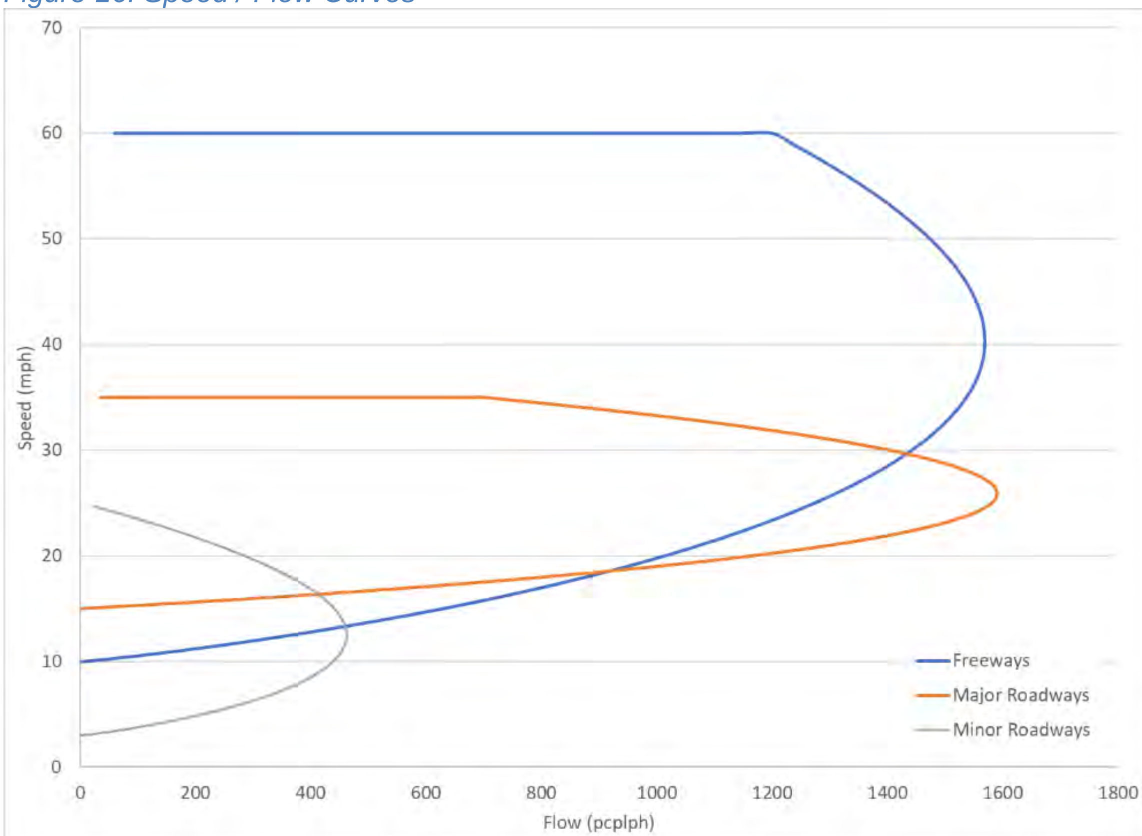
Facility Type	Total Daily Volume	Run 14
Interstate Freeways	586,900	583,201 (-1%)
Other Freeway	360,706	351,304 (-3%)
Major Arterials	725,755	663,198 (-9%)
Minor Arterials / Collectors	210,557	218,290 (4%)
Ramps	1,213,427	1,255,975 (3%)
Collector-Distributor System	41,906	41,281 (-2%)
Total	3,139,251	3,113,249 (-1%)

The table summarizes the parameters of the speed flow curves, while Figure 16 illustrates each of the curves.

Table 8. Traffic Flow Curve Characteristics

Parameter	Freeway	Major Road	Minor Road
Shape Term Alpha	3.640	1.400	2.500
Shape Term Beta	1.000	1.000	1.000
Density Breakpoint (pcphpl)	20	20	0
Minimal Speed (mph)	10	15	3
Jam Density (pcphpl)	200	200	150
Regime Type	Two Regime	Two Regime	One Regime
Sample Speed (mph)	60	35	25

Figure 16. Speed / Flow Curves



The figures below illustrate the volume comparisons and R^2 for the Daily, AM peak period (7-9am) and PM peak period (2-6pm).

Figure 17. Daily Volume Comparisons

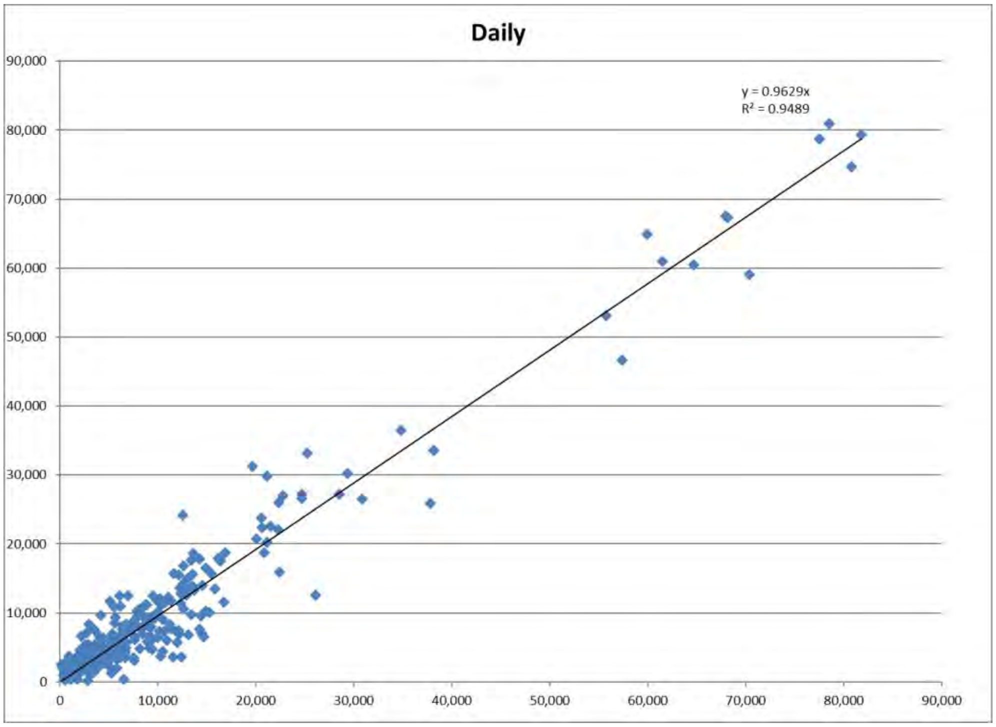


Figure 18. AM Peak Period Volume Comparison

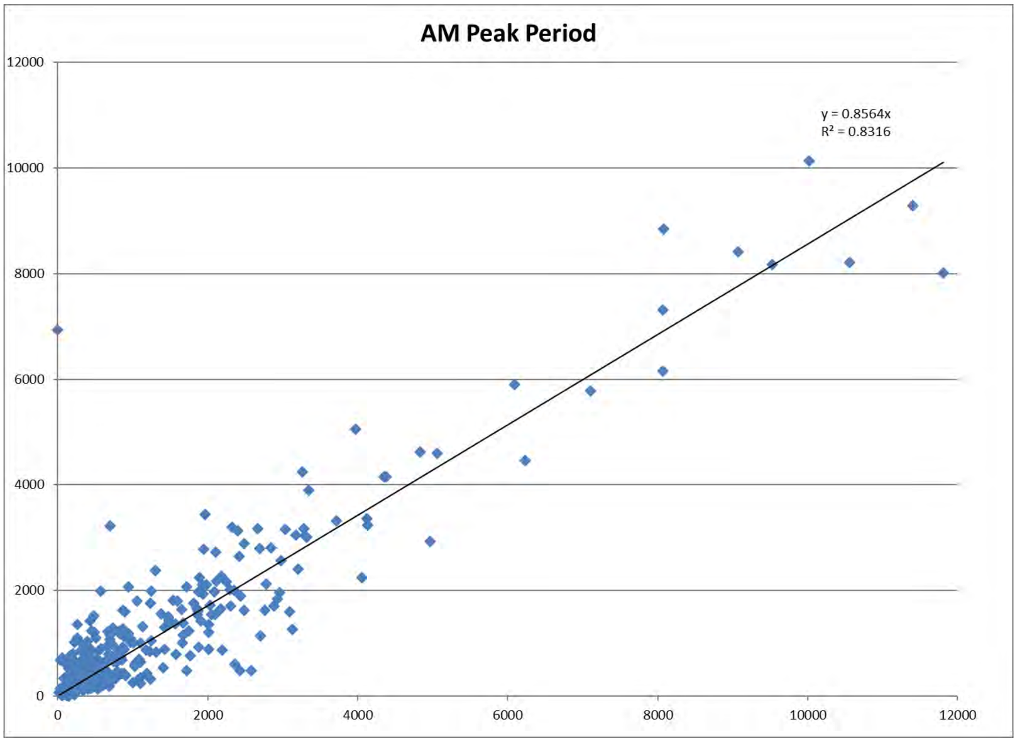
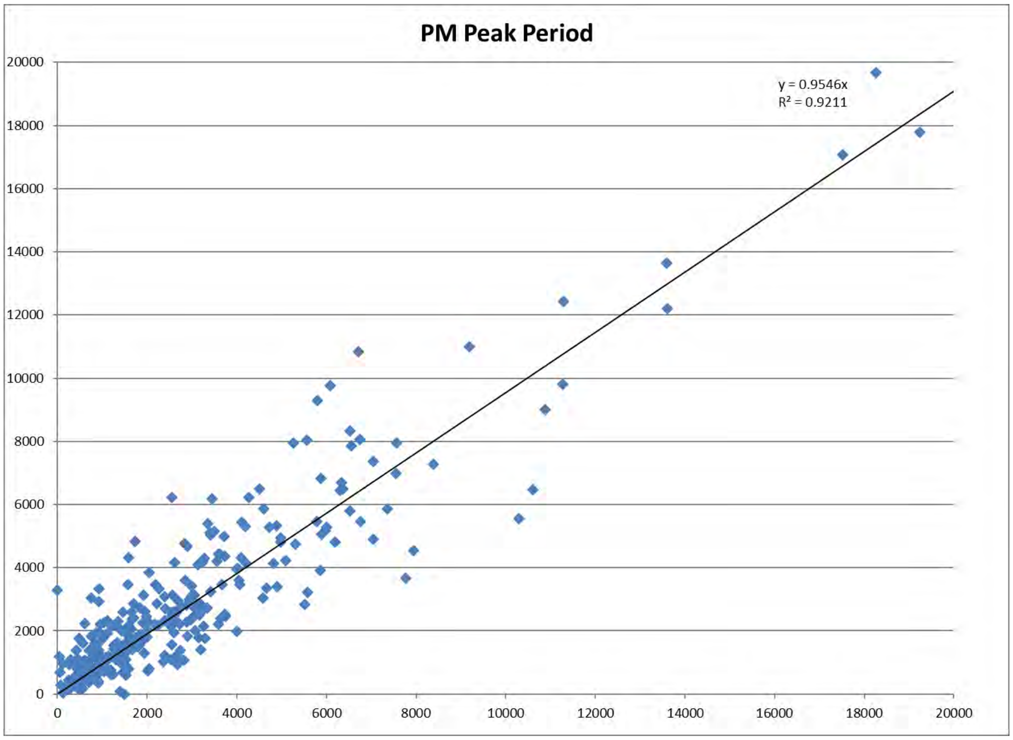


Figure 19. PM Peak Period Volume Comparison



The model was run for a total of 50 iterations, the overall convergence was just under two-percent. Fifteen-percent of the car and truck classification received en-route information, which means that those vehicles receive information regarding the best travel time in real time. Vehicles typically receive en-route information via GPS applications, such as Waze or Google Traffic, and are given the option to stay on the current route or take the updated route. The software will always opt to take the updated route. The remaining 85-percent of the vehicles utilized the user equilibrium function, which was the best travel time from the previous iteration. Table 9 summarizes information from the base year model, including average travel time and average travel distance.

Table 9. Base Year Results

Parameter	Base Year
Total Vehicle Miles Travelled	160,163
Total Vehicle Hours Travelled	5,368,075
Average Travel Time (minutes)	7.7
Average Travel Distance (miles)	4.3
Average Delay (minutes)	0.45

Below is a table summarizing the average and maximum travel time and distance for the subarea as well as some select links within the subarea.

Table 10. Base Year Results

Parameter	Number of Vehicles	Average Travel Time (min)	Average Travel Distance (miles)	Maximum Travel Time (min)	Max Travel Distance (miles)
Subarea	1,246,121	7.7	4.3	49.3	14.5
SB I-375	41,908	10.3	6.7	31.1	13.4
NB I-375	44,664	11.5	7.1	46.8	13.7
SB Madison Ramp	4,722	12.8	6.6	39.2	9.2
NB Madison Ramp	4,816	11.1	6.3	40.3	10.8
EB Gratiot Connector*	12,327	9.8	5.9	41.0	11.0
WB Gratiot Connector*	21,245	10.9	6.5	45.2	13.3
Average	129,682	10.9	6.7	46.8	13.7

*Does not include vehicles that used I-375

11 Development of 2045 Future Year Model

The development of the 2045 origin-destination matrices followed the same pattern as the development of the base year matrices. The 2045 Regional Model was run for the whole region with all the projects included in the 2045 Regional Transportation Plan. Within the subarea, there is one major project, as well as some several smaller changes. These include:

- Expansion/Reconfiguration of I-94 between I-96 and Conner Avenue from 3 lanes in each direction to 4/5 lanes in each direction
    - Reconfiguration of I-94 and M-10 interchange to remove left-sided ramps
    - Continuous service drives along I-94, M-10, and I-75 along the I-94 freeway
    - Reconfiguration of some interchanges/ramps along I-94
- Conversion of one-way to two-way streets within northwest downtown Detroit, including:
    - Park Avenue between NB I-75 Service Drive and Adams Avenue
    - Clifford Street between SB I-75 Service Drive and Adams Avenue
    - Columbia Street between Cass Avenue and Park Avenue
    -
- Road Diet from 2 Lanes in each direction to 1 Lane in each direction:
    - Mount Elliott between Lafayette Avenue and Gratiot Avenue
    - Mack Avenue between Van Dyke Street to Saint Jean Street

A subarea OD matrix extraction was performed on the subarea that was developed in Chapter 4 of this document. Table 11 summarizes the number of trips for each of the five time periods for the year 2015 and the year 2045. Much like the development of the base year matrices, there were two vehicle classes, car and truck.

Table 11. Subarea Trip Growth from 2015 to 2045

Year and Class	AM	MD	PM	EV	NT	Total
2015 Cars	187,790	339,290	377,489	182,379	117,346	1,204,294
2015 Trucks	10,657	51,342	12,909	3,705	3,604	82,218
2015 Total	198,447	390,633	390,398	186,085	120,950	1,286,512
2045 Cars	205,032	370,081	412,193	203,661	130,339	1,321,306
2045 Trucks	10,445	50,303	12,518	3,632	3,532	80,431
2045 Total	215,478	420,384	424,711	207,292	133,871	1,401,737
Car Difference (2045-2015)	17,243	30,791	34,704	21,281	12,993	117,012
Car % Diff	9.2%	9.1%	9.2%	11.7%	11.1%	9.7%
Truck Difference (2045-2015)	-212	-1,039	-391	-74	-72	-1,787
Truck % Diff	-2%	-2%	-3%	-2%	-2%	-2%
Total Difference	**17,031**	**29,752**	**34,313**	**21,208**	**12,921**	**115,224**
Total % Diff	**8.6%**	**7.6%**	**8.8%**	**11.4%**	**10.7%**	**9.0%**
2045 % Trucks	**5%**	**12%**	**3%**	**2%**	**3%**	**6%**

Overall, there was a nine-percent increase in trips from 2015 to 2045 in the study area, with the largest percentage increase occurring in the evening period. The number of trucks is expected to decrease from the year 2015 to the year 2045. This is due to expected decreases in manufacturing in the region between now and the year 2045.

There were three different ways to develop the 2045 future year origin-destination (OD) matrices, these being:

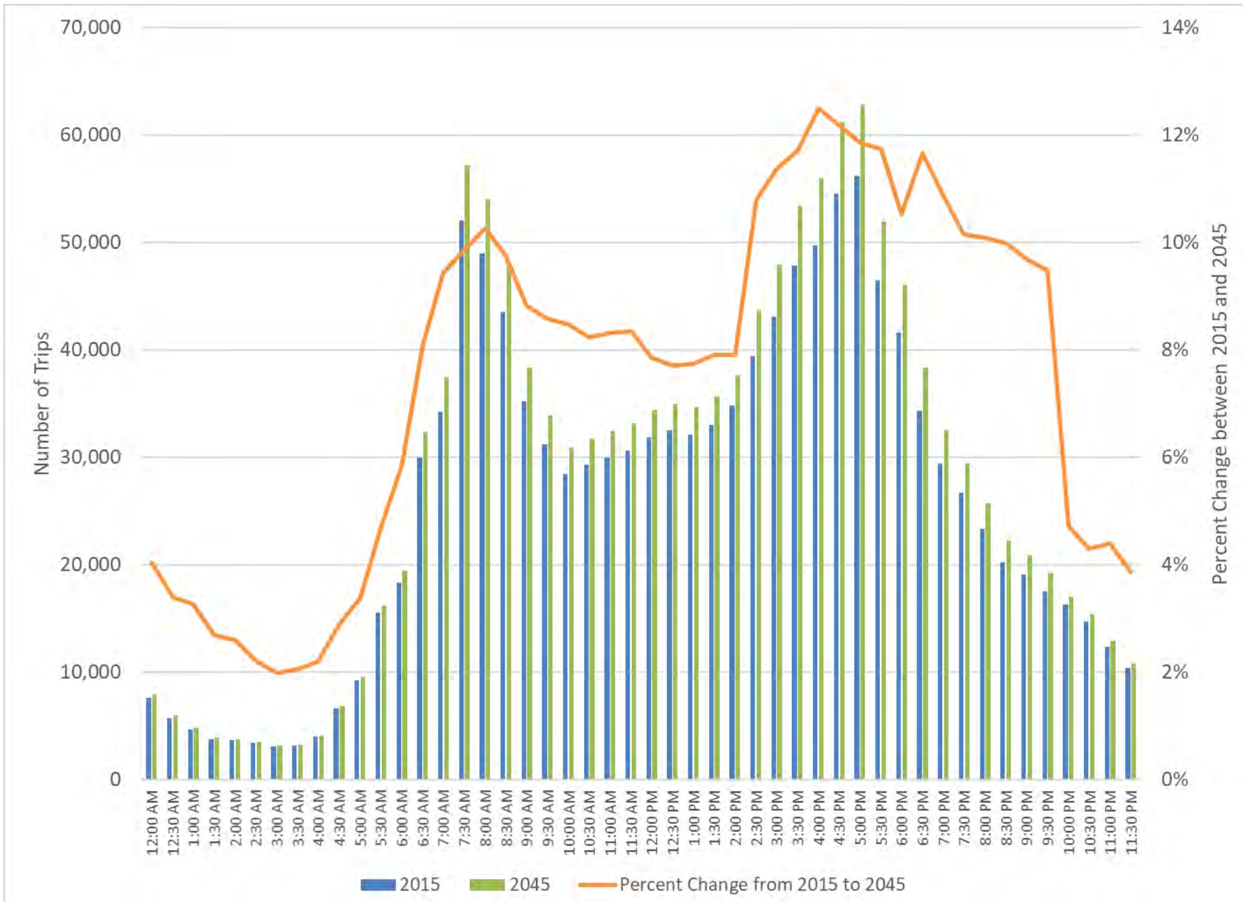
1. Utilize the 2045 subarea matrices from the regional model
2. Take the vehicular differences between the 2045 and 2015 matrices and apply to the ODME matrices
3. Take the percent differences between the 2045 and 2015 matrices and apply to the ODME matrices

The concern with utilizing the 2045 matrices from the regional model (Option #1) is that it does not utilize the ODME process that was utilized in the base year and ignores that process. The concern with utilizing percent difference (Option #3) is that there are large percent changes between some of the zones which could cause some large differences in trips. The chosen option was to utilize the volume difference (Option #2) between the 2015 and 2045 matrices and apply those to the base year ODME matrices. This way, the volume changes between each OD pair will be maintained. It is assumed that the same time of day factors from the base year were applied to the change in future year trips. The total number of trips in the subarea increased from 1,250,145 in the base year to

1,366,401 in the future year, which is an increase of nine percent. This is consistent with the original subarea matrices. Figure 20 summarizes the changes by each of the 48 time periods.

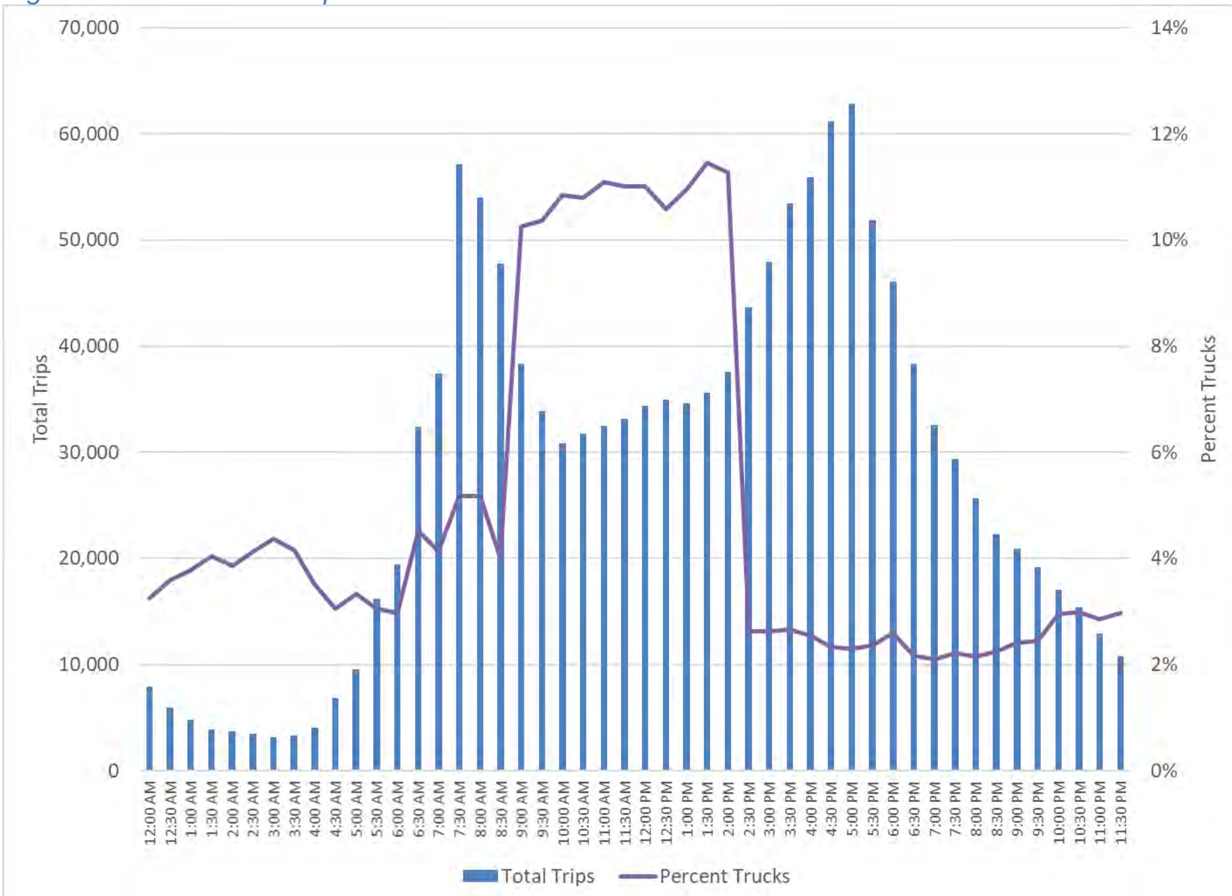
As seen in the figure, there is larger growth expected in the morning and evening peak periods, with additional growth seen until 10:00 PM in the evening. There is less growth expected in the very late hours and very early hours.

Figure 20. Growth from 2015 to 2045



Once the total vehicular trips were developed for 2045, the matrices were divided into a car matrix and a truck matrix based on the percentages from the regional model. Figure 21 illustrates the total vehicular trips in 2045 and the truck percentage by each time period. The overall percent trucks for the subarea is approximately 5.2-percent. Much like the base year, the percent trucks increase in the mid-day and is lower during the morning and evening peak periods and overnight.

Figure 21. 2045 Total Trips and Percent Trucks



The DynusT network was updated to include the projects that were listed at the beginning of this chapter, including the I-94 expansion project, one-way to two-way conversions, and the road diets.

Below is a summary of the future year results compared with the base year results.

Table 12. Future Year Results

Parameter	Base Year (2015)	Future Year (2045)
Total Vehicle Hours Travelled	160,163	179,309
Total Vehicle Miles Travelled	5,368,075	5,746,364
Average Travel Time (minutes)	7.7	7.9
Average Travel Distance (miles)	4.3	4.2
Average Delay (minutes)	0.45	0.44

Below is a comparison of trips in the I-375 in the base year as well as the future year.

Table 13. Future Year I-375 Corridor Results

Parameter	Base Year (2015)			Future Year (2045)		
	Number of Vehicles	Average Travel Time (min)	Average Travel Distance (miles)	Number of Vehicles	Average Travel Time (min)	Average Travel Distance (miles)
Subarea	1,246,121	7.7	4.3	1,361,731	7.9	4.2
SB I-375	41,908	10.3	6.7	46,553	10.1	6.4
NB I-375	44,664	11.5	7.1	52,977	11.4	6.8
SB Madison Ramp	4,722	12.8	6.6	5,853	12.4	6.5
NB Madison Ramp	4,816	11.1	6.3	7,329	10.7	6.4
EB Gratiot Connector*	12,327	9.8	5.9	13,657	8.8	5.3
WB Gratiot Connector*	21,245	10.9	6.5	19,650	10.5	6.2
Average	129,682	10.9	6.7	145,993	10.6	6.4

**Does not include vehicles that used I-375*

The average travel time from 2015 to 2045 increased by 0.2 minutes, while the travel distance decreased by 0.1 miles. This could be due to the added continuous service drives along I-94, I-75, and M-10 that was added to the model. Within the I-375 corridor, the number of trips increased by 13-percent, while the average travel time and average travel distance both decreased. This could be due to the widening of I-94 and added accessibility of the continuous service drives. The smaller increases in traffic volumes on the Gratiot Connector indicate that less traffic is utilizing the Gratiot Connector and likely staying on I-94 due to the widening.

12 Preferred Alternative

One major impetus of creating the mesoscopic DTA model was to evaluate the conversion of I-375 from a freeway with unconstrained flow to a boulevard with constrained flow. The results of the analysis will be used to inform the microscopic traffic analysis that is being conducted within VISSIM. The results of the mesoscopic model are not being fed into the VISSIM analysis. Instead, the results of the DTA model are informing the VISSIM model as to the amount and location of the diversion of traffic from the I-375 corridor. The questions being asked are:

1. Will there be any diversion from the I-375 corridor to other roadways?
2. If there is diversion, where will the traffic go?
3. Will any additional traffic that gets diverted negatively impact those roadways?
4. What is the impact to other roadways within downtown Detroit and roadways surrounding I-375?

From these answers, the study team conducted a microscopic analysis of the roadways that are expected to be impacted by the conversion. The analysis was conducted on both the base year and the future year (2045) models.

To evaluate the roadway changes, both networks were coded in such a way that the boulevard was already coded into the base year model. For example, any new ramps from I-75 to the new boulevard were included in the base year model but were turned “off” when calibrating the base year network. To test the boulevard, certain roadways were then turned “off” (such as the I-375 freeway) and the new roadways were turned “on”. Within the model, the southbound I-375 service drive south of Clinton was converted from the service drive to the Boulevard. In addition to turning “off” and “on” roadways, signals within the I-375 corridor were either removed, added, and/or updated.

After consultation with the City of Detroit Planning and Development Department, some roadways were also changed from one-way roadways to two-way roadways, these included:

- Southbound I-375 Service Drive between Clinton Street and Jefferson Avenue
- Northbound I-375 Service Drive between Monroe Avenue and Antietam Avenue
- Beaubien Street between Madison Avenue and Lafayette Avenue
- Lafayette Avenue /Bates Street between Farmer Street and Beaubien Street
- Macomb Street between Brush Street and Southbound I-375 Service Drive
- St. Antoine Street between Lafayette Avenue and Madison Avenue
- Brush Street between Congress Street and Madison Avenue

All these roadways are currently one-way. Beaubien Street, Lafayette Avenue/Bates Street, Macomb Street, St. Antoine Street, and Brush Street were coded as two-way two-lane roadways in each direction with a speed of 20mph. Most of these roadways are narrow in nature and would likely still retain parking on one side which would result in a lower speed. These conversions are a separate project outside of the MDOT I-375 project and are expected to be completed in the next five years (prior to the reconstruction of I-375).

The new I-375 corridor was coded with either three- to four-lanes, with turn bays where indicated by the study team and a speed of 35 mph. The saturation flow rate was reduced from 2,200 vehicles per hour per lane (vphpl) to 1,800 vphpl. The speed flow curve was also changed from a freeway to a major roadway. New ramps were coded for I-75 and the Gratiot Connector was removed entirely. Speeds were increased on two segments of freeway along I-75 near the I-375 corridor due to the new alignment. The speed increase is a result of a geometric change which converts the I-75 through-movement from an exit ramp to a true through-movement. The change in speed corresponds with the change in design speed. Currently, the section of roadway where this speed will increase has a ramp with a design speed of 35 mph, which will be increased to a design speed of 60 mph. The Brush Street on-ramp to the eastbound Gratiot Connector was converted to a northbound I-75 on-ramp. A northbound I-75 on-ramp from the boulevard was added. A southbound I-75 off-ramp to Eastern Market and the boulevard was added. Lastly, eastbound Madison Avenue ends at Beaubien Street and Madison Avenue was converted from two-way to one-way westbound between St. Antoine Street and Beaubien Street.

Figure 22 illustrates the current design and the coding of the conceptual design within the DynusT model of the I-75/I-375 area. Appendix A illustrates the Preferred Alternative. Due to the new configuration, there were several signals within the study area that were removed, added, or updated.

Signals that were removed include the following:

- Northbound I-75 Service Drive at Jefferson Avenue
- Northbound I-75 Service Drive at Larned Street
- Northbound I-75 Service Drive at Lafayette Avenue
- Northbound I-75 Service Drive at Monroe Street
- Gratiot Avenue at Antietam Avenue
- Madison Avenue at St. Antoine Street

Several signals were added to the project, these include:

- Southbound I-75 Service Drive at New Local Connector
- Northbound I-75 Service Drive at New Local Connector
- Rivard Street at New Local Connector
- Northbound Boulevard and Southbound Boulevard
- I-375 and Northbound I-75 Off-ramp
- I-375 and Gratiot Avenue

- I-375 and Clinton Street
- I-375 and Macomb Street
- Jefferson Avenue and St. Antoine Street
- Beaubien Street and St. Antoine Street

The following signals were modified:

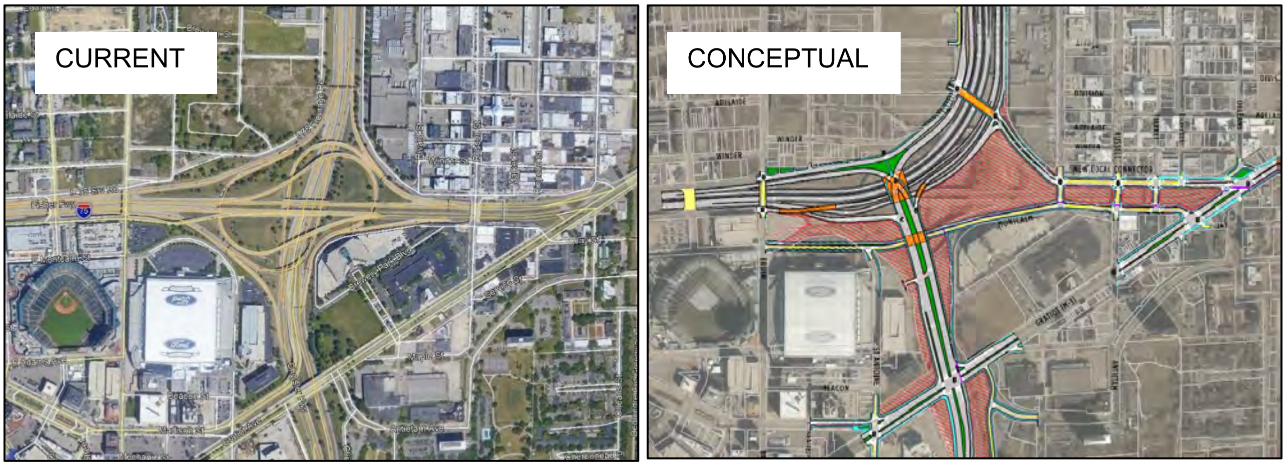
- Gratiot Avenue and New Local Connector
- Gratiot Avenue and Montcalm Street / Jay Street
- Gratiot Avenue and St. Antoine Street
- Gratiot Avenue and Beaubien Street
- Gratiot Avenue and Brush Street
- I-375 and Monroe Street
- I-375 and Lafayette Avenue
- I-375 and Congress Street / Larned Street
- I-375 and Jefferson Avenue
- Madison Avenue and Beaubien Street
- Monroe Street and Beaubien Street
- Lafayette Avenue and Beaubien Street
- Madison Avenue and Brush Street
- Monroe Street and Brush Street
- Lafayette Avenue and Brush Street
- Congress Street and Brush Street
- Monroe Street and Randolph Street
- Lafayette Avenue and Randolph Street

Signal timings along the boulevard were updated to reflect the MDOT VISSIM AM and PM peak period models but were still modeled as actuated signals. DynusT does not allow for pedestrian push buttons or pedestrian timings but does allow for a minimum amount of green time for vehicles which would equate to a pedestrian crossing time. The signal at the Blue Cross Blue Shield garage was not included in the DTA model since the garage is not explicitly included in the mesoscopic model. This signal would not impact the overall results of the DTA model. This signal is included in the microsimulation model.

The following signals were updated in the DTA model and the signal timings within Appendix C of this report:

- I-375 at Clinton Street
- I-375 at Macomb Street
- I-375 at Monroe Street
- I-375 at Lafayette Avenue
- I-375 at Congress Street / Larned Street
- I-375 at Jefferson Avenue

Figure 22. I-375 / I-75 Current Design and Conceptual Design



The model was run with the option that all vehicles would determine a new route based on shortest travel time. For both models, 15-percent of the vehicles received en-route information while 85-percent did not. This was the same for the base year and the future year. Additional sensitivity testing could be conducted on the en-route percentage for the future year model to determine if additional vehicles would change, but this was a conservative estimate.

The model was initially run and found that there was excessive diversion onto Rivard Street to east of the I-375 corridor where traffic volumes doubled and tripled during the peak hours. This was brought to the attention of the City of Detroit where they indicated that this roadway is mainly residential in nature and they don't expect or want traffic volumes to increase. The City and MDOT have had workshops and will discuss further traffic calming options in the design phase. It was found that Rivard Street within the model was classified as a "Major Collector", therefore had a higher speed and saturation flow rate. Given the input from the City of Detroit, the classification was lowered to a "Local Road", which has a speed of 20mph and a saturation flow rate of 1300 vphpl and is consistent to other roadways with a classification of "Local Road".

12.1 Model Reasonableness

The purpose of this chapter of the report is to illustrate that the results from the mesoscopic model are reasonable with changes to the roadway network, as well as provide overall model and corridor results.

The conversion to the boulevard was only run for the future year (2045) model. Table 13 summarizes the overall subarea model results for the base year and future year model with the freeway (No-Build) and with the boulevard (Build). The average travel time and travel distance is the average for all vehicles within the subarea. The average travel distance is the total vehicle miles travelled (VMT) divided by the total number of vehicles. The average travel time is the total vehicle hours travelled (VHT) divided by the total number of vehicles. These results are for the 24-hour time period for all vehicles.

Table 14. 2045 Subarea Daily Model Results

Parameter	With Freeway (No-Build)	With Boulevard (Build)
Total Vehicle Miles Travelled	5,746,364	5,728,314
Total Vehicle Hours Travelled	179,309	181,388
Average Travel Time (minutes)	7.9	8.0
Average Travel Distance (miles)	4.2	4.2
Average Delay (minutes)	0.44	0.49

As shown in the above table, the VMT decreased slightly and the VHT increased slightly with the boulevard in 2045. The average travel time for the subarea is expected to increase by 0.1 minutes or six-seconds. This is reasonable given that I-375 would be converted from a freeway to a boulevard and there would be added travel time. The average travel distance is expected to stay the same, which is reasonable again given that the overall length of the roadway is not expected to change. The average delay is expected to increase by 0.05 minutes, which is approximately 3 seconds, which is expected given that additional traffic signals will be implemented along I-375.

Below is a table summarizing the average travel time and distance for the subarea as well as some select links within the subarea with and without the boulevard for the future year (2045). The I-375 corridor is defined as the I-375 freeway and any ramps connecting to the I-375 freeway, including the Gratiot Connector and the ramps to Brush Street and Madison Avenue.

Table 15. Daily Future Year (2045) Comparison

Parameter	With Freeway (No-Build)			With Boulevard (Build)		
	Number of Vehicles	Average Travel Time (min)	Average Travel Distance (miles)	Number of Vehicles	Average Travel Time (min)	Average Travel Distance (miles)
Subarea	1,361,731	7.9	4.2	1,361,731	7.8	4.2
SB I-375	46,553	10.1	6.4	29,623	10.8	6.1
NB I-375	52,977	11.4	6.8	29,711	12.4	6.4
SB Madison Ramp	5,853	12.4	6.5	N/A	N/A	N/A
NB Madison Ramp	7,329	10.7	6.4	N/A	N/A	N/A
EB Gratiot Connector*	12,105	8.9	5.6	N/A	N/A	N/A
WB Gratiot Connector*	19,650	10.5	6.2	N/A	N/A	N/A
SB Eastern Market Ramp	N/A	N/A	N/A	7,029	12.2	7.0
NB Eastern Market Ramp	N/A	N/A	N/A	4,878	8.4	4.6
EB/NB Brush Ramp	1,552	8.2	3.3	13,352	11.3	6.7
Total (minus Subarea)	145,993	10.6	6.4	84,593	11.4	6.3

*Does not include vehicles that used I-375

The number of daily vehicles using the I-375 corridor decreased from 145,993 vehicles to 84,593 vehicles, a decrease of 42-percent. The number of users on I-375 north of Gratiot Avenue decreased from 99,593 vehicles to 59,334, a decrease of 40-percent.

Tables 16 and 17 illustrate the traffic volume, average travel time, and travel distance for those same select links for the AM and PM peak hours, respectively, with the freeway and with the boulevard.

Table 16. AM Peak Hour Future Year (2045) Comparison

Parameter	With Freeway (No-Build)			With Boulevard (Build)		
	Number of Vehicles	Average Travel Time (min)	Average Travel Distance (miles)	Number of Vehicles	Average Travel Time (min)	Average Travel Distance (miles)
SB I-375	3,593	13.2	6.1	2,727	15.1	6.0
NB I-375	2,644	9.9	5.7	1,982	12.8	6.4
SB Madison Ramp	1,009	15.3	5.9	N/A	N/A	N/A
NB Madison Ramp	256	9.0	5.9	N/A	N/A	N/A
EB Gratiot Connector*	775	10.4	5.3	N/A	N/A	N/A
WB Gratiot Connector*	1,559	13.6	6.2	N/A	N/A	N/A
SB Eastern Market Ramp	N/A	N/A	N/A	417	15.3	5.9
NB Eastern Market Ramp	N/A	N/A	N/A	545	9.9	4.7
EB/NB Brush Ramp	145	8.2	3.4	415	10.2	6.3
Total	9,981	12.2	5.9	6,086	13.6	6.0

*Does not include vehicles that used I-375

Table 17. PM Peak Hour Future Year (2045) Comparison

Parameter	With Freeway (No-Build)			With Boulevard (Build)		
	Number of Vehicles	Average Travel Time (min)	Average Travel Distance (miles)	Number of Vehicles	Average Travel Time (min)	Average Travel Distance (miles)
SB I-375	3,234	10.4	6.3	1,739	11.5	6.1
NB I-375	5,051	14.7	6.3	3,333	15.5	6.0
SB Madison Ramp	270	10.5	6.5	N/A	N/A	N/A
NB Madison Ramp	934	13.4	6.1	N/A	N/A	N/A
EB Gratiot Connector*	1,283	11.3	5.6	N/A	N/A	N/A
WB Gratiot Connector*	1,783	12.3	5.6	N/A	N/A	N/A
SB Eastern Market Ramp	N/A	N/A	N/A	273	12.4	6.8
NB Eastern Market Ramp	N/A	N/A	N/A	802	9.3	4.63
EB/NB Brush Ramp	171	11.3	3.4	1,188	14.3	6.3
Total	12,725	12.7	6.1	7,335	13.6	6.0

*Does not include vehicles that used I-375

For both the AM and PM peak hours, approximately 24-percent of trips diverted in the AM and 39-percent in the PM peak hour. The travel time for those travelling in the corridor is expected to increase in the AM peak hour and PM peak hour with the boulevard compared to the freeway. The number of vehicles utilizing the northbound Brush Street ramp is expected to increase by 186-percent in the AM peak hour and 595-percent in the PM peak hour, this is due to the direct access with northbound I-75.

12.2 Model Results

Generally, the results of the model varied throughout the day, but there were some overall increases and decreases that were consistent. Below are some overall observations.

- Volumes on I-75 decreased by around 20%
- Volumes along the I-375 corridor decreased by up to 50%
- Volumes on Gratiot Avenue decreased north of the Gratiot Connector and increased south of Gratiot Avenue
- Volumes along Clinton Street increased
- Volumes along Monroe Street and Macomb Street decreased
- Volumes increased along Lafayette Avenue, Larned Street, and Congress Street
- Volumes along WB Jefferson Avenue west of I-375 increased
- Volumes along the NB I-375 Service Drive / New Road increased
- Volumes along Brush Street increased

Table 18 summarizes the daily volumes with the freeway and with a boulevard, and provide a percent and volume change, as well as capacity of the roadway section. There are no roadways that are expected near or over capacity before or after the conversion, except for the New Local Road north of Clinton Street, which is close to capacity but still not over.

Figure 23 illustrates the daily diversion of those roadways that had an increase or decrease of more than 1,000 vehicles per day or more, either directionally or bi-directionally. From the figure there is more diversion to I-94 and M-10 and less diversion to Gratiot Avenue and I-75. This is due to the widening of I-94 between Conner Avenue and I-96 and having extra capacity on I-94.

Table 18. Future Year (2045) Daily Volume Changes with Conversion

Roadway	Daily Volume with Freeway	Daily Volume with Boulevard	Change	% Change	Capacity Before	Capacity After
NB I-75 under Mack	68,268	51,733	-16,535	-24%	88,000	88,000
SB I-75 under Mack	63,845	50,259	-13,586	-21%	88,000	88,000
NB I-375 north of Gratiot	52,976	29,711	-23,265	-44%	66,000	40,000
SB I-375 north of Gratiot	46,553	29,623	-16,930	-36%	66,000	40,000
NB I-375 south of Larned*	17,200	16,363	-837	-5%	76,000	30,000
SB I-375 south of Larned*	16,482	6,543	-9,939	-60%	76,000	30,000
NB Rivard south of Larned	4,365	3,777	-588	-13%	7,000	7,000
SB Rivard south of Larned	3,842	2,406	-1,436	-37%	7,000	7,000
I-375 Service Dr / New Road north of Clinton	826	10,332	9,506	1151%	12,000	14,000
SB Madison/Eastern Market off-ramp	5,853	7,029	1,176	20%	14,000	18,000
NB Madison/Brush on-ramp	7,329	13,352	6,023	82%	7,000	18,000
SB Gratiot north of Gratiot Connector	20,951	9,127	-11,824	-56%	33,000	33,000
NB Gratiot north of Gratiot Connector	17,812	15,851	-1,961	-11%	33,000	33,000
SB Gratiot north of I-375	2,948	10,233	7,285	247%	24,000	24,000
NB Gratiot north of I-375	6,476	8,378	1,902	29%	24,000	24,000
SB Gratiot south of St. Antoine	3,301	19,268	15,967	484%	24,000	24,000
NB Gratiot south of St. Antoine	2,248	4,450	2,202	98%	24,000	24,000
Clinton west of I-375 (total)	3	4,679	4,676	155867%	12,000	12,000
Macomb west of I-375 (total)	8,817	6,963	-1,854	-21%	18,000	12,000
Monroe west of I-375 (total)	14,270	9,353	-4,917	-34%	18,000	12,000
EB Lafayette west of I-375	5,673	6,489	816	14%	21,000	21,000
WB Lafayette west of I-375	7,034	3,419	-3,615	-51%	21,000	21,000
EB Larned west of I-375	5,682	11,528	5,846	103%	24,000	24,000
WB Congress west of I-375	5,955	8,203	2,248	38%	24,000	24,000
EB Jefferson west of I-375	13,707	10,482	-3,225	-24%	24,000	24,000
WB Jefferson west of I-375	10,145	11,209	1,064	10%	24,000	24,000
Beaubien north of Lafayette	4,815	6,747	2,229	49%	14,000	14,000
Brush north of Lafayette	1,609	9,336	7,727	480%	14,000	14,000
Total	**418,688**	**376,843**	**-41,845**	**-10%**	**883,000**	**744,000**

*Includes volume on ramp and service drive

Figure 23. Future Year (2045) Daily Diversion

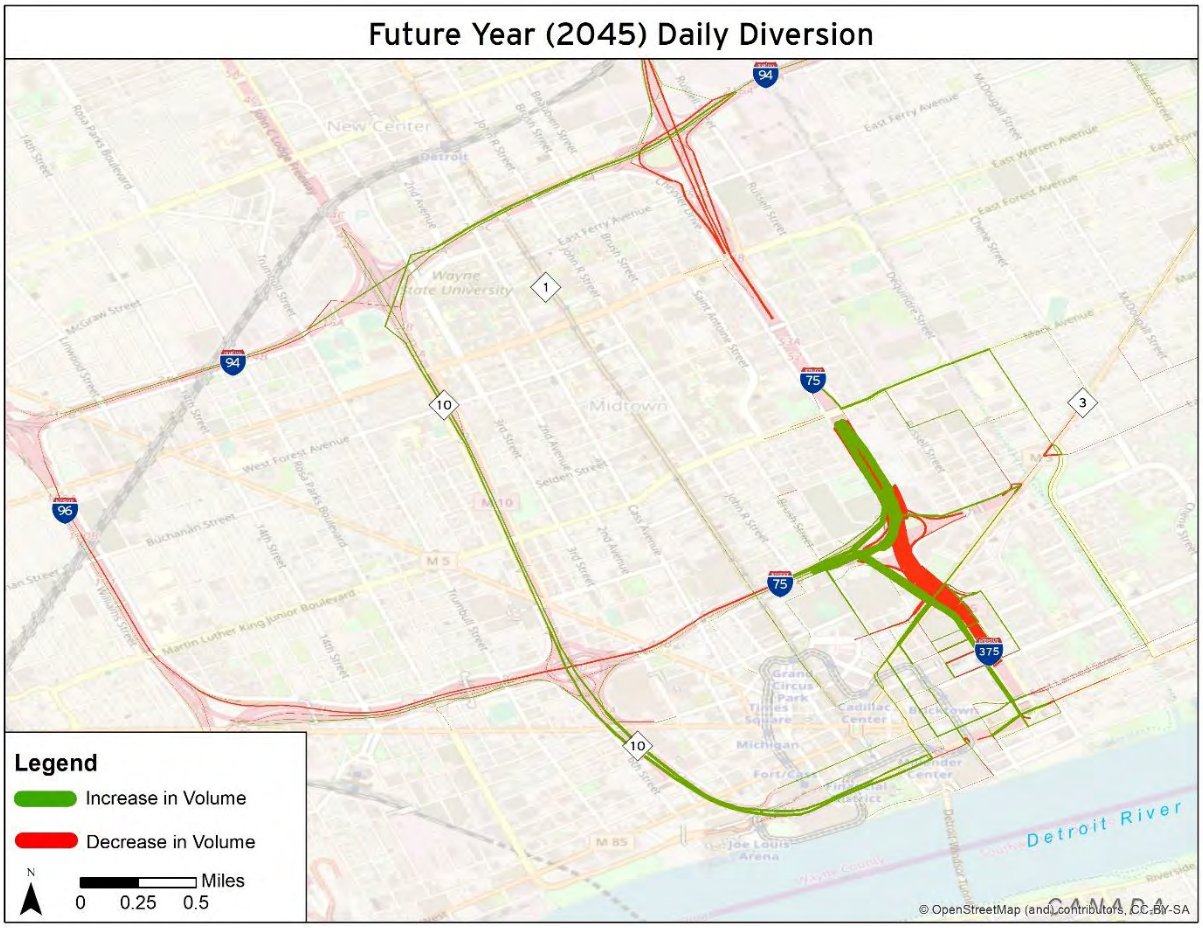


Table 19 summarizes the AM peak period volumes from the DTA model before and after the conversion for the year 2045. There is an overall increase in traffic volumes for most of the roadways, except for Gratiot Avenue, where there is an overall decrease in traffic volumes. There seems to be less or the same amount of traffic diverting off of the I-375 corridor.

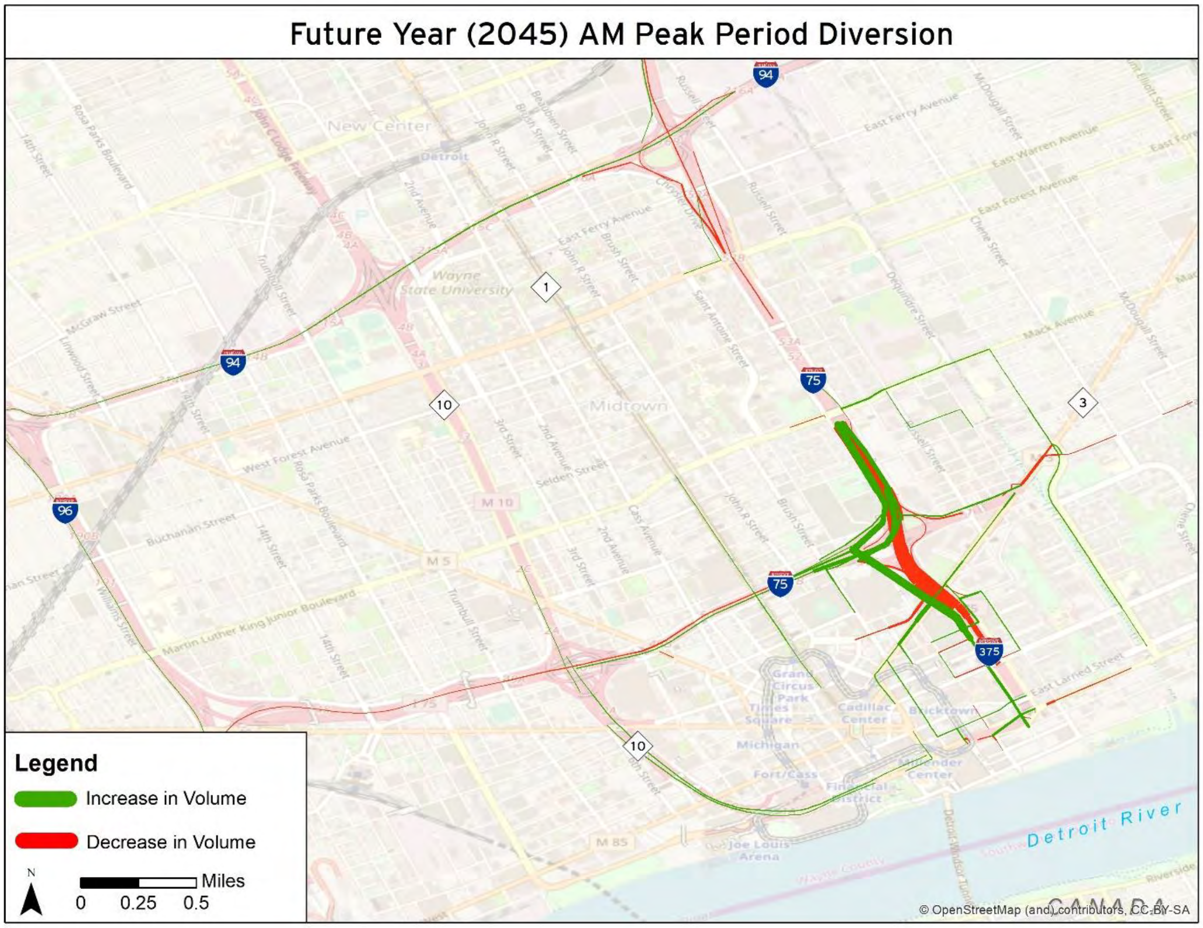
Table 19. Future Year (2045) AM Peak Period (7AM to 9AM) Changes with Conversion

Roadway	AM Peak Volume with Freeway	AM Peak Volume with Boulevard	Change	% Change	Capacity Before	Capacity After
NB I-75 under Mack	7,000	5,344	-1,656	-24%	17,600	17,600
SB I-75 under Mack	10,668	7,657	-3,011	-28%	17,600	17,600
NB I-375 north of Gratiot	5,321	3,475	-1,846	-35%	13,200	8,000
SB I-375 north of Gratiot	7,567	5,631	-1,936	-26%	13,200	8,000
NB I-375 south of Larned*	2,483	2,217	-266	-11%	15,200	6,000
SB I-375 south of Larned*	1,266	1,313	47	4%	15,200	6,000
NB Rivard south of Larned	161	148	-13	-8%	1,400	1,400
SB Rivard south of Larned	78	90	12	15%	1,400	1,400
I-375 Service Dr/New Road north of Clinton	55	1,254	1,199	2180%	2,400	2,800
SB Madison/Eastern Market off-ramp	1,810	1,078	-732	-40%	2,800	5,600
NB Madison/Brush on-ramp	499	1,086	587	118%	1,400	5,600
SB Gratiot north of Gratiot Connector	4,119	2,451	-1,668	-40%	6,600	6,600
NB Gratiot north of Gratiot Connector	1,694	1,179	-515	-30%	6,600	6,600
SB Gratiot north of I-375	1,189	2,428	1,239	104%	4,800	4,800
NB Gratiot north of I-375	308	265	-43	-14%	4,800	4,800
SB Gratiot south of St. Antoine	1,385	3,416	2,031	147%	4,800	4,800
NB Gratiot south of St. Antoine	126	199	73	58%	4,800	4,800
Clinton west of I-375 (total)	1	780	779	77900%	2,400	2,400
Macomb west of I-375 (total)	1,309	566	-743	-57%	3,600	2,400
Monroe west of I-375 (total)	735	589	-146	-20%	3,600	2,400
EB Lafayette west of I-375	382	483	101	26%	4,200	4,200
WB Lafayette west of I-375	1,669	918	-751	-45%	4,200	4,200
EB Larned west of I-375	374	1,061	687	184%	4,800	4,800
WB Congress west of I-375	1,735	1,829	94	5%	4,800	4,800
EB Jefferson west of I-375	3,143	1,726	-1,417	-45%	4,800	4,800
WB Jefferson west of I-375	2,852	2,958	106	4%	4,800	4,800
Beaubien north of Lafayette	533	775	242	45%	2,800	2,800
Brush north of Lafayette	190	904	714	376%	2,800	2,800
Total	**58,652**	**51,820**	**-6,832**	**-12%**	**176,600**	**152,800**

*Includes volume on ramp and service drive

Figure 24 illustrates the increases and decreases in the downtown area in the AM Peak Period. This is for roadways with changes of over 400 vehicles per period (or 200 vehicles per hour).

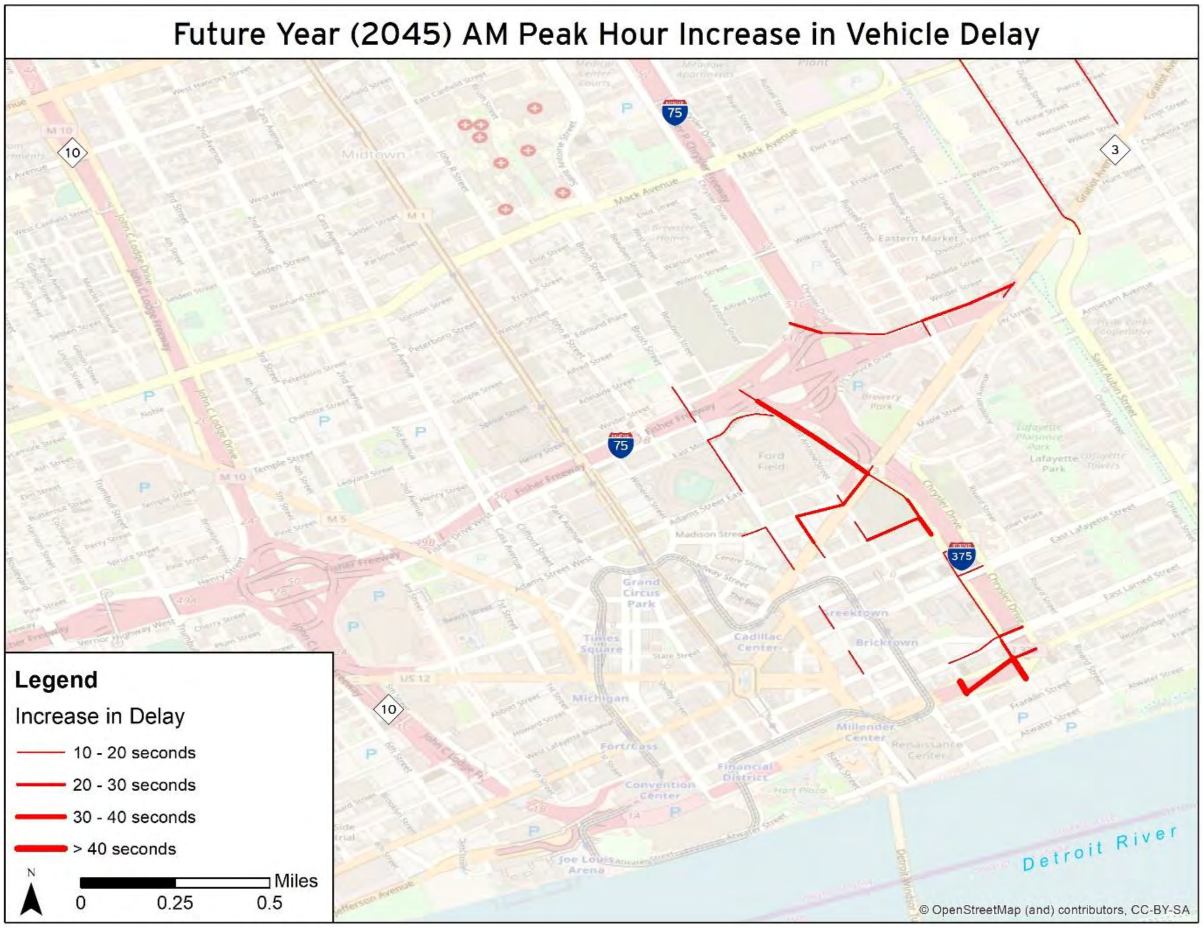
Figure 24. Future Year (2045) AM Peak Period Diversion



As seen in Figure 24, there is still some expected increases along Gratiot Avenue south of the Gratiot Connector, as well as along Mack Avenue and Warren Avenue near I-75 and along parts of Larned Street. There were also some increases along I-94 and M-10.

Figure 25 illustrates those roadways that had more than a 10-second increase in vehicle delay within the study area in the AM Peak Hour.

Figure 25. Future Year (2045) AM Peak Hour Increase in Vehicle Delay



There were only a handful of roadways that are expected to see an increase in vehicle delay greater than 10 seconds. These include sections of Gratiot Avenue, Clinton Street, Brush Street, and the new boulevard, which is expected because it is a new roadway.

Table 20 summarizes the changes in traffic volume in within and near the I-375 corridor for the PM peak period, from 2 PM to 6PM.

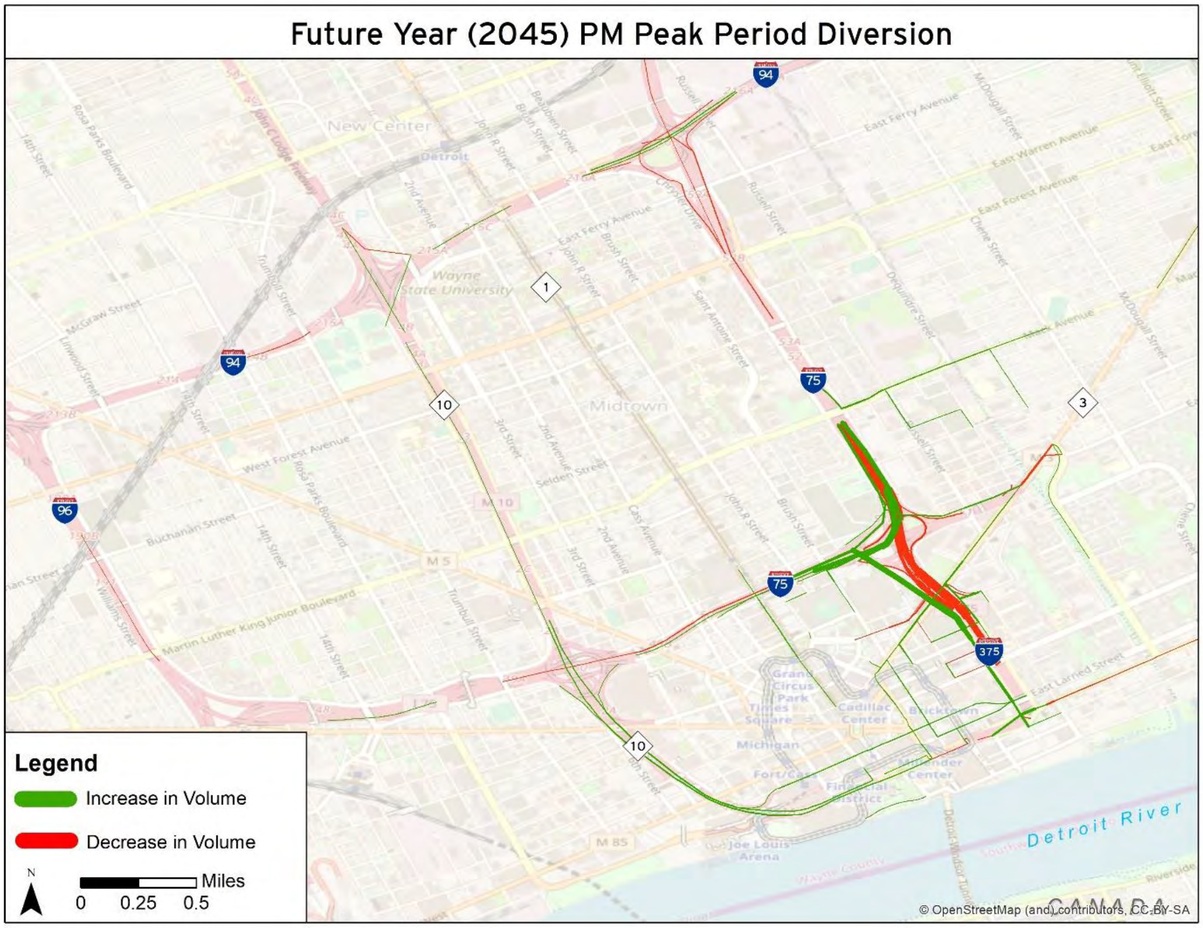
Table 20. Future Year (2045) PM Peak Period (2PM to 6PM) Changes with Conversion

Roadway	PM Peak Volume with Freeway	PM Peak Volume with Boulevard	Change	% Change	Capacity Before	Capacity After
NB I-75 under Mack	22,118	17,960	-4,158	-19%	35,200	35,200
SB I-75 under Mack	15,580	12,688	-2,892	-19%	35,200	35,200
NB I-375 north of Gratiot	17,390	11,177	-6,213	-36%	26,400	16,000
SB I-375 north of Gratiot	10,166	5,465	-4,701	-46%	26,400	16,000
NB I-375 south of Larned*	5,610	6,051	441	8%	30,400	12,000
SB I-375 south of Larned*	2,809	1,981	-828	-29%	30,400	12,000
NB Rivard south of Larned	389	514	125	32%	2,800	2,800
SB Rivard south of Larned	338	232	-106	-31%	2,800	2,800
I-375 Service Dr/New Road north of Clinton	389	2,908	2,519	648%	4,800	5,600
SB Madison/Eastern Market off-ramp	877	1,333	456	52%	5,600	11,200
NB Madison/Brush on-ramp	2,957	4,235	1,278	43%	2,800	11,200
SB Gratiot north of Gratiot Connector	6,074	2,786	-3,288	-54%	13,200	13,200
NB Gratiot north of Gratiot Connector	5,946	5,057	-889	-15%	13,200	13,200
SB Gratiot north of I-375	479	3,060	2,581	539%	9,600	9,600
NB Gratiot north of I-375	2,912	3,070	158	5%	9,600	9,600
SB Gratiot south of St. Antoine	553	3,302	2,749	497%	9,600	9,600
NB Gratiot south of St. Antoine	1,266	2,032	766	61%	9,600	9,600
Clinton west of I-375 (total)	0	1,382	1,382	N/A	4,800	4,800
Macomb west of I-375 (total)	2,706	2,668	-38	-1%	7,200	4,800
Monroe west of I-375 (total)	4,583	3,020	-1,563	-34%	7,200	4,800
EB Lafayette west of I-375	2,334	2,474	140	6%	8,400	8,400
WB Lafayette west of I-375	1,950	1,009	-941	-48%	8,400	8,400
EB Larned west of I-375	1,815	3,923	2,108	116%	9,600	9,600
WB Congress west of I-375	1,454	2,903	1,449	100%	9,600	9,600
EB Jefferson west of I-375	6,093	4,227	-1,866	-31%	9,600	9,600
WB Jefferson west of I-375	3,960	3,678	-282	-7%	9,600	9,600
Beaubien north of Lafayette	1,460	1,264	-196	-13%	5,600	5,600
Brush north of Lafayette	599	2,149	1,550	259%	5,600	5,600
Total	**122,807**	**112,548**	**-10,259**	**-8%**	**353,200**	**305,600**

*Includes volume on ramp and service drive

Again, very similar daily and AM peak period, there were generally traffic volume increases from the 2015 model, except for Gratiot Avenue, where there were volume decreases. There was still diversion from the I-375 corridor between 20% to 60%. Figure 26 illustrates those roadways in the PM peak period that had more than an 800 vehicles per period increase (or 200 vehicles per hour).

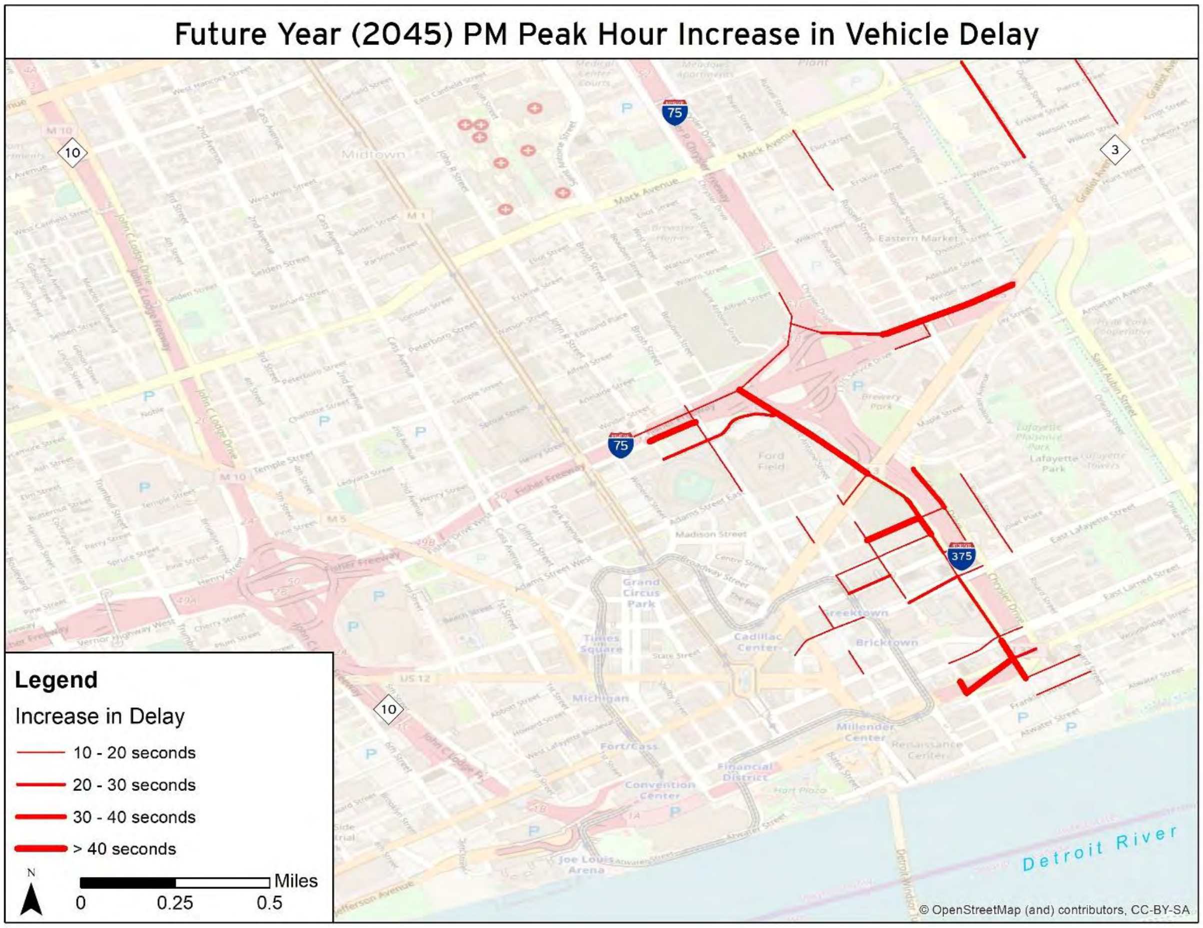
Figure 26. Future Year (2045) PM Peak Period Diversion



The PM peak period diversion is very similar to the daily and AM peak period. There was some increase in traffic using M-10 and a decrease along I-75. There was some increased volume within downtown, including along Gratiot Avenue, Randolph Street, Brush Street, and Congress Street.

Figure 27 illustrates those roadways that had more than a 10-seccond increase in vehicle delay within the study area in the PM Peak Hour.

Figure 27. Base Year (2015) PM Peak Hour Increase in Vehicle Delay



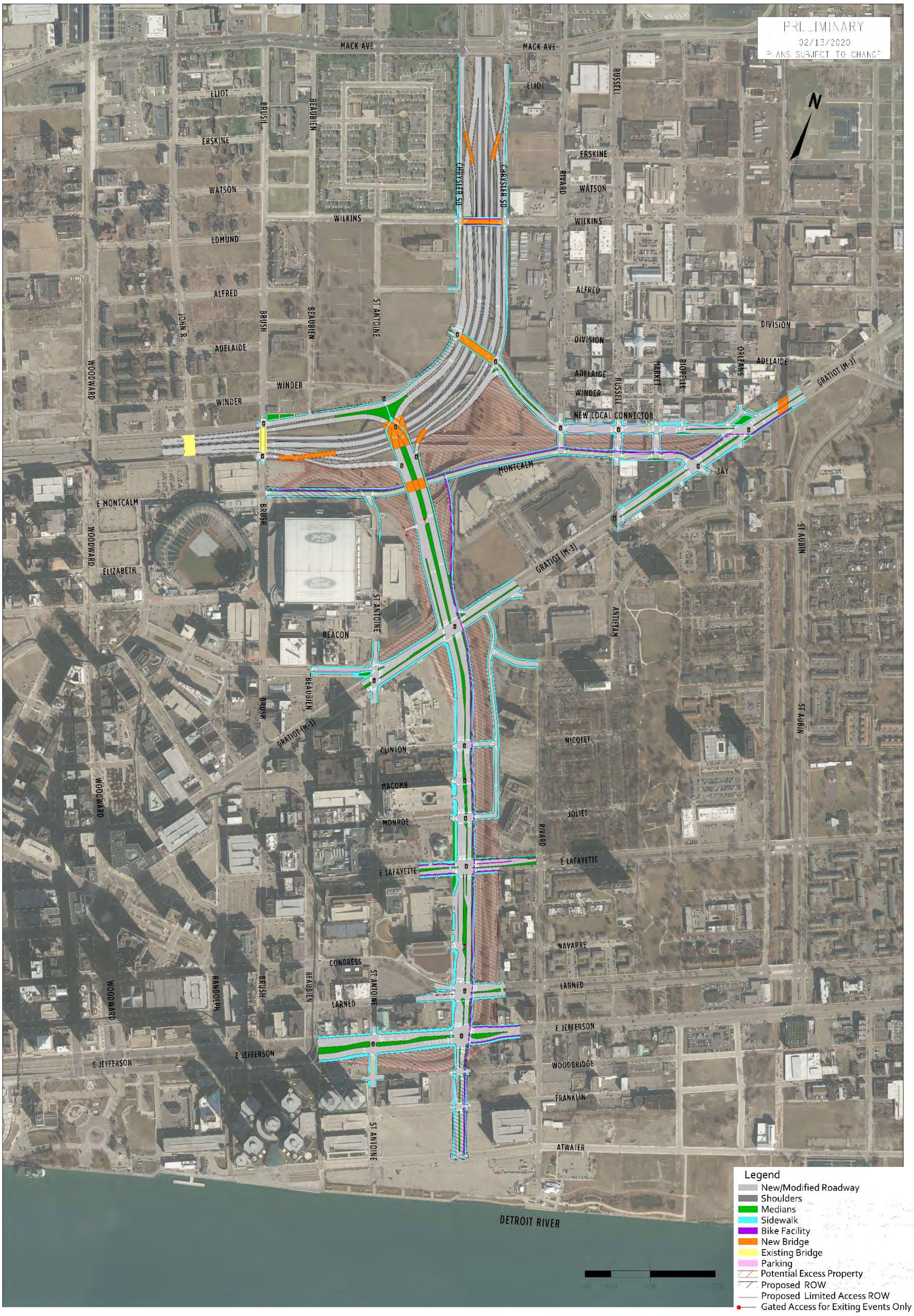
This is very similar to the AM peak hour additional delay, where there were only a handful of roadways that are expected to see an increase in vehicle delay greater than 10 seconds. Some of these roadways are new roadways, such as the new local roadway, the boulevard, and eastbound Jefferson Avenue at the boulevard. There are some roadways approaching the boulevard that are expected to have some additional delay, including Clinton Street, Lafayette Avenue, and Macomb Street. Brush Street near the new northbound I-75 on-ramp would also experience some additional delay.

Based on the results of the DTA model, additional study intersections were added to the microsimulation analysis. The additional intersections were chosen based on the additional vehicular volume that is expected after the conversion. Figure 28 summarizes which intersections were evaluated as part of the expanded study area analysis and summarized in the *I-375 Expanded Study Area Technical Memo*.

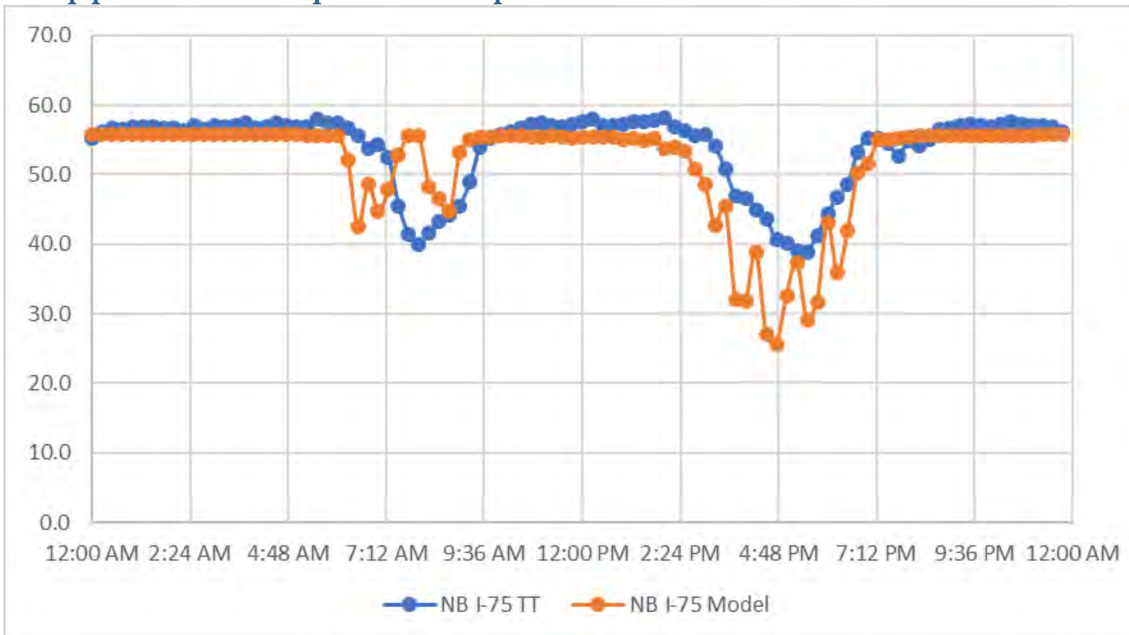
Figure 28. Additional Study Intersections

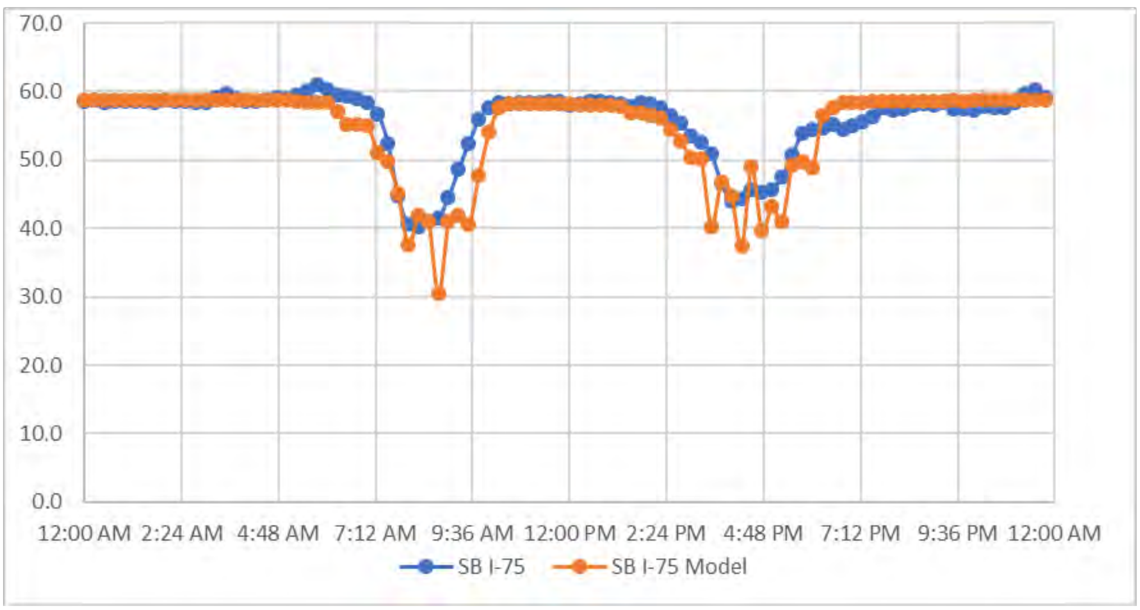
Appendix A –Preferred Alternative

I-375 Improvement Project - Preferred Alternative

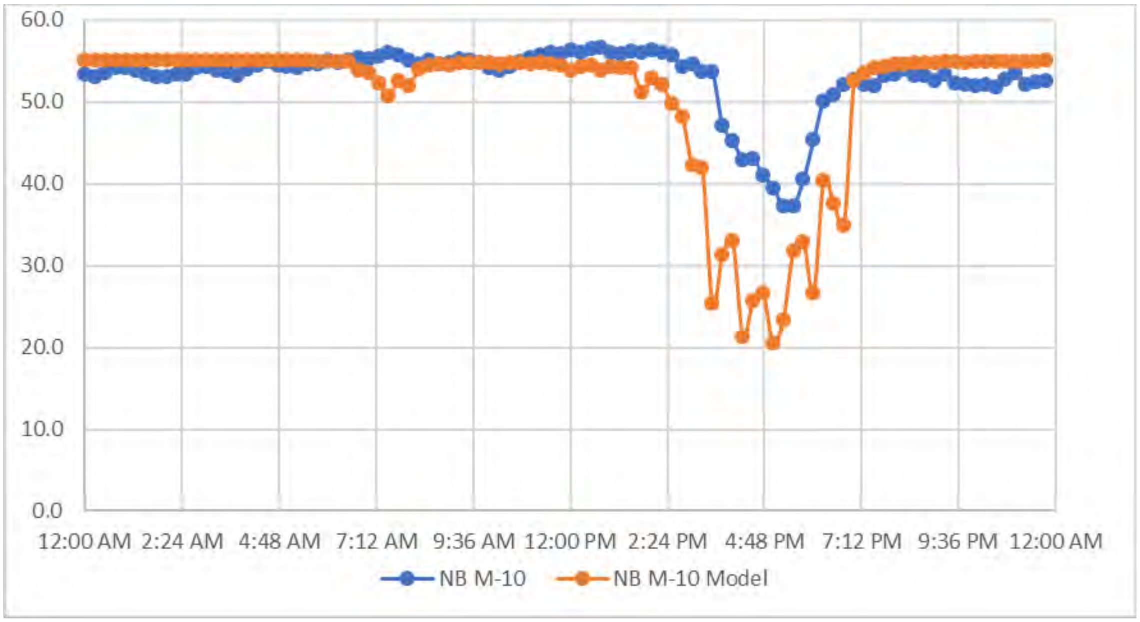


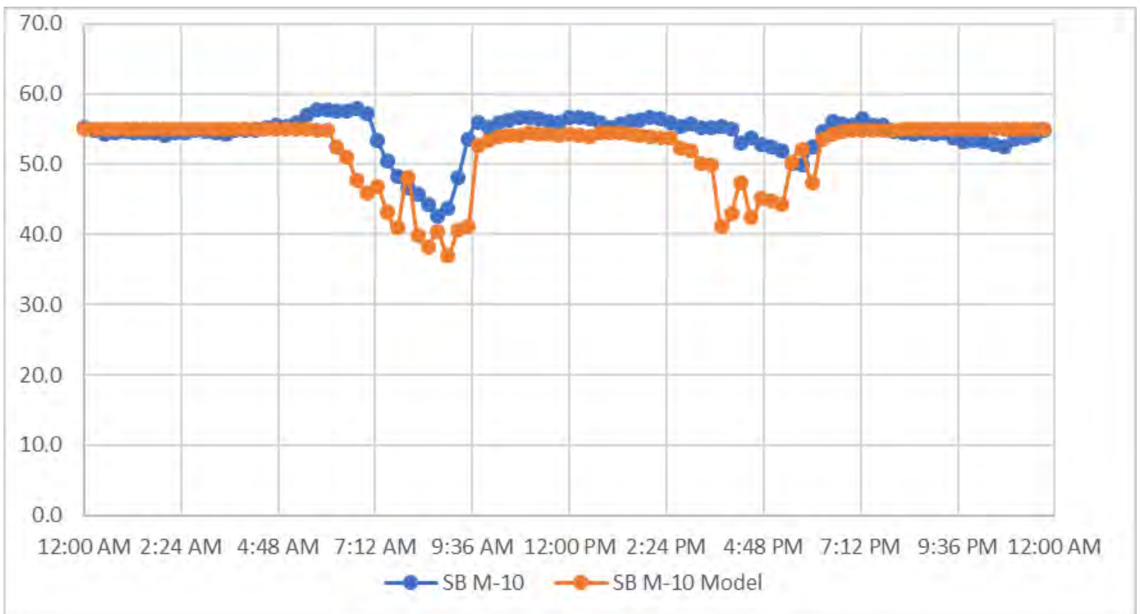
Appendix B – Speed Comparisons



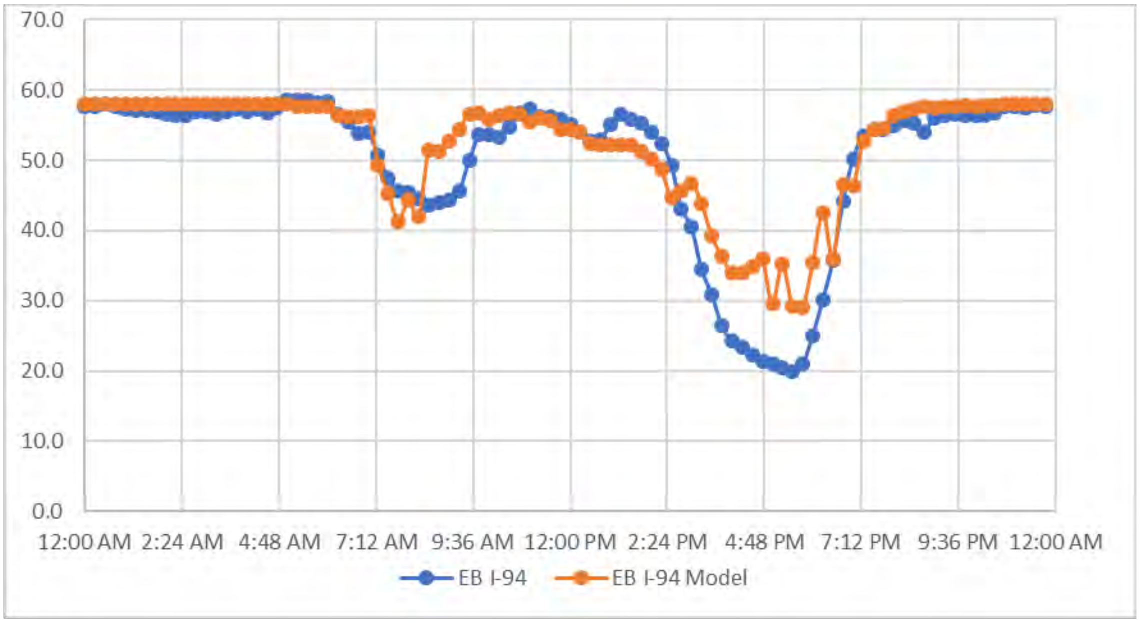


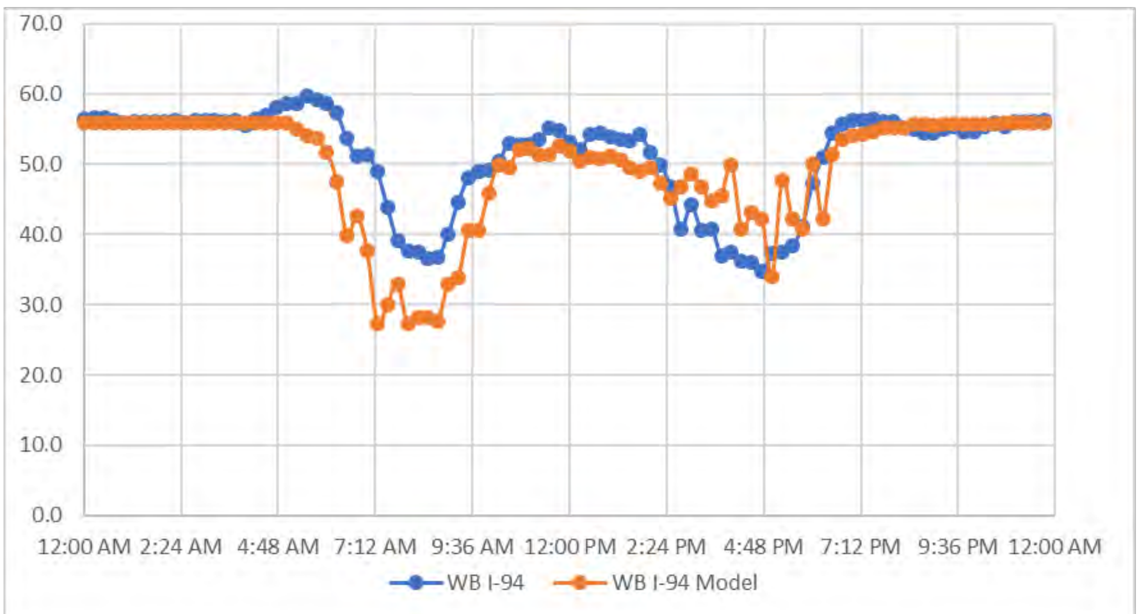
*Blue based on RITIS historical information



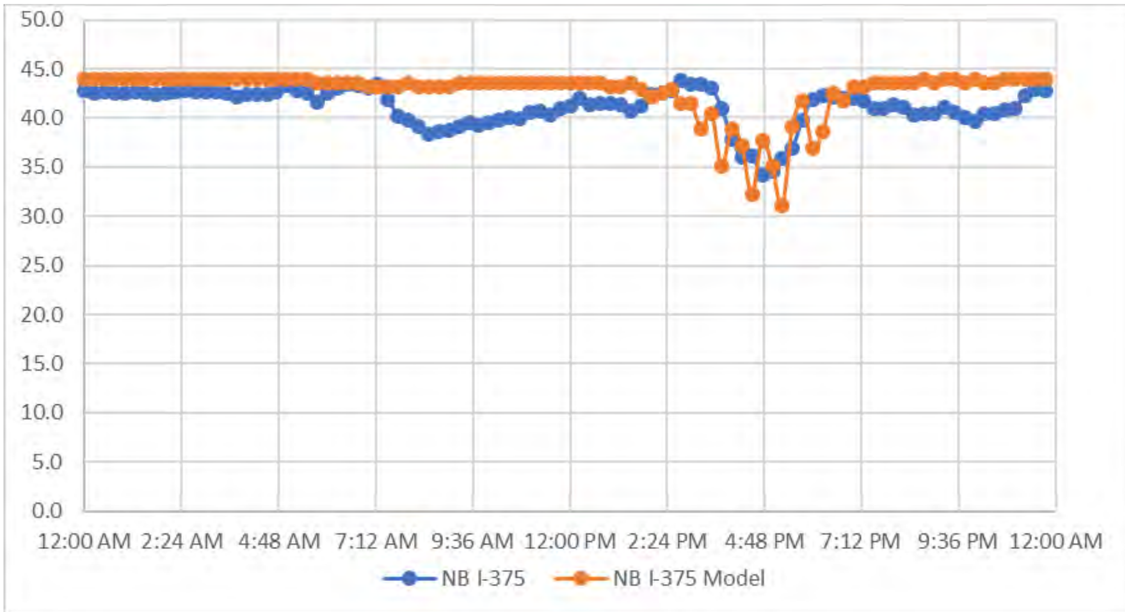


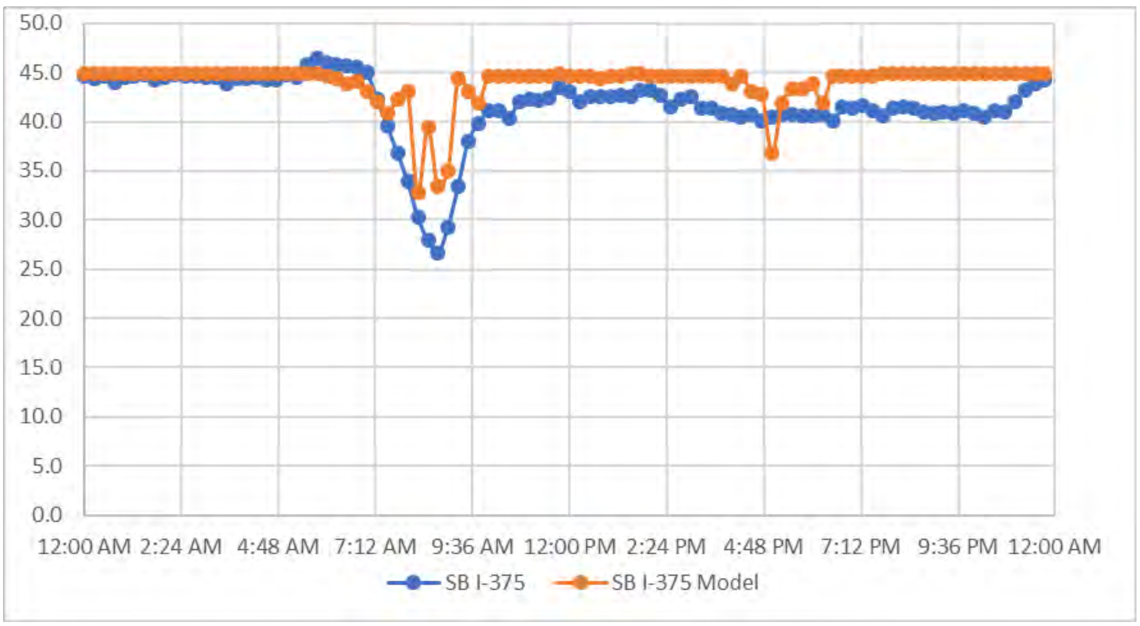
*Blue based on RITIS historical information



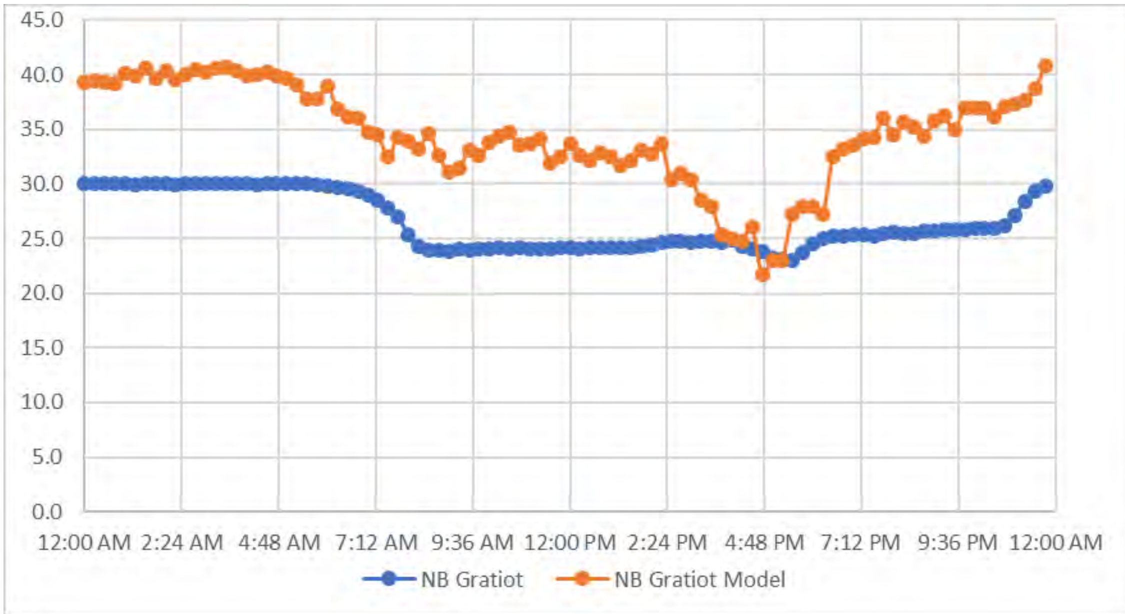


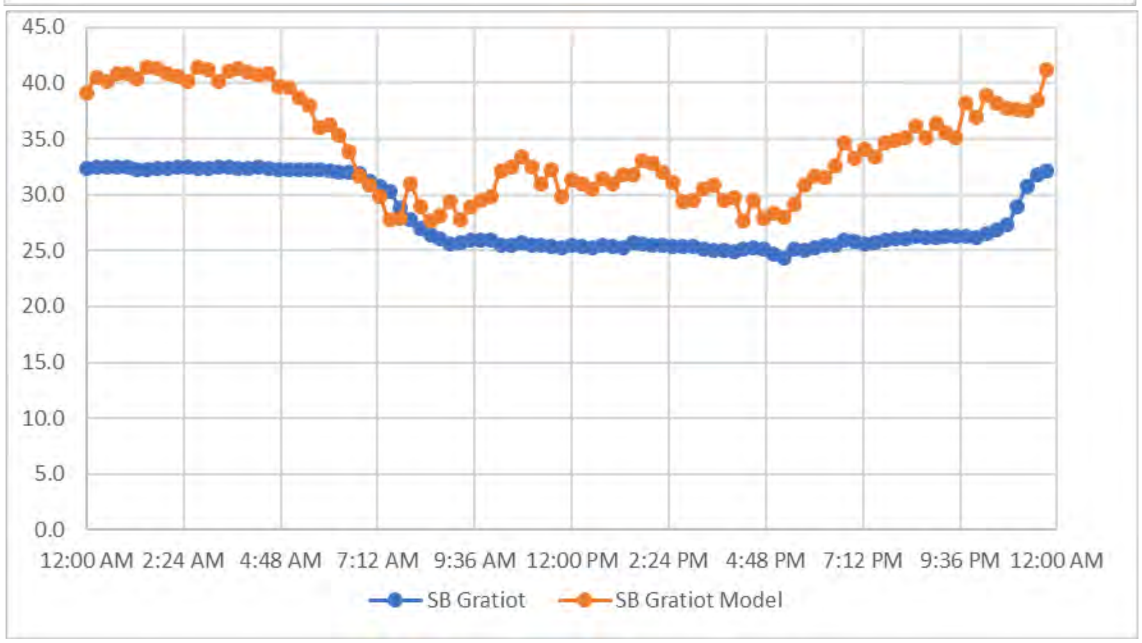
*Blue based on RITIS historical information



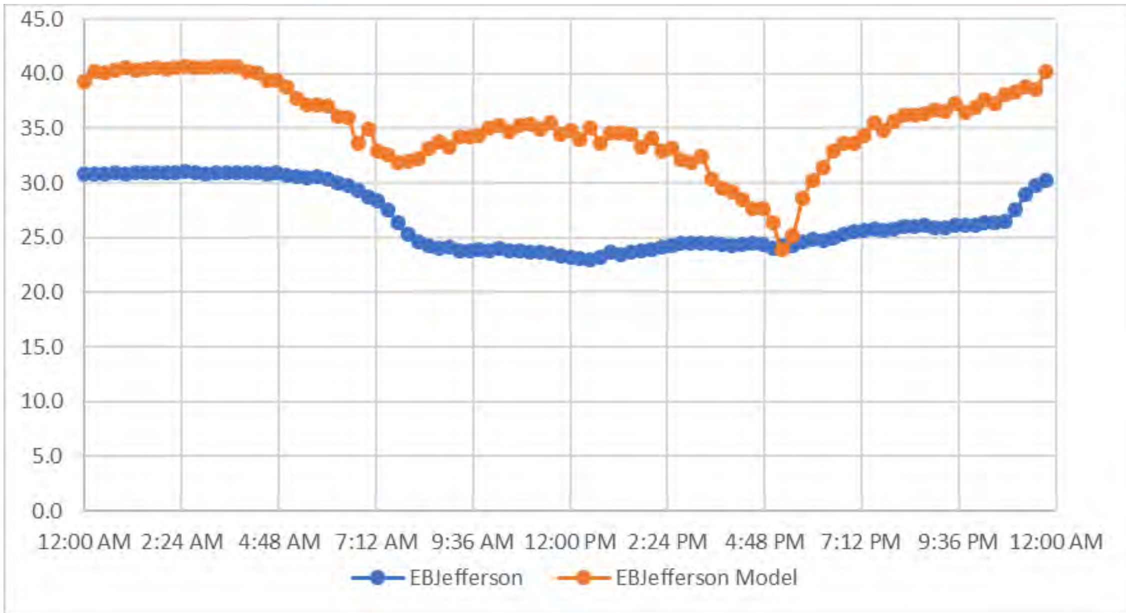


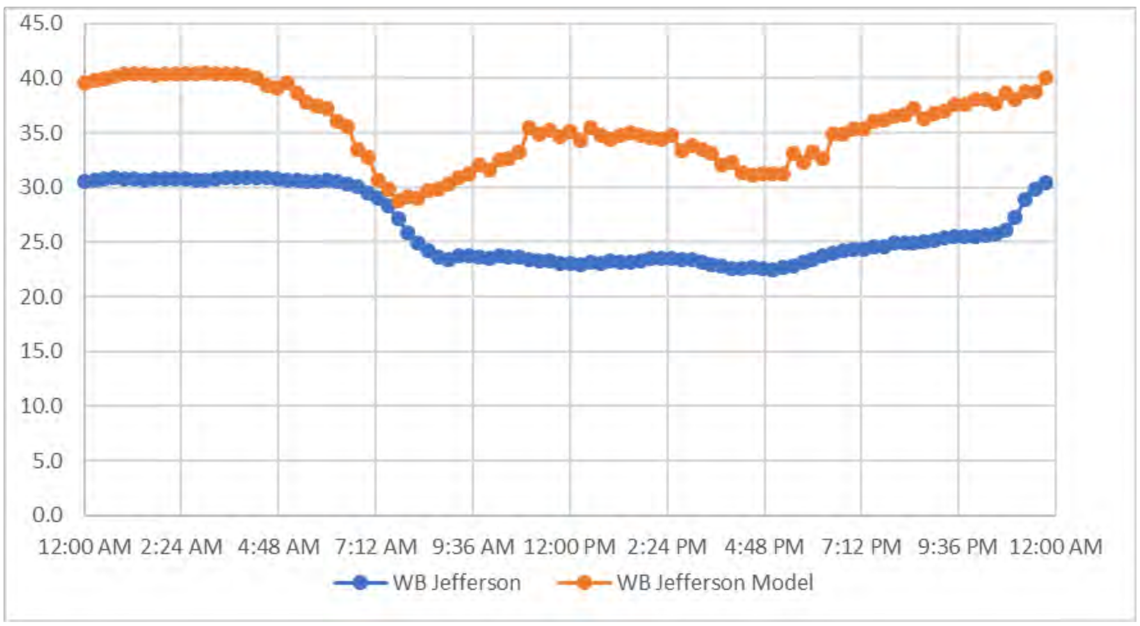
*Blue based on RITIS historical information





*Blue based on RITIS historical information





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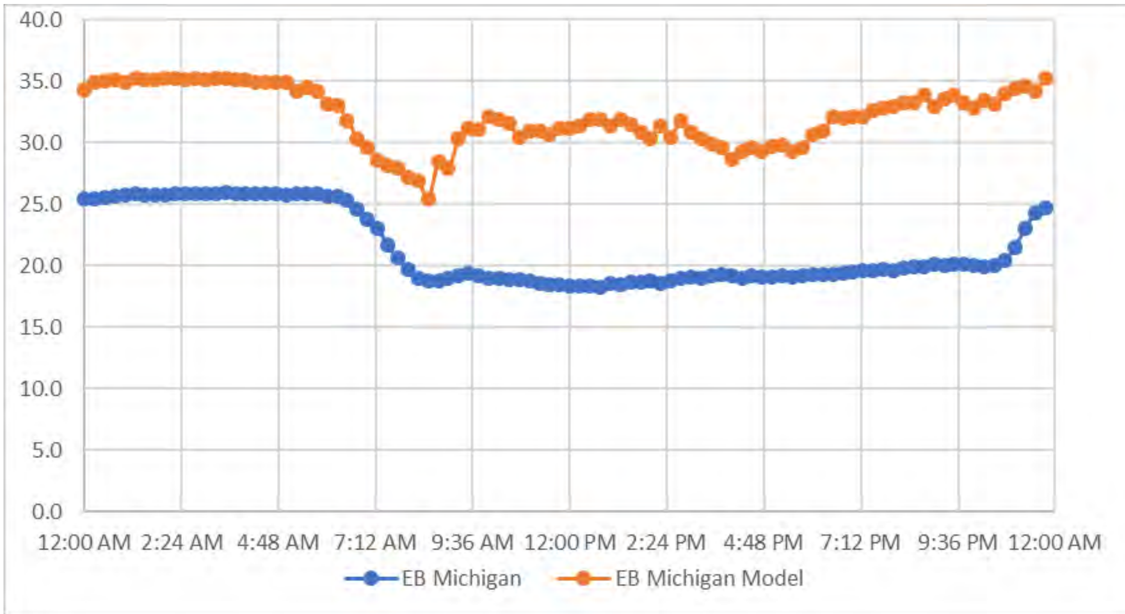

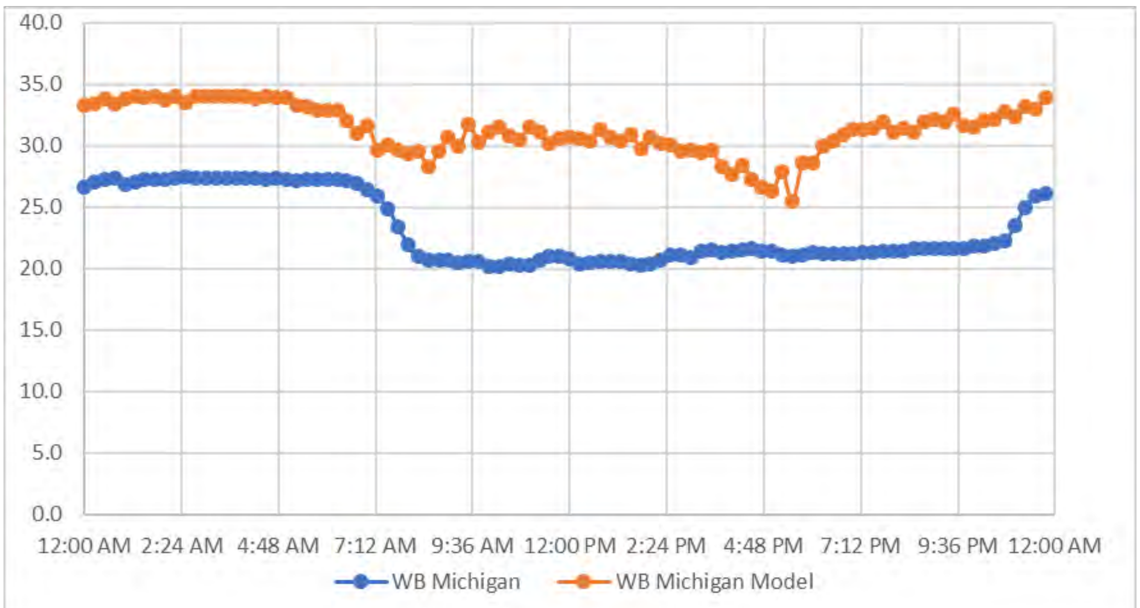

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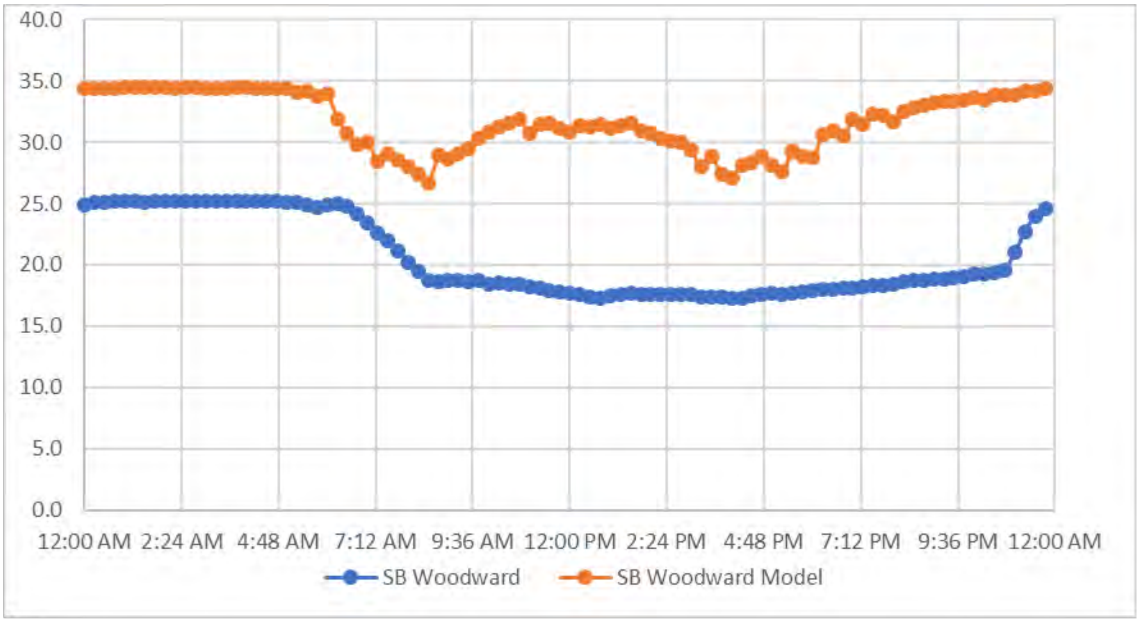

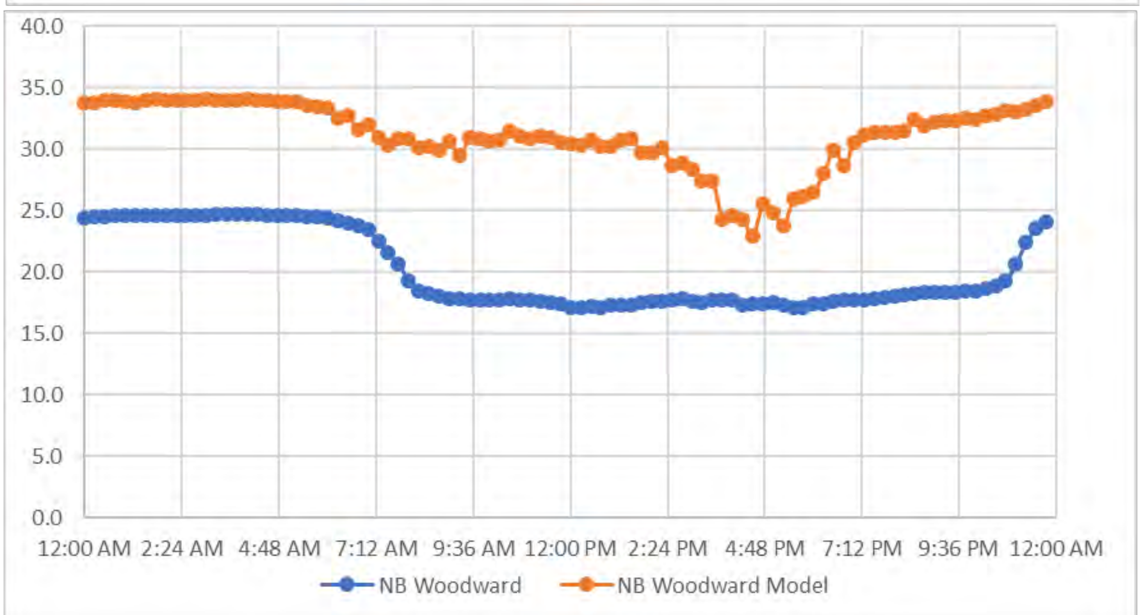

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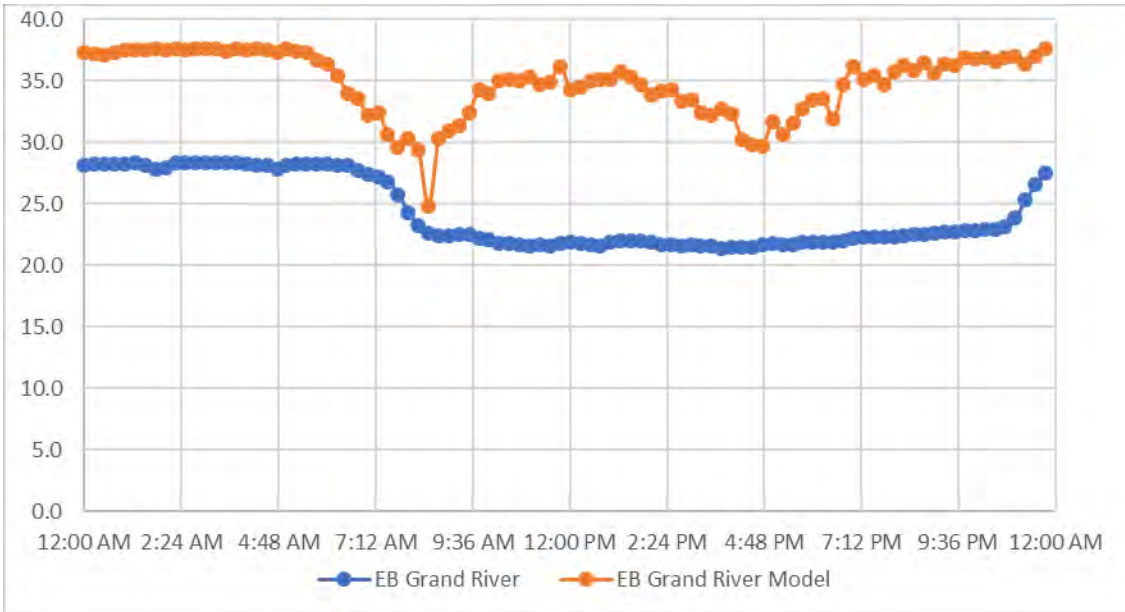

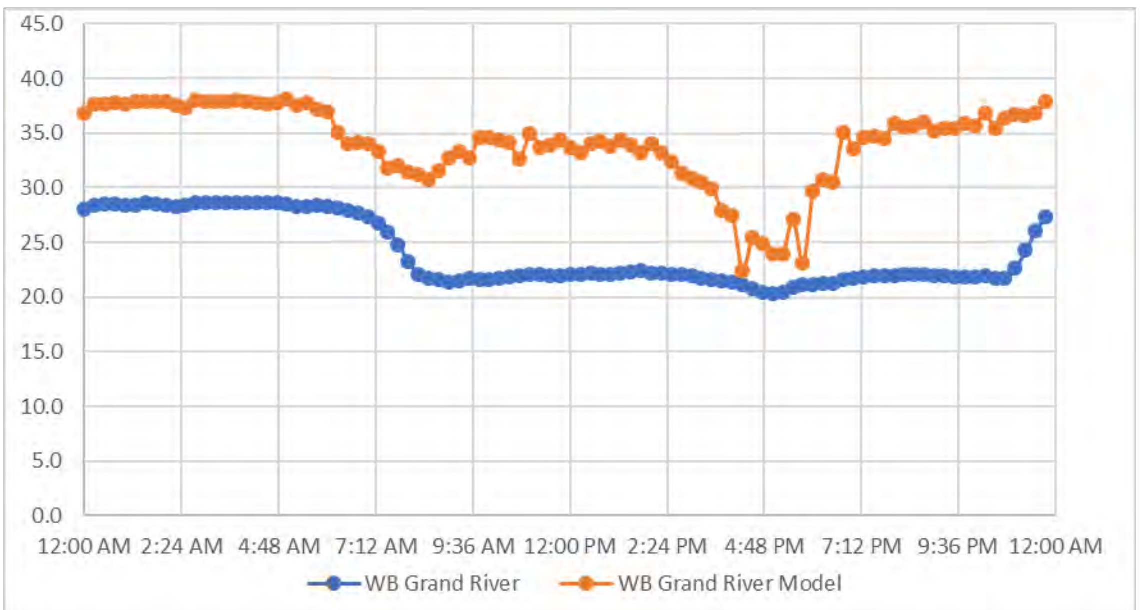

*Blue based on RITIS historical information

Appendix C – Signal Timings for Boulevard

Intersection	Type	# of Phases	Minimum Green Timing	Maximum Green Timing
Clinton and Boulevard	Actuated	4	5 seconds – Clinton EB 5 seconds – Boulevard Lefts 20 seconds – Boulevard Thru 5 seconds – Clinton WB	20 seconds – Clinton EB 20 seconds – Boulevard Lefts 60 seconds – Boulevard Thru 20 seconds – Clinton WB
Macomb and Boulevard	Actuated	2	20 seconds – Boulevard Thru 5 seconds – Macomb	60 seconds – Boulevard Thru 20 seconds – Macomb
Monroe and Boulevard	Actuated/ Pretimed	4	20 seconds – Boulevard Thru 5 seconds – Boulevard SB Left 27 seconds – Monroe EB 5 seconds – Monroe WB	68 seconds – Boulevard Thru 15 seconds – Boulevard SB Left 27 seconds – Monroe EB 10 seconds – Monroe WB
Lafayette and Boulevard	Actuated/ Pretimed	4	5 seconds – Boulevard NB LTR 20 seconds – Boulevard Thru 5 seconds – Boulevard SB LTR 41 seconds - Lafayette	10 seconds – Boulevard NB LTR 39 seconds – Boulevard Thru 20 seconds – Boulevard SB LTR 41 seconds – Lafayette
Larned and Boulevard	Actuated/ Pretimed	5	16 seconds – Larned EB LTR 9 seconds – Larned Thru 14 seconds – Larned WB LTR 5 seconds – Boulevard SB LTR 20 seconds – Boulevard Thru	16 seconds – Larned EB LTR 9 seconds – Larned Thru 14 seconds – Larned WB LTR 18 seconds – Boulevard SB LTR 53 seconds – Boulevard Thru
Jefferson and Boulevard	Actuated/ Pretimed	5	5 seconds – Jefferson Lefts, SB Right 48 seconds – Jefferson Thru 5 seconds – Boulevard Lefts 10 seconds – Boulevard SB LTR 10 seconds – Boulevard Thru	23 seconds – Jefferson Lefts, SB Right 48 seconds – Jefferson Thru 10 seconds – Boulevard Lefts 19 seconds – Boulevard SB LTR 10 seconds – Boulevard Thru