

September 29, 2022

Mr. Bill Parkhill
Navona Investors, LLC
631 High Street
Denver, CO 80218

RE: Metro Center PA-B ISP – Aurora, Colorado
Chambers Road & Center Avenue Traffic Signal Warrant

FHU No. 119405-03



9/29/2022

Dear Mr. Parkhill:

As you are aware, comments received from City of Aurora Staff regarding the Metro Center PA-B ISP Traffic Impact Study (PA-B TIS) included a request to document traffic signal warrant analyses for the Chambers Road & Center Avenue intersection on the southeast corner of the Metro Center site, including an analysis for the buildout period of the site.

Traffic signal warrants were previously evaluated for the Chambers Road & Center Avenue intersection in the Metro Center Master Plan Traffic Impact Study (Master TIS). These analyses indicated that existing (2020) traffic volumes warrant the installation of a traffic signal without any development traffic volume from Metro Center.

We have prepared this letter to document new traffic signal warrant analyses for the intersection that are based on revised traffic volumes presented in the PA-B TIS.

METHODOLOGY

The Manual on Uniform Traffic Control Devices (MUTCD) identifies several warrants justifying the use and installation of traffic control signals. Three of these warrants are based on traffic volume:

- Warrant 1 – Eight-Hour Vehicular Volume
- Warrant 2 – Four-Hour Vehicular Volume
- Warrant 3 – Peak Hour

Using traffic volume forecasts from the PA-B TIS, each of the three volume-based warrants were evaluated for Existing Conditions, Existing Plus Site, 2040 Background Traffic, and 2040 Total Traffic scenarios to understand the timeline of when the Chambers Road & Center Avenue intersection may warrant signalization based on traffic volume.

Warrant Criteria Thresholds

The MUTCD provides the option that, if the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the thresholds for traffic volumes meeting Warrants 1, 2, and 3 may be reduced to 70% of the original values. The posted speed limit of Chambers Road (the major street) is 40 MPH, and the intersection is not located within the built-up area of an isolated community. Therefore, the 70% thresholds were not used in the signal warrant analyses.

MUTCD Thresholds also vary based on lane configurations of the major and minor streets. Chambers Road has four approach lanes in each direction (1 left-turn lane, 2 through lanes, and 1 shared through/right-turn

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lane). Center Avenue has single approach lanes in each direction (1 shared left-turn/through/right-turn lane). Based on this configuration, it is appropriate to use the MUTCD thresholds for intersections with 2-or-more lanes on the major street and 1 lane on the minor street.

Minor Street Right-Turn Reductions

The MUTCD notes that traffic signal warrant studies should consider the effects of the right-turn vehicles from the minor-street approaches. Engineering judgment should be used to determine what, if any, portion of the right-turn traffic is subtracted from the minor-street traffic count when evaluating the count against the signal warrants. Because of the single-lane approaches, it is expected that approximately 25% of right-turning traffic would not benefit from the presence of a traffic signal as they would be able to turn right on red and avoid incurring additional delay.

However, due to the wide paved area on the Center Avenue approach legs (22 feet for the eastbound lane and 18 feet for the westbound lane), it is possible that additional right-turning vehicles may be able to bypass a queue by treating Center Avenue as a flared minor-street approach. As such it was assumed for this analysis that 50% of right-turning traffic would not benefit from the presence of a traffic signal and were subtracted from the signal warrant counts. This assumption is similar to evaluating Center Avenue if exclusive right-turn lanes were constructed on the eastbound and westbound approaches.

Traffic Volume Forecasts

Turning movement counts for the Chambers Road & Center Avenue intersection used for the PA-B TIS and Master TIS were conducted in September 2019. These counts evaluated peak periods from 7:00 AM to 9:00 AM and from 4:00 PM to 6:00 PM. Additionally, daily traffic volume counts were conducted on Chambers Road north of Center Avenue and on Center Avenue east of Chambers Road. These daily counts were used to develop scaling factors to estimate turning movement counts during off-peak periods.

In the Master TIS, Existing Conditions were correlated to Year 2020. To achieve traffic volume forecasts for Year 2020, a uniform annual growth rate of 1.5% was applied to the entire study area based on the Northeast Aurora Transportation Study (NEATS) 2040 travel demand model. The annual uniform growth rate from NEATS was also used to develop traffic volume forecasts for the 2040 Background Traffic Scenario.

Existing Plus Site and 2040 Total Traffic scenario traffic volume forecasts included background volumes from the NEATS model, as well as site-generated traffic from proposed development within Metro Center. Although site-generated traffic was only evaluated during AM and PM peak hours in the Master TIS, the Institute of Transportation Engineers provides tools within *Trip Generation* (10th Edition) which estimate distribution of site-generated trips over typical weekdays for most land-use types. These tools were used to approximate the portion of traffic related to Metro Center at the Chambers Road & Center Avenue intersection in 15-minute increments with respect to the total PM peak hour trip generation rate for the site.

SIGNAL WARRANT ANALYSES

The following sections describe the results of signal warrant analyses for the Chambers Road & Center Avenue intersection.

Warrant 1 – Eight-Hour Vehicular Volume

Warrant 1 is satisfied when, for eight or more hours of an average day, traffic volumes along the major street (total of both approaches) and the higher-volume minor street approach exceed the threshold values specified in Table 4C-1 of the MUTCD. The threshold values for Condition A – Minimum Vehicular Volume are useful when the high approach volumes are the primary reason for signalization. The Condition B – Interruption of Continuous Traffic thresholds are used when major street volumes cause minor street vehicles to suffer excessive delay or experience conflicts when attempting to cross the major street. These threshold values are

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adjusted downward to account for higher roadway speeds or rural (<10,000 population) conditions. These thresholds also change relative to the number of lanes provided along each intersection approach. Warrant 1 is satisfied when Condition A or Condition B is met. Warrant 1 is also satisfied when 80 percent of the threshold traffic volumes in Condition A and Condition B are exceeded.

Table 1 displays a summary of analyses for Warrant 1. As shown, traffic volumes in all four scenarios would meet criteria for Condition B – Interruption of Continuous Traffic. This indicates that the intersection *currently* meets Warrant 1.

Of note, the addition of traffic volumes from proposed development within Metro Center would not change the higher minor street approach. Westbound Center Avenue would still have higher approach volumes than eastbound Center Avenue.

Table 1. Center Ave & Chambers Rd Warrant 1 Evaluation

Hour	Scenario							
	Existing		Existing Plus Site		Future (2040) Background		Future (2040) Total	
	Major Street	Minor Street	Major Street	Minor Street	Major Street	Minor Street	Major Street	Minor Street
3:00 PM – 4:00 PM	2865	105	2970	105	3860	145	3960	145
1:00 PM – 2:00 PM	1885	105	1970	105	2535	140	2615	140
7:15 AM – 8:15 AM	2945	100	3035	100	3965	135	4030	135
10:15 AM – 11:15 AM	1575	100	1650	100	2120	135	2185	135
2:00 PM – 3:00 PM	2095	95	2190	95	2825	125	2905	125
4:00 PM – 5:00 PM	3135	95	3260	95	4220	125	4345	125
11:45 AM – 12:45 PM	1910	90	2000	90	2575	125	2655	125
6:30 PM – 7:30 PM	1905	90	1985	90	2565	120	2650	120
Criteria A*	600	150	600	150	600	150	600	150
Criteria B*	900	75	900	75	900	75	900	75

Notes: * 8-Hour Warrant Criteria for a Major Street with 2+ Lanes and a Minor Street with 1 Lane

	Meets Criteria A & B
	Meets Criteria A
	Meets Criteria B
	Meets Criteria 80% of A & B

Warrant 2 – Four-Hour Vehicular Volume

This warrant is fulfilled when traffic volumes for the major street (total of both approaches) and the higher volume minor street plot above the threshold guidelines as represented on Figure 4C-1 or 4C-2 of the MUTCD for any four hours of an average day for the existing combination of approach lanes.

Attachment 1 displays a summary of the four-hour vehicular volumes and graphs for Warrant 2. As shown on the graph, traffic volumes in all four scenarios would meet criteria for Warrant 2 (the appropriate threshold line for this intersection is highlighted in yellow). This indicates that the intersection *currently* meets Warrant 2.

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Of note, the addition of traffic volumes from proposed development within Metro Center would not change the higher minor street approach. Westbound Center Avenue would still have higher approach volumes than eastbound Center Avenue.

Warrant 3 – Peak Hour

This warrant is intended for application where traffic conditions are such that for one hour of the day minor street traffic suffers undue delay in entering or crossing the major street. This warrant may also be satisfied when traffic volumes for the major street (total of both approaches) and the higher volume minor street approach plot above the threshold guidelines as represented on Figure 4C-3 or 4C-4 of the MUTCD for the existing combination of approach lanes during the peak hour of the day.

The 2009 Edition of the MUTCD includes the following statement in the Peak Hour Warrant description:

This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.

As a result of this statement, Warrant 3 must be used with caution and should not be used for typical public street intersections. Therefore, this warrant is not applicable to the Chambers Road & Center Avenue intersection.

Attachment 2 displays a summary of the four-hour vehicular volumes and graphs for Warrant 3. As shown on the graph, traffic volumes in all four scenarios would meet criteria for Warrant 3 (the appropriate threshold line for this intersection is highlighted in yellow). This indicates that the intersection *currently* meets Warrant 3. However, MUTCD's clarification for applying Warrant 3 as described above precludes the use of this warrant for justifying the signalization of the Chambers Road & Center Avenue intersection.

Of note, the addition of traffic volumes from proposed development within Metro Center would not change the higher minor street approach. Westbound Center Avenue would still have higher approach volumes than eastbound Center Avenue.

SUMMARY

Traffic volume forecasts for the Chambers Road & Center Avenue intersection based on the PA-B TIS indicate that signalization of the intersection is warranted based on existing (2020) traffic counts using Warrant 1 – Eight-Hour Vehicular Volume and Warrant 2 – Four-Hour Vehicular Volume from the MUTCD. Existing traffic volumes also meet Warrant 3 – Peak Hour, but the application of this warrant should not be considered for the Chambers Road & Center Avenue intersection.

Future traffic volumes anticipated at the intersection also indicate that a traffic signal would be warranted after proposed development occurs in Metro Center, but it is important to note that new development is not expected to change the higher minor street approach. Westbound Center Avenue would still have higher approach volumes than eastbound Center Avenue.

The results of this signal warrant analysis are consistent with the outcomes and recommendations of the Metro Center Master TIS. Signalization of this intersection should be considered as soon as possible to accommodate minor street traffic from Center Avenue, both from anticipated development on the west side of Chambers Road as well as commercial and residential development on the east side of Chambers Road.

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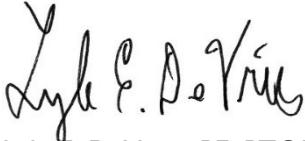
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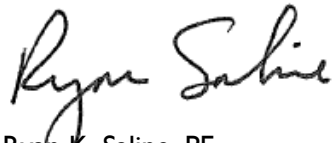
If you have any questions about this letter, please contact Lyle DeVries (lyle.devries@fhueng.com) or Ryan Saline (ryan.saline@fhueng.com) or call 303-721-1440.

Sincerely,

FELSBURG HOLT & ULLEVIG



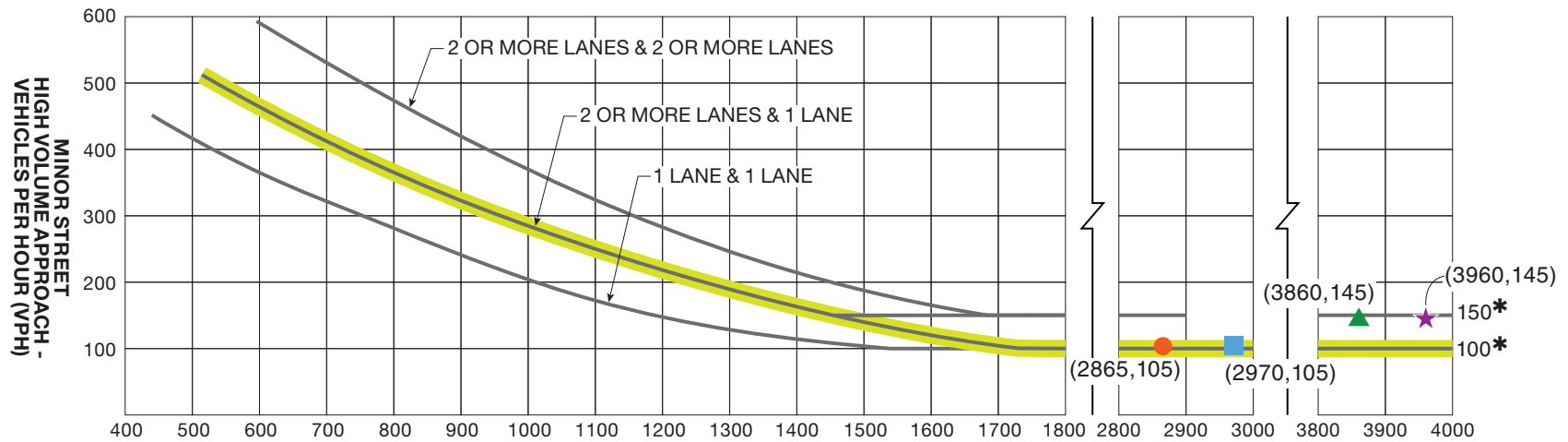
Lyle E. DeVries, PE, PTOE
Principal



Ryan K. Saline, PE
Transportation Engineer

Attachment 1 – Warrant 2 (Four-Hour Vehicular Volume)

Attachment 2 – Warrant 3 (Peak Hour)



**MAJOR STREET - TOTAL OF BOTH APPROACHES -
VEHICLES PER HOUR (VPH)**

* Note: 150 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor street approach with one lane.

LEGEND

- = Existing (2020)
- = Existing Plus Site (2020)
- ▲ = Future (2040) Background
- ★ = Future (2040) Total