



October 15, 2015

To: Urban Design Committee, City of Richmond

RE: *Left-Turn Allowances for GRTC Bus Rapid Transit Project*

UDC/PC Comment 3 and 23:

- That a review of the 60% design stage include connectivity to the neighborhoods, access to the Scott's Addition particularly at Summit Avenue, and the median running design of the system
- That the BRT planning team continues to study opportunities to provide additional left turn movements from Broad Street, particularly at N. Boulevard and N. Lombardy Street, fully recognizing the impact to parking totals and the important role that parking provides as a buffer for pedestrians from moving travel lanes

Applicant Response:

- An eastbound left-turn lane is not recommended at Summit Avenue. The path of an eastbound left-turn movement at Summit Avenue would cross into the proposed BRT station. The proposed station cannot be relocated due to an adjacent high pressure gas line running beneath Broad Street.
- A westbound left-turn lane is not recommended at Lombardy Street. A turn lane at Lombardy Street would be costly, require reduction of existing sidewalk width by 3-4 feet, and cause poor traffic operations in the short block between Lombardy Street and Bowe Street. Left-turning traffic will become trapped between the two intersections without an opportunity to make a permissive left-turn at the end of the Broad Street signal phase, potentially extending beyond the dedicated turn lane during the peak hours.
- A westbound left-turn movement from Broad Street onto N. Boulevard is recommended during the off-peak periods. A westbound left-turn will be prohibited from 7:00 AM to 9:00 AM, and from 4:00 PM to 6:00 PM Monday through Friday, but allowed at all other times, pending further detailed traffic analysis. This left-turn movement supports access to major cultural attractions including the VMFA, Historical Society, and Byrd Park as well as preserves the land use patterns on this ceremonial street.

SUPPORTING DOCUMENTATION

Left-turn movements along the Broad Street corridor currently occur from shared left/through lanes. Vehicles often queue in the shared left/through lanes while turning vehicles wait for a gap in opposing traffic, forcing through traffic to utilize the two outside lanes to efficiently move through the corridor. Since the BRT project will eliminate the inside shared left/through lanes between Thompson Street and Foushee Street to accommodate exclusive BRT lanes, alternate left-turn accommodations were considered.

Turning movement count data was collected in October 2014 at 29 intersections along the proposed BRT alignment. These traffic counts were supplemented by traffic counts performed in October 2008 as part of the City's Retiming of Traffic Signals Phase III program. Not all intersections were counted again in 2014 since traffic volumes and patterns in the study area remained relatively stable, and 2008 data could be balanced with 2014 data. Count data allowed the study team to better assess demand for left-turn access at various locations along the BRT corridor.

Left-turn accommodations from Thompson Street to Foushee Street (where the BRT buses will operate in dedicated median transit lanes) were carefully considered for efficient movement of traffic, safety, and neighborhood and business access. For efficient movement of traffic, exclusive left-turn lanes should be constructed to provide storage for left-turn queues and minimize congestion in the adjacent through lane. For safety, left-turn movements across dedicated transit guideways should occur at signalized intersections and use protected-only left-turn phasing, as documented in the American Public Transportation Association (APTA) Recommended Practice "Designing Bus Rapid Transit Running Ways." Protected left-turn phasing is recommended in order to prevent driver interactions with head-on vehicular traffic, head-on BRT vehicles, and BRT vehicles approaching from behind. In mixed-flow or curb running segments of the corridor, there will no reduction of left-turn access.

Based on a detailed review of existing traffic volumes and operations between Thompson Street and Foushee Street as well as community input received from numerous public meetings, it is recommended that left-turn movements from exclusive left-turn lanes be allowed at the following locations:

- Eastbound left turn at Roseneath Road
- Westbound left turn at Tilden Street
- Eastbound and westbound left turns at Sheppard Street
- Eastbound left turn at Terminal Place
- Westbound left turn at Robinson Street
- Eastbound left turn at Davis Avenue
- Eastbound left turn at DMV Drive
- Eastbound left turn at Allison Street
- Eastbound and westbound left turns at Hermitage Road/Meadow Street
- Eastbound left turn at Allen Avenue
- Eastbound left turn at Bowe Street

- Westbound left turn at Harrison Street
- Eastbound and westbound left turns at Belvidere Street
- Westbound left turn at Monroe Street

Three additional locations for exclusive left-turn lanes were investigated for feasibility.

- Eastbound left turn at Summit Avenue
- Westbound left turn at Lombardy Street
- Westbound left turn at Boulevard Avenue

Eastbound Left Turn at Summit Avenue (Scott's Addition access)

An eastbound left-turn movement at Summit Avenue would provide access into Scott's Addition. Scott's Addition is located north of Broad Street while the Museum District is located south of Broad Street, each lying between I-195 and Boulevard. The BRT station was strategically located to balance left-turn access to both neighborhoods with convenient transit accessibility. Currently, there are proposed eastbound left-turn movements for access to Scott's Addition at Roseneath Road and at Sheppard Street. There are proposed westbound left-turn movements for access to the Museum District at Sheppard Street and Tilden Street.

An eastbound left turn is not recommended for Summit Avenue. The path of an eastbound left-turn movement at Summit Avenue would cross into the proposed BRT station. The raised concrete median for the station extends beyond Summit Avenue, as denoted by the grey marking in Figure 1. Additionally, the BRT station location physically prevents a traffic signal at Summit Avenue, which would also be required to accommodate an eastbound left-turn onto Summit Avenue. The BRT station cannot be relocated due to the presence of a high pressure gas line to the west of Cleveland Street, located along Broad Street and Highpoint Avenue which poses safety risks to a potential BRT station. City Transportation and Planning staff acknowledge that circulation in Scott's Addition could be improved; therefore, a circulation study for Scott's Addition is being considered separate from the GRTC BRT Project.

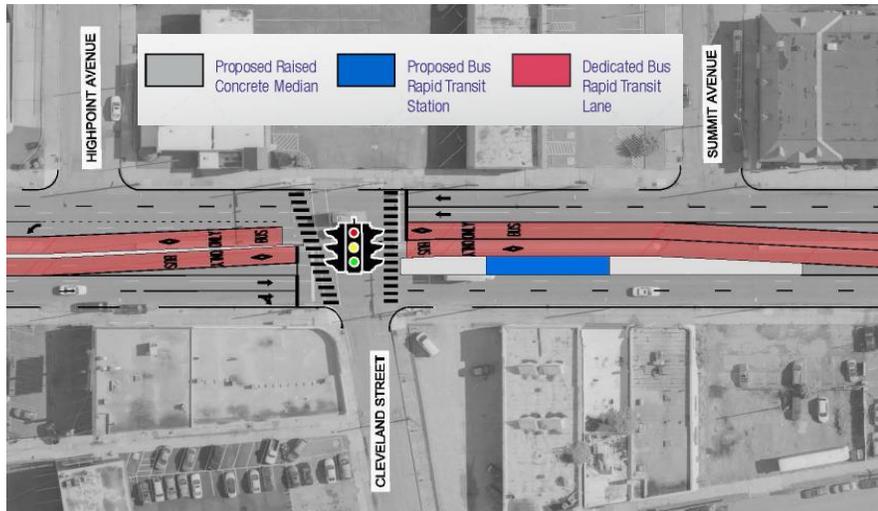


Figure 1. The location of the proposed BRT station and raised concrete median extended beyond Summit Avenue.

Several jughandle options were considered as an alternative to an exclusive left-turn lane on Broad Street at Summit Avenue. A jughandle is a slip road on the right side of the main roadway prior to an intersection. Left-turning traffic is diverted onto the slip road to turn left, as illustrated in Figure 2. Jughandle configurations were considered at Summit Avenue, Altamont Avenue, and Wayne Street (via Cutshaw Avenue) to provide access into Scott’s Addition. However, in all three instances property acquisition would be required. The project’s Transportation Investment Generating Economic Recovery (TIGER) Grant will not allow for property acquisition. Therefore, a long-term solution should be pursued for Scott’s Addition separate from the GRTC BRT Project.

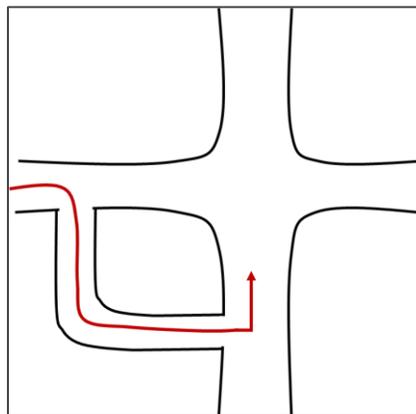


Figure 2. A simple jughandle intersection configuration sketch.

Westbound Left Turn at Lombardy Street

A westbound left-turn movement at Lombardy Street would provide access to the Fan District which is located south of Broad Street between Boulevard and Belvidere Street. Westbound left-turn access into the Fan District is currently proposed at Robinson Street, Hermitage Road/Meadow Street, and Harrison Street.

The minimum required travel lane, parking lane, and median widths are currently proposed at Lombardy Street; therefore construction of a left-turn lane at this intersection would require acquiring approximately 3-4 feet of sidewalk space, as shown in Figure 3. Construction of a left-turn lane would involve widening Broad Street to one side at a cost of approximately \$200,000. A major component of this cost is the relocation of two traffic signal poles, two light poles, and one drainage drop inlet.

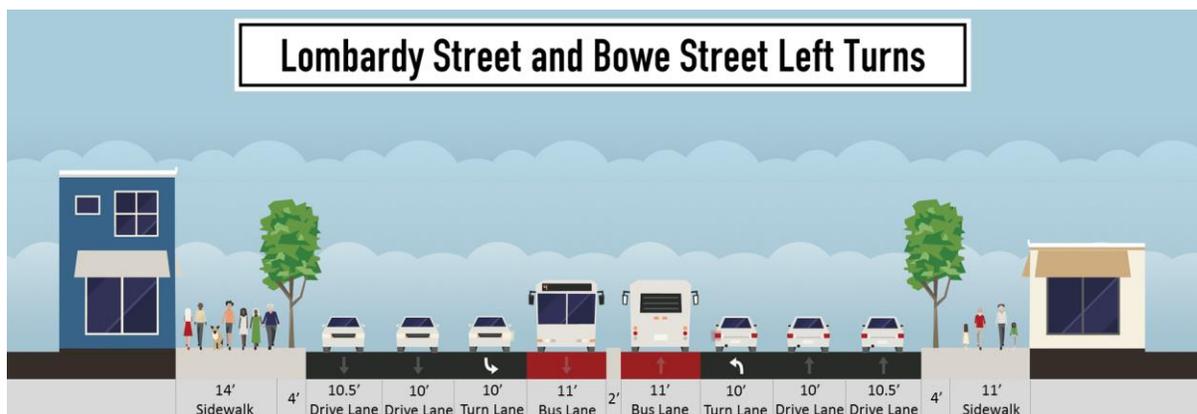


Figure 3. The cross-section of Broad Street at Lombardy Street if an exclusive left-turn lane is installed. Note lanes are at minimum require widths and sidewalk space must be acquired on one side of the roadway.

In addition to sidewalk width reductions and project cost implications, traffic flow is a concern in this congested area of the BRT corridor. There is approximately 270 feet between Lombardy Street and Bowe Street. The close proximity of these two intersections will result in inefficient traffic flow if both intersections include simultaneous protected left-turn phases. Left-turning traffic will become trapped between Lombardy Street and Bowe Street without an opportunity to make a permissive left-turn at the end of the Broad Street signal phase. This operation will result in accommodating only left-turn traffic that is stored between the two intersections at the beginning of the left-turn phase. Left-turn traffic that is not accommodated during the protected phase would be served in the next signal cycle resulting in additional queuing, potentially extending beyond the dedicated turn lane during the peak hours. Additionally, a decision was made to install an eastbound left-turn at Bowe Street since the existing eastbound left-turn volume turning onto Bowe Street is greater than the existing westbound left-turn volume turning onto Lombardy Street. For these reasons, a westbound left-turn movement is not recommended at Lombardy Street.

Westbound Left Turn at Boulevard

A westbound left-turn movement at Boulevard would support access to major cultural attractions including the Virginia Historical Society, Virginia Museum of Fine Arts, Byrd Park, and Maymont as well as preserve the land use patterns along this ceremonial street. However, the addition of a westbound left-turn phase and dedicated turn lane combined with BRT median running operation will result in on-street parking loss and level of service (LOS) degradation from a LOS E to a LOS F. The delay and LOS for the intersection of Broad Street at Boulevard with and without a westbound left-turn phase is shown in Table 1. A 90 second cycle was assumed per direction of City Transportation staff.

Table 1. Delay and Level of Service (LOS) of Broad Street at Boulevard Avenue with and without an exclusive westbound left-turn lane (worst-case PM peak hour)

Options for Broad Street at Boulevard	Delay	Level of Service	Notes
90 second cycle	63.3	E	--
90 second cycle with westbound left-turn onto Boulevard	114.3	F	Addition of left-turn lane, signal phase and additional timings required for this phase pushes the intersection over-capacity.

The advantages of a westbound left-turn lane at Boulevard are as follows:

- More access for vehicles to historical locations and to attractions such as the Virginia Museum of Fine Arts
- Shorter queue lengths at both Boulevard and Sheppard

The disadvantages of a westbound left-turn lane at Boulevard are as follows:

- Additional loss of parking (approximately 13 additional parking spaces)
- Additional signal phase and therefore an increased cycle length will cause more pedestrian delay on some approaches and along the corridor
- Left-turn only phase will reduce green time for the Pulse BRT

Time of day restrictions on a westbound left-turn movement at Boulevard would be feasible and consistent with existing operations along Boulevard south of Broad Street.

Based on the advantages and disadvantages of left-turn access, it was determined by City Planning and Transportation staff to allow a westbound left-turn from Broad Street onto Boulevard during the off-peak periods. Essentially, a westbound left-turn will be prohibited from 7:00 AM to 9:00 AM and from 4:00 PM to 6:00 PM Monday through Friday and allowed at all other times, pending further detailed traffic analysis.