

MEMORANDUM

TO: Jane Canada, Justin Stuehrenberg, and Ben Smith (IndyGo)
FROM: Matt Duffy and Ericka Miller (WSP)
CC: Jeff Bislich, Duane McKinney and Tristan Tate (WSP)
SUBJECT: Purple Line Diversion Analysis
DATE: December 12, 2018

Introduction

The purpose of this memorandum is to outline, estimate, and provide recommendations to accommodate the anticipated impacts of diverted vehicular traffic to the surrounding roadway network due to the implementation of the Purple Line Bus Rapid Transit (BRT). The Purple Line will travel from Downtown Indianapolis along the one-way pairs of Alabama/Delaware Streets, Ohio Street, Meridian Street, 38th Street, Post Road, Otis Avenue, and Wheeler Road to Downtown Lawrence. The Purple Line is expected to convert one existing General Purpose (GP) vehicular travel lane in each direction along Meridian Street, 38th Street, and Post Road to one transit-only lane in each direction. The focus of this memo is to assess the impacts of an anticipated increase in GP traffic along parallel diversion routes adjacent to the Purple Line corridor. The Purple Line route is shown in Figure 1 below. It should be noted that the Red Line BRT (opening in 2019) overlaps with the Purple Line on Meridian Street from 18th Street to 38th Street and on 38th Street from Meridian Street to College Avenue.

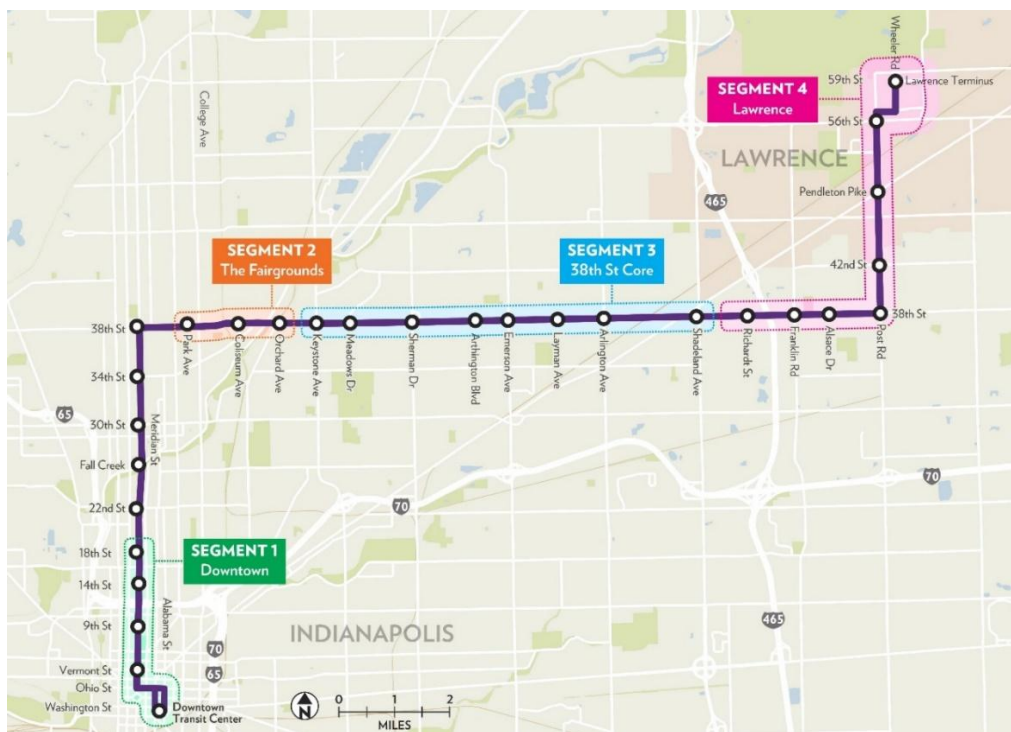


Figure 1: Purple Line Corridor

Study Area

Of the corridors along which the 14.8-mile-long Purple Line will operate, the longest segments will be on Meridian Street (for 3.8 miles) and 38th Street (for 7.8 miles). As such, parallel routes adjacent to these two corridors were identified for analysis.

Meridian Street Diversion Routes

The Purple Line will operate along Meridian Street from Ohio Street to 38th Street. As mentioned above, overlap with the Red Line will occur from 18th Street to 38th Street. A diversion analysis was already completed to evaluate routes parallel to Meridian Street from 16th Street to 38th Street for the Red Line; therefore, this analysis will only focus on routes parallel to Meridian Street south of 18th Street. Although the northern boundary of the study area is 18th Street, there are no major cross-streets between 12th Street and 16th Street; therefore, the analysis herein focuses on parallel routes between 12th Street and Ohio Street (area shown in Figure 2). Parallel diversion routes were selected based on continuity between Ohio Street and 38th Street. The following corridors were identified as potential diversion routes: Capitol Avenue, Illinois Street, Central Avenue, and College Avenue (the same routes selected as diversion routes in the Red Line analysis).

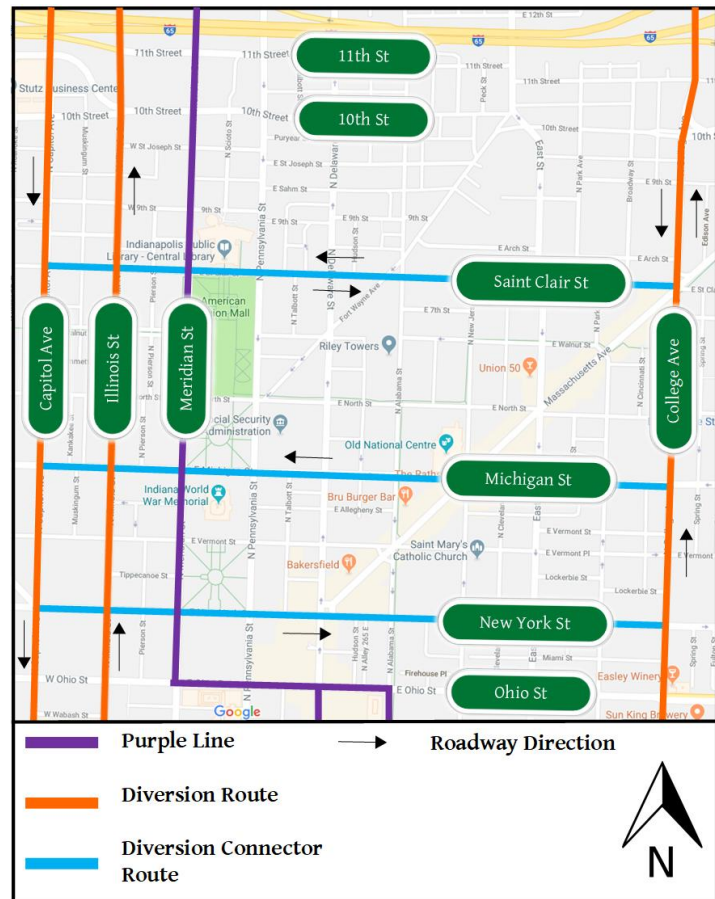


Figure 2: Meridian Street Diversion Routes and Connectors

Roads that a motorist could use to access a diversion route from the Purple Line corridor, called diversion route connectors herein, were identified based on familiarity with the study area. Generally, major cross-streets were identified as diversion connectors; this assumption applies to both the Meridian Street diversion routes and the 38th Street diversion routes. For the Meridian Street segment, Saint Clair Street, Michigan Street, and New York Street were identified as potential diversion connectors. Figure 2 shows the diversion routes and the diversion connectors to/from Meridian Street.

38th Street Diversion Routes

The Purple Line will operate along 38th Street from Meridian Street to Post Road. Given the Red Line overlap with the Purple Line on 38th Street from Meridian Street to College Avenue, this portion of 38th Street was not considered as a part of this analysis. Potential diversion routes for 38th Street were

selected based on continuity from Meridian Street to Post Road and proximity to the Purple Line. For the 38th Street segment, 46th Street to the north and 30th Street to the south were selected as potential diversion routes. It should be noted that some diversion traffic may utilize 42nd Street and/or 34th Street due to the proximity of those streets to the Purple Line, but they were not included in this analysis due to lack of continuity between Meridian Street and Post Road.

The following roads were identified as potential diversion route connectors to/from 38th Street: Keystone Avenue, Sherman Drive, Emerson Avenue, Arlington Avenue, Shadeland Avenue, Franklin Road, and Post Road (south of 38th Street). Figure 3 shows the diversion routes and the diversion connectors to/from 38th Street.

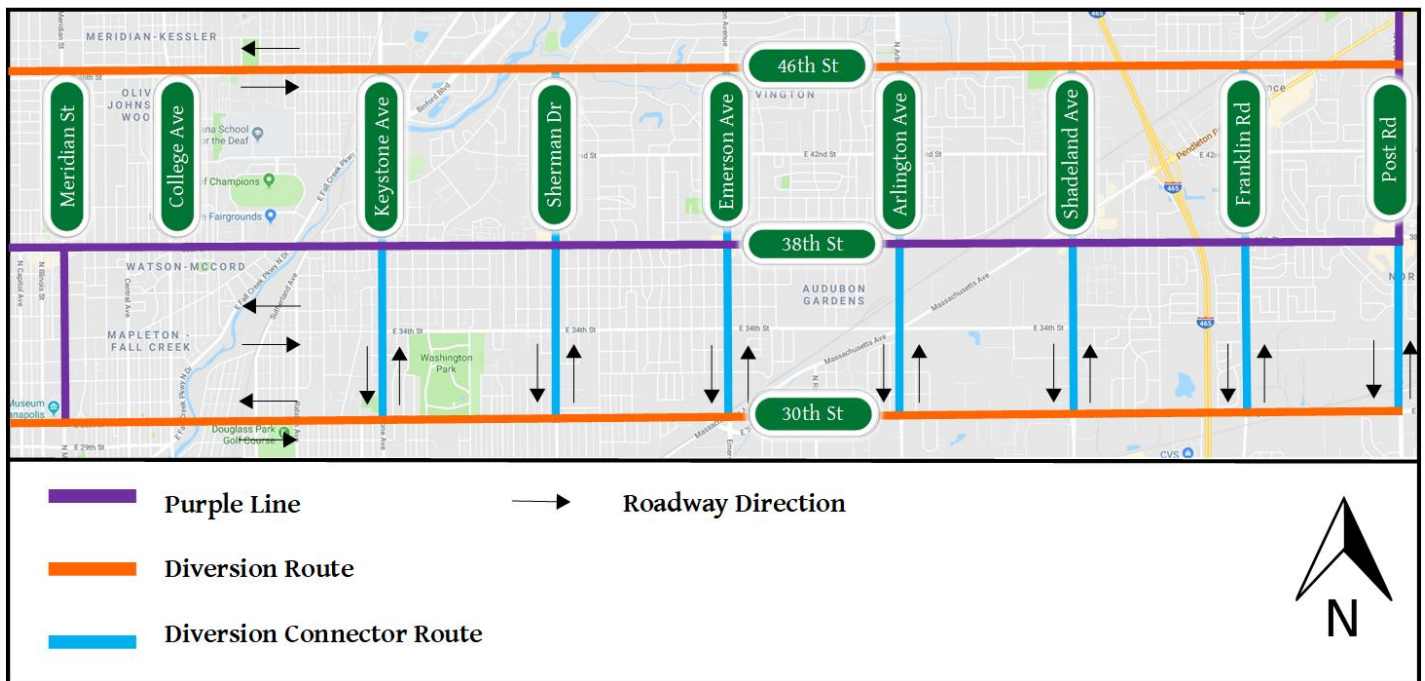


Figure 3: 38th Street Diversion Routes and Connectors

Key Intersections

Data collection, traffic analysis, and observations were concentrated at key intersections along the diversion routes. Key intersections were selected based on knowledge of existing intersection operations along the diversion routes and verified via field observation. Locations where existing vehicular traffic experiences delay and/or queues that result in regular split failure were identified as key intersections, as were locations where intersection operations may be impacted by additional vehicular traffic. The key intersections, shown in Figure 4 for Meridian Street and in Figure 5 for 38th Street, are often located at the intersection of diversion routes with diversion connector routes.

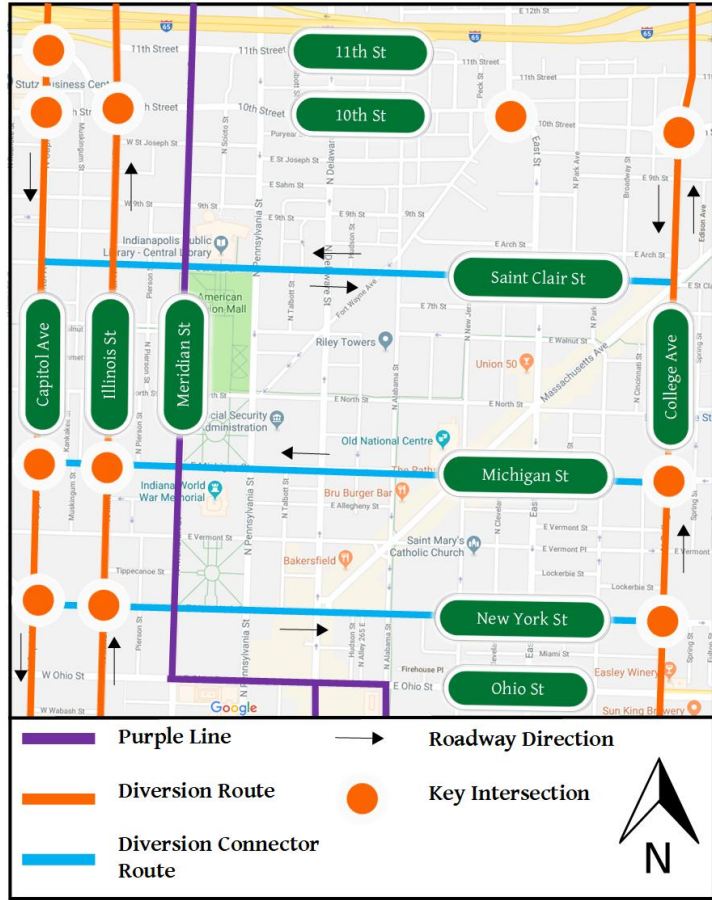


Figure 4: Meridian Street Key Intersections

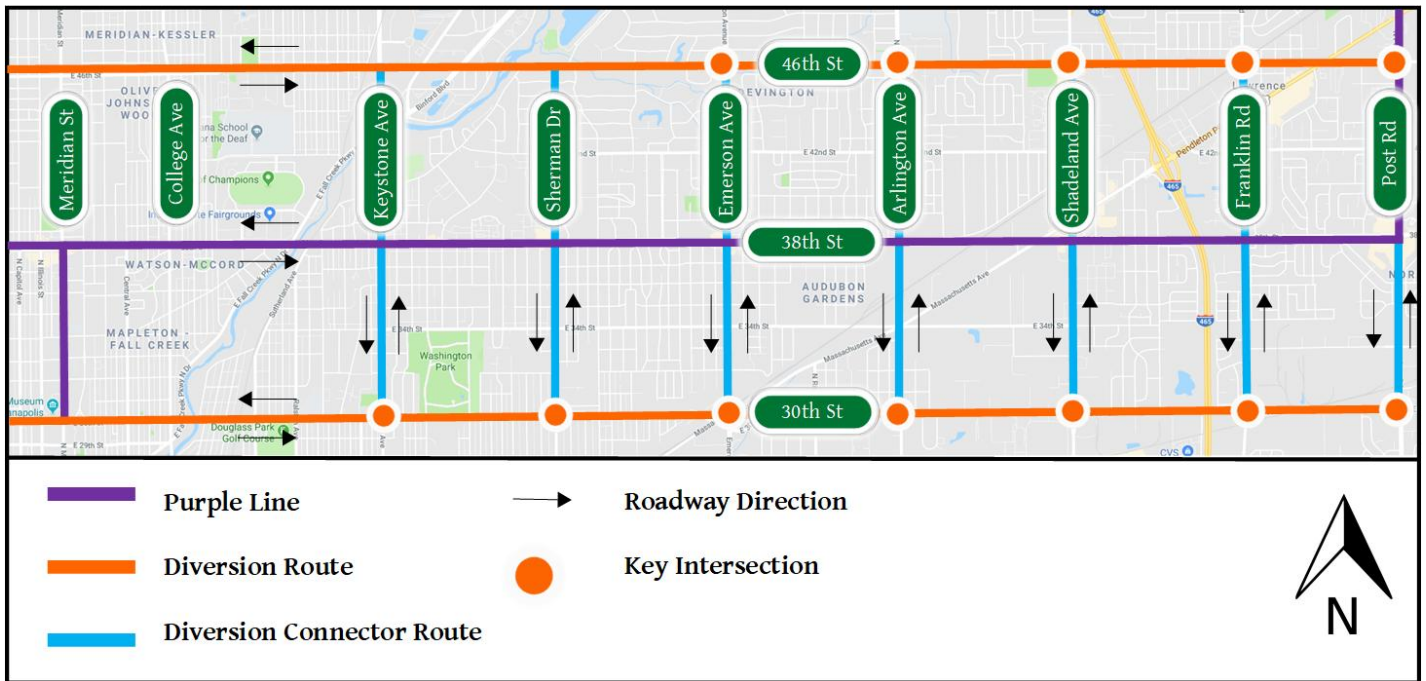


Figure 5: 38th Street Key Intersections

Data Collection

Traffic Counts

Traffic counts were obtained at each key intersection on September 11th, 2018 from 7-9am and from 4-6pm; exact peak hours were determined from this data. At the time of the traffic counts (and the field observations), the following road closures were in effect:

- Meridian Street closed at 28th Street
- Central Avenue bridge closed over Fall Creek Parkway

These road closures and their resulting impact on travel patterns to/from downtown Indianapolis is notable. Traffic volumes/distributions may vary after ongoing roadway construction is complete, and in the coming years before the Purple Line becomes operational. For locations where traffic volumes are significantly different than currently projected, future analysis may be necessary to confirm impacts.

Observations

To qualitatively assess the current conditions of the diversion routes, two site visits were completed at each key intersection during both the AM and PM peak hours. During site visits, the diversion routes were driven end-to-end to assess operations at a corridor level. The corridor assessments were completed in September, 2018. As previously mentioned, street closures in the downtown area may have altered travel patterns at the time of these observations. However, there were no known closures that would have impacted typical conditions along 30th or 46th Streets at the time of observation. During the key intersection site visits, the following roadway and traffic characteristics were observed/noted:

- Vehicular operations, including long queue lengths
- Signal split failures
- Signal operations including cycle lengths, splits, and phasing
- School zones
- Signage and pavement markings
- Pavement condition

General roadway characteristics along the diversion routes were recorded in addition to the key intersection data collection described above; roadway characteristics are summarized in Table 1 below.

Table 1: Diversion Route Roadway Characteristics

Corridor	Direction	Number of Lanes	Queuing	Progression	Pavement Condition
Capitol Avenue	N-S	3-4	Minimal	Good	Good
Illinois Street	N-S	3-4	Moderate	Average	Good
College Avenue	N-S	Varies ¹	Moderate	Average	Good
46th Street	E-W	2	Minimal	Poor	Fair to Good
30th Street	E-W	1	Moderate to Heavy	Poor	Fair

¹ Operation along College Avenue is one-way northbound south of Massachusetts Avenue and two-way north of Massachusetts Avenue

Traffic Diversion

The Red Line project assumed that 25% of traffic will divert from Meridian Street due to a reduction of GP capacity along the corridor. The Purple Line project assumed the same rate of diversion along Meridian Street, and 15% diversion along 38th Street and Post Road. The analysis herein will consider the impacts to identified diversion routes due to the addition of this diverted traffic. For each segment (Meridian Street and 38th Street), two scenarios were identified for evaluation, as described below.

Meridian Street

- Scenario 1 – split diverted traffic evenly between the one-way pair of Capitol Avenue / Illinois Street and Central Avenue / College Avenue
- Scenario 2 – assume that 60% of the diverted traffic uses the one-way pair of Capitol Avenue / Illinois Street and that 40% of the diverted traffic uses Central Avenue / College Avenue

Scenario 2 may be more likely given the proximity of Capitol Avenue and Illinois Street to Meridian Street. However, the Red Line will be constructed and in operation along Capitol Avenue before Purple Line construction begins, which may influence motorists' decisions to use other alternate routes. It should be noted that south of Massachusetts Avenue, College Avenue is one-way northbound; therefore, all diverted southbound traffic was assigned to Capitol Avenue south of Saint Clair Street. It should also be noted that Central Avenue was converted from one-way operation (southbound) to two-way operation during the timeframe that this analysis was conducted. The analysis herein assumes two-way operation on Central Avenue.

38th Street

- Scenario 1 – split diverted traffic evenly between 30th Street & 46th Street
- Scenario 2 – assume that 60% of the diverted traffic uses 30th Street and that 40% of the diverted traffic uses 46th Street

Due to more existing excess capacity along 46th Street than 30th Street, it is conservative to assume that a higher percentage of diverted traffic will utilize 30th Street (as opposed to 46th Street).

Existing Condition

Capacity analysis was conducted using Synchro software for each of the key intersections along the diversion routes, for the existing condition as well as for both diversion scenarios. The existing analysis summarizes operating conditions for the intersection configurations as they existed at the time that this report was prepared, using 2018 traffic volumes. Table 2 below summarizes existing capacity analysis results at each key intersection for the AM and PM peak hours. As shown in the summary table, all key intersections currently operate at acceptable Levels of Service (LOS), overall intersection LOS D or better.

Table 2: Key Intersection Capacity Analysis Results - Existing

Intersection	AM Peak			PM Peak		
	Max V/C Ratio	Delay (s)	Level of Service	Max V/C Ratio	Delay (s)	Level of Service
Capitol Avenue & 11th Street	0.59	11.5	B	0.43	10.5	B
Capitol Avenue & Michigan Street	0.78	14.3	B	0.54	14.1	B
Capitol Avenue & New York Street/Indiana Avenue	0.79	37.7	D	0.94	38.8	D
Illinois Street & 11th Street	0.78	17.5	B	0.91	11.3	B
Illinois Street & 10th Street	0.35	16.8	B	0.95	31	C
Illinois Street & Michigan Street	0.64	19	B	0.68	12.2	B
Illinois Street & New York Street	0.47	14.3	B	0.68	15.1	B
10th Street & Central Avenue/Fort Wayne Avenue/East Street	0.63	19.2	B	0.36	18.3	B
10th Street & College Avenue	0.64	18.1	B	0.84	21.3	C
College Avenue & Michigan Street	0.69	19	B	0.55	12.1	B
College Avenue & New York Street	0.36	12.5	B	0.77	21.7	C
46th Street & Emerson Avenue	1.11	32.2	C	1.08	37.8	D
46th Street & Arlington Avenue	0.62	21.3	C	0.79	23.6	C
46th Street & Shadeland Avenue	0.93	34.6	C	0.96	35.3	D
46th Street & Post Road	0.37	9.2	A	0.38	9.2	A
30th Street & Keystone Avenue	0.97	33.2	C	0.81	29.8	C
30th Street & Sherman Drive	0.82	21.1	C	0.72	21.6	C
30th Street & Emerson Avenue	1.14	42.9	D	0.95	30	C
30th Street & Arlington Avenue	0.46	16.2	B	0.6	17.4	B
30th Street & Shadeland Avenue	0.41	26.7	C	0.81	41.4	D
30th Street & Franklin Road	0.83	26.9	C	0.86	31.4	C
30th Street & Post Road	1.13	29.7	C	1.18	30.6	C

Diversion Scenarios

To assess the impacts to the diversion corridors, capacity analyses were conducted using Synchro software at the key intersections for Scenarios 1 and 2. The existing Synchro models were modified to include the following:

- Added diversion traffic volumes (differing values for Scenarios 1 and 2)
- Known reconfigurations to key intersections that would change operations. This included intersections along the corridor modified by the Red Line as well as at the intersection of 10th Street/East Street/Fort Wayne Avenue.
- Intersection-specific recommendations developed via Synchro testing with the goal of improving operations and safety.

As mentioned above, Central Avenue has been converted from one-way operation (southbound) to two-way operation between 10th Street and Fall Creek Parkway. This reconfiguration modifies operations and traffic patterns at the key intersection of 10th Street/East Street/Fort Wayne Avenue. A Synchro model and associated volume assumptions were developed for this intersection (for another project) by Shrewsberry & Associates; for the analysis herein, diverted traffic was simply added to the previously established volumes summarized in the Synchro file provided by Shrewsberry.

Tables 3 and 4 below summarize capacity analysis results for Diversion Analysis Scenarios, including recommendations that impact operations at the key intersections. It should be noted that operations in the Diversion Scenarios are significantly different from existing operations at the intersections of Illinois Street & 10th Street and Illinois Street & 11th Street, largely due to infrastructure modifications related to the Red Line construction, not necessarily due to added traffic as a result of the Purple Line BRT.

Table 3: Diversion Scenario 1, Key Intersection Capacity Analysis Results

Intersection	AM Peak			PM Peak			Recommendations
	Max V/C Ratio	Delay (s)	Level of Service	Max V/C Ratio	Delay (s)	Level of Service	
Capitol Avenue & 11th Street	0.78	14.5	B	0.56	11.3	B	
Capitol Avenue & Michigan Street	0.62	13.6	B	0.44	16.6	B	
Capitol Avenue & New York Street/Indiana Avenue	0.69	34.5	C	0.66	27.8	C	
Illinois Street & 11th Street	0.59	14.1	B	0.76	15.1	B	
Illinois Street & 10th Street	0.46	17.2	B	1.00	47.2	D	Install 5-section signal head for EB LT and implement protected/permitted phasing.
Illinois Street & Michigan Street	0.65	21.5	C	0.75	13.1	B	
Illinois Street & New York Street	0.58	15.6	B	0.82	25	C	
10th Street & Central Avenue/Fort Wayne Avenue/East Street	0.8	47.5	D	0.38	19.3	B	
10th Street & College Avenue	0.78	24.7	C	0.78	34.3	C	Install 5-section signal head for LT's in all directions and implement protected/permitted phasing.
College Avenue & Michigan Street	0.69	19.2	B	0.58	12.1	B	
College Avenue & New York Street	0.37	12.3	B	0.78	22	C	Increase green time for EB traffic on New York Street during the PM Peak.
46th Street & Emerson Avenue	0.69	19.9	B	0.72	18.9	B	Change cycle length to 90s and increase green time for NB LT.
46th Street & Arlington Avenue	0.64	23.7	C	0.8	25.3	C	Change cycle length to 90s.
46th Street & Shadeland Avenue	0.89	36.1	D	0.83	31.7	C	Change cycle length to 90s.
46th Street & Post Road	0.55	10.8	B	0.68	10.6	B	Change cycle length to 90s.
30th Street & Keystone Avenue	0.93	33.9	C	0.91	34.3	C	
30th Street & Sherman Drive	0.8	19.3	B	0.79	22.9	C	Change cycle length to 90s and increase green time for E/W traffic.
30th Street & Emerson Avenue	0.81	27	C	0.91	34	C	Change cycle length to 90s.
30th Street & Arlington Avenue	0.67	16.8	B	0.8	16.8	B	Change cycle length to 90s and increase green time for E/W traffic.
30th Street & Shadeland Avenue	0.64	22.8	C	0.96	40.8	D	
30th Street & Franklin Road	0.86	28.4	C	0.91	36.1	D	Change cycle length to 90s.
30th Street & Post Road	0.84	23.7	C	0.83	29.1	C	

Table 4: Diversion Scenario 2, Key Intersection Capacity Analysis Results

Intersection	AM Peak			PM Peak			Recommendations
	Max V/C Ratio	Delay (s)	Level of Service	Max V/C Ratio	Delay (s)	Level of Service	
Capitol Avenue & 11th Street	0.83	16.9	B	0.61	12.9	B	
Capitol Avenue & Michigan Street	0.63	13.7	B	0.45	11.7	B	
Capitol Avenue & New York Street/Indiana Avenue	0.6	28.8	C	0.73	28.1	C	
Illinois Street & 11th Street	0.59	14.1	B	0.77	24.8	C	
Illinois Street & 10th Street	0.46	17.3	B	1.00	51.8	D	Install 5-section signal head for EB LT and implement protected/permitted phasing.
Illinois Street & Michigan Street	0.7	18.5	B	0.76	14.8	B	
Illinois Street & New York Street	0.58	14.9	B	0.82	19.7	B	
10th Street & Central Avenue/Fort Wayne Avenue/East Street	0.8	47.4	D	0.38	19.3	B	
10th Street & College Avenue	0.78	31.1	C	0.75	32.1	C	Install 5-section signal head for LT's in all directions and implement protected/permitted phasing.
College Avenue & Michigan Street	0.69	20	B	0.57	12.1	B	
College Avenue & New York Street	0.36	13.3	B	0.78	22	C	Increase green time for EB traffic on New York Street during the PM Peak.
46th Street & Emerson Avenue	0.72	21.3	C	0.74	19.8	B	Change cycle length to 90s and increase green time for NB LT.
46th Street & Arlington Avenue	0.67	23.7	C	0.82	25.7	C	Change cycle length to 90s.
46th Street & Shadeland Avenue	0.86	34.2	C	0.82	30.9	C	Change cycle length to 90s.
46th Street & Post Road	0.54	10.5	B	0.66	10	A	Change cycle length to 90s.
30th Street & Keystone Avenue	0.89	30.6	C	0.91	33.4	C	
30th Street & Sherman Drive	0.81	19.6	B	0.8	23.5	C	Change cycle length to 90s and increase green time for E/W traffic.
30th Street & Emerson Avenue	0.81	27.2	C	0.92	34.9	C	Change cycle length to 90s.
30th Street & Arlington Avenue	0.67	16.6	B	0.82	17.7	B	Change cycle length to 90s and increase green time for E/W traffic.
30th Street & Shadeland Avenue	0.59	21	C	0.94	40.8	D	
30th Street & Franklin Road	0.87	28.7	C	0.91	36.1	D	Change cycle length to 90s.
30th Street & Post Road	0.69	19.9	B	0.8	29	C	

Findings and Recommendations

Based on the capacity analysis results and site observations summarized herein, it was determined that the diversion routes of Capitol Avenue, Illinois Street, Central Avenue, College Avenue, 46th Street, and 30th Street are viable alternate routes for traffic diversion from the Purple Line corridor. The following recommendations were developed in order to improve safety and operations along these parallel diversion routes.

Pavement Marking Improvements (striping, stop bars, crosswalks and turn arrows):

- 30th Street & Keystone Avenue
- 30th Street & Sherman Drive
- 30th Street & Emerson Avenue
- 30th Street & Arlington Avenue
- 30th Street & Franklin Road
- 46th Street & Arlington Avenue
- 46th Street & Shadeland Avenue

Signal Timing Modifications:

- College Avenue & New York Street – increase eastbound green time during PM Peak; optimize offsets along both cross-streets' signal systems to improve progression
- 46th Street & Emerson Avenue – change cycle length to 90 seconds and increase green time allocated to the northbound left-turn phase
- 46th Street & Arlington Avenue - change cycle length to 90 seconds so that there is a consistent cycle length along the corridor
- 46th Street & Shadeland Avenue - change cycle length to 90 seconds so that there is a consistent cycle length along the corridor
- 46th Street & Post Road - change cycle length to 90 seconds so that there is a consistent cycle length along the corridor
- 30th Street & Sherman Drive - change cycle length to 90 seconds and increase green time allocated to eastbound/westbound phase
- 30th Street & Emerson Avenue - change cycle length to 90 seconds so that there is a consistent cycle length along the corridor
- 30th Street & Arlington Avenue - change cycle length to 90 seconds and increase green time allocated to EB/WB phase
- 30th Street & Franklin Road - change cycle length to 90 seconds so that there is a consistent cycle length along the corridor

Infrastructure Modifications:

- Illinois Street & 10th Street – install 5-section signal head for the eastbound left-turn and implement leading protected phase (could be accomplished via revision to Red Line plans at this intersection).

- This recommendation stems from a 2016 MPO Safety Study, with the intent that the change would mitigate eastbound left-turn crashes at this intersection.
- 10th Street & College Avenue - install 5-section signal heads for left-turns in all directions and implement protected/permitted phasing
 - Left-turning vehicles have limited safe gaps during green phases, especially in the southbound and eastbound directions. The installation of 5-section signal heads will require a cantilever arm for southbound traffic, and may require cantilever modifications on other legs of the intersection.
- 46th Street & Emerson Avenue – detection may be malfunctioning at this intersection, causing unnecessary congestion in the eastbound direction during the PM peak. Check status of detection and minimum green times during the PM peak
- 30th Street & Sherman Drive – fill in pothole on the east leg; slowdown to avoid the pothole was causing congestion
- 30th Street & Franklin Road – remove existing stop bar for the eastbound left-turn lane and install new stop bar further to the west to reduce conflict with southbound right-turning vehicles.

The analysis and findings summarized in this memo reflect the anticipated corridor/intersection improvements required based on existing traffic data and assumptions made related to traffic diversion along parallel routes to the Purple Line. In the instance where traffic volumes are significantly different than currently projected, future analysis may be warranted near areas of concern.