Multimodal Coordination for Bus Priority Hot Spots

Task 4 Technical Memorandum - Concept Plans

Submitted to:

National Capital Region Transportation Planning Board

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DRAFT Task 4 Technical Memorandum: Concept Plans

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1 INTRODUCTION

1.1 Purpose of Memo

This technical memo summarizes the conceptual design and impact assessment associated with the six refined bus "hot spot" sites for MWCOG's Multimodal Coordination for Bus Hot Spots Study. The memo initially presents the evaluation methodology in further analyzing the six sites, then presents the evaluation results – first the individual site improvement layout plans, then the assessment of bus operations savings and general traffic impacts associated with the physical and operational improvements identified.

1.2 Six Sites Evaluated in Detail

Two sites in the District of Columbia, Maryland and Virginia were identified for the refined analysis. These include:

District of Columbia

- 14th Street between Corcoran Street and Otis Place
- North Capitol Street at New York Avenue

Maryland

- Wheaton Metrorail Station Area, including Reedie Drive, Weirs Mill Road, and Georgia Avenue
- Piney Branch Road between Sligo Avenue and University Drive

Virginia

- Van Dorn Street between Franconia Road and Eisenhower Avenue
- Glebe Road at Arlington Road

2 EVALUATION METHODOLOGY

2.1 Layout Plans

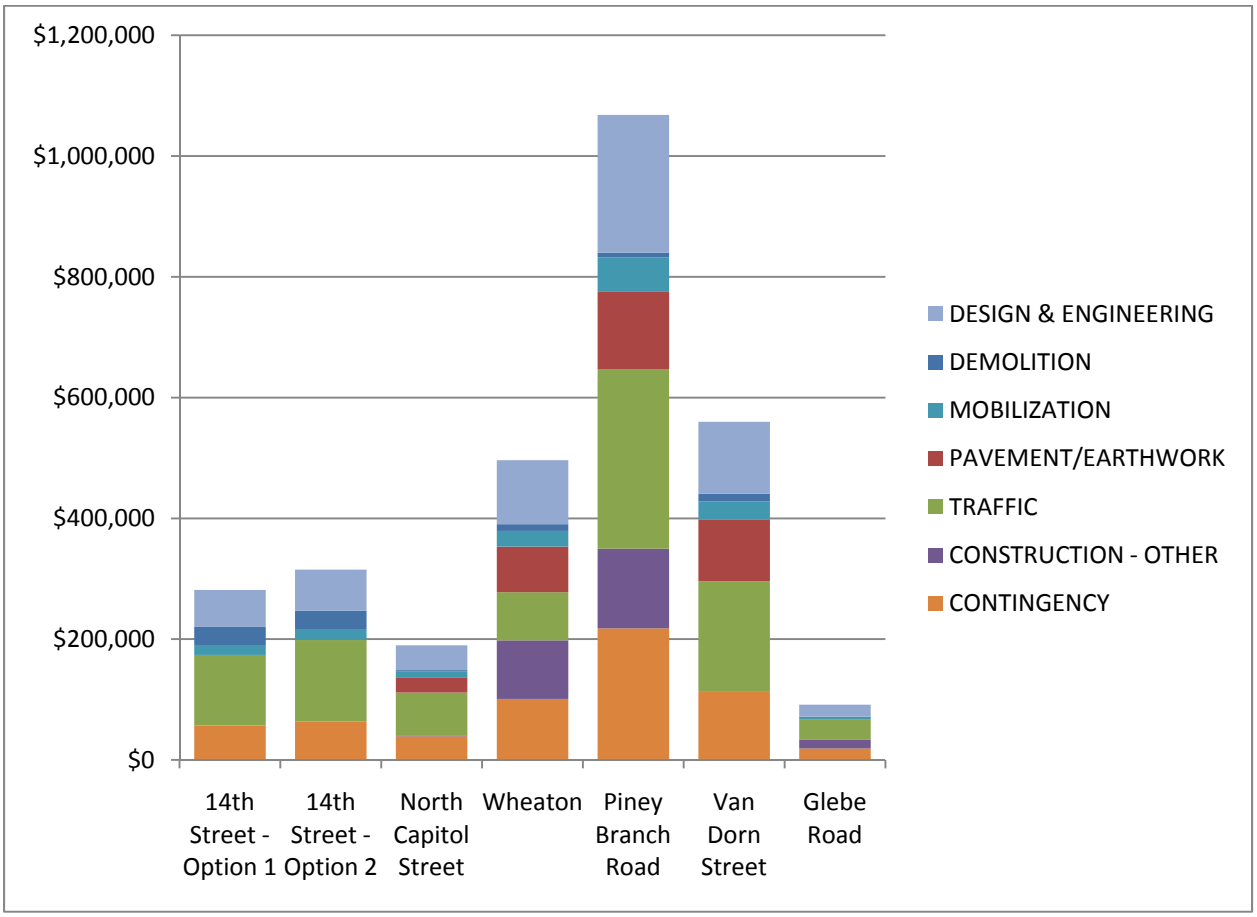
The physical improvements associated with each of the six "hot spots" were laid out on aerial mapping, using 1" = 100' scale to illustrate corridor improvements, and 1" = 50' scale to illustrate a solitary intersection improvement. The plans are intended to be conceptual in nature, showing the extent of physical improvements associated with identified bus priority treatments, such as extended turn lanes

for queue jumps, new bus lanes, added auxiliary lanes, and relocation of existing bus stops. The plans are presented in Appendices A through F for the six hot spot sites.

2.2 Capital Cost Estimates

Capital cost estimates for the various physical improvements were derived based on a limited set of quantities, and applying unit costs based on information from the District Department of Transportation, Maryland State Highway Administration, and Virginia Department of Transportation. Major cost categories include demolition, pavement/earthwork, traffic, other, and mobilization. A 35% contingency was applied to the basic construction cost, with added costs identified for preliminary engineering, final design, construction services, and public involvement. As all physical improvements were identified to be undertaken within existing roadway right-of-way, no right-of-way costs were identified. Figure 1 summarizes the capital cost components for the improvements recommended for each hotspot corridor

Figure 1: Capital Cost Estimates by Hotspot



The detailed capital cost estimates for the six hot spot sites are presented in Appendices A through F, associated with the corresponding concept plan drawings.

2.3 Impact Assessment

2.3.1 2.3.1 Traffic Operations Analysis

For all of the final Hot Spot locations, a comprehensive traffic analysis was performed to document the existing traffic operations as well as future traffic operations under the identified potential bus priority treatments. The methodology of the Highway Capacity Manual (HCM) year 2000 edition was used to evaluate capacity for selected intersections during the weekday AM and PM peak hours. A Synchro traffic model, with current traffic volume data and signal timings for each weekday peak period, was obtained from each respective DOT (VDOT, DDOT, Montgomery County and SHA). Existing roadway geometry/ lane configuration was verified based on Task 3 field observations.

Performance measures of effectiveness for HCM analysis include level of service, delay and volume-to-capacity ratio. The level of service (LOS) is a letter designation that corresponds to a certain range of roadway operating conditions. The levels of service range from A to F, with A indicating the best operating conditions and F indicating the worst, or a failing, operating condition. The volume-to-capacity ratio (v/c ratio) is the ratio of current flow rate to the capacity of the intersection. This ratio is often used to determine how sufficient capacity is on a given roadway. Generally speaking, a ratio of 1.0 indicates that the roadway is operating at capacity. A ratio of greater than 1.0 indicates that the facility is failing as the number of vehicles exceeds the roadway capacity.

When modeling Transit Signal Priority (TSP), a 7-second all-red vehicle phase was coded to simulate the bus only phase. However, in practice the TSP could operate as an early green for a particular phase, an extended green or an exclusive bus-only phase. Where a queue jump lane is present, TSP can also operate concurrently with bus use of a queue jump lane.

In all locations where TSP is proposed, it is recommended that more detailed traffic analysis be performed to evaluate cycle lengths, queues, transitions, hardware needs, software needs, policy for granting priority requests, and consideration of future traffic volumes.

2.3.2 Bus Travel Time Savings/Operating Costs

Bus Travel Time Savings

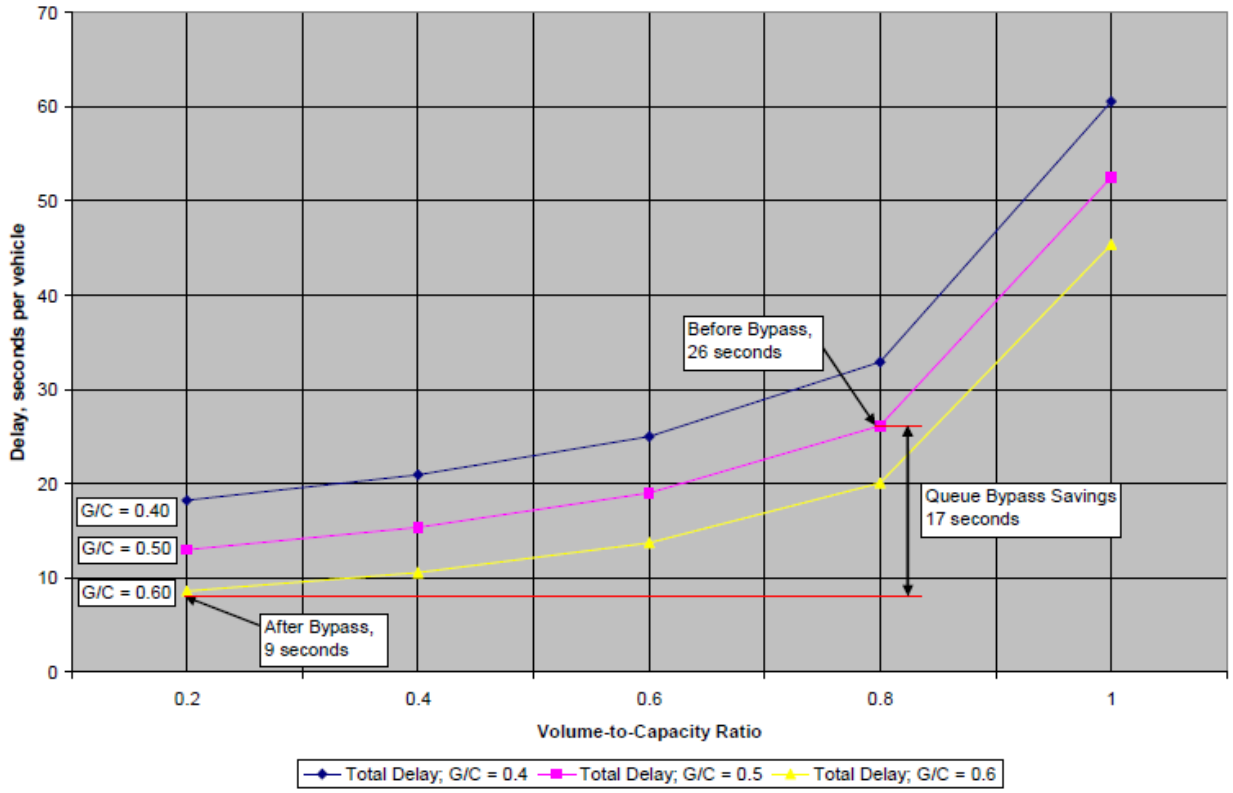
For each site, the bus travel time savings associated with particular transit priority treatments were estimated based on information from the Synchro model data available and established relationships for

queue jump signals, transit signal priority, and exclusive bus lanes identified from Transit Cooperative Research program research, in particular TCRP Synthesis 83 – Bus and Rail Preferential Treatments in Mixed Traffic. Travel time savings were only estimated for the weekday AM(6 to 9 AM and PM (3 to 7 PM) peak hour periods, as the traffic Synchro files which provided operational data were only available for two hours (one AM and one PM peak hour). The extended five hours during the combined peak periods was addressed by assuming that the travel time savings would be only 80% of the one hour savings. Annual peak period savings was then estimated, and discounted for the next five years and 20 years. It was assumed that the majority of bus travel time savings would be during the seven hour period, and hence no added savings associated with the remaining hours of the day nor on weekends was estimated. Peak period bus travel time savings for a particular treatment were identified by applying a unit travel time savings times the number of buses that would use the priority treatment during the identified period.

Unit bus travel time savings for different bus priority treatments were estimated as follows:

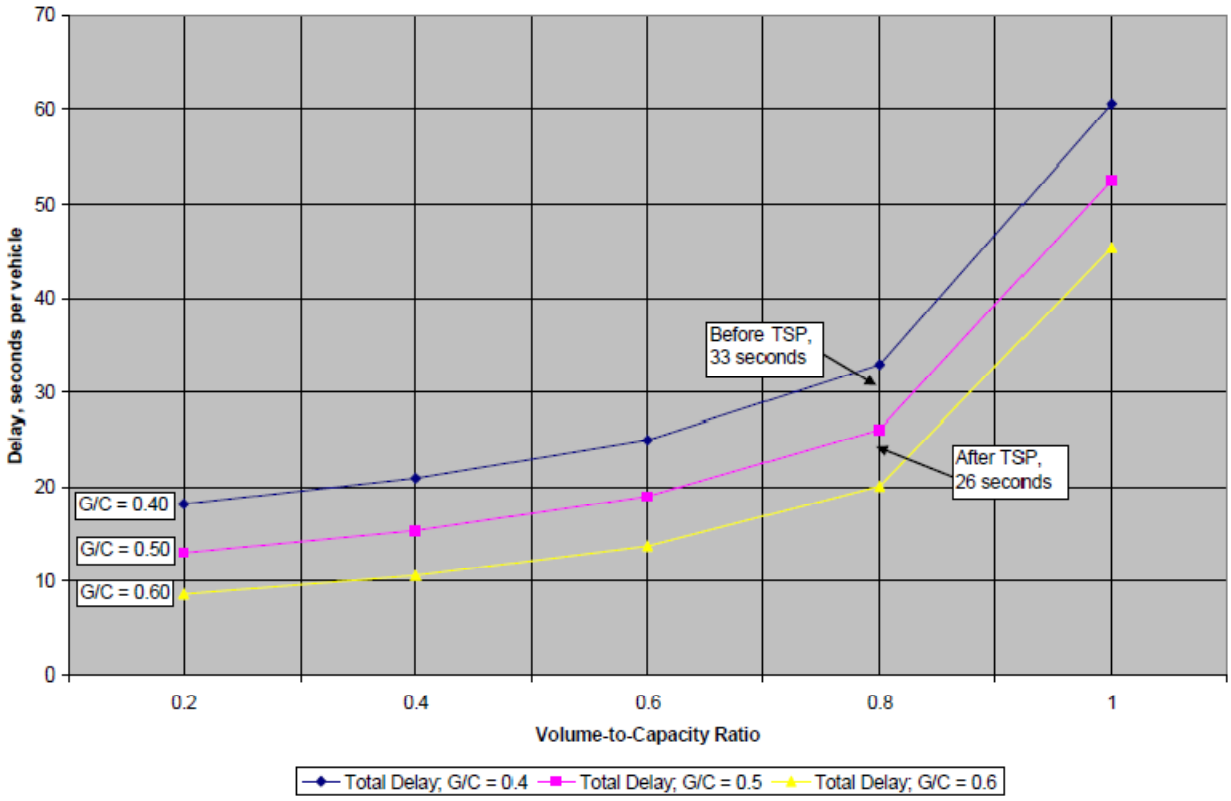
- Queue Jumps
  The bus travel time savings with a queue jump was estimated as the difference in delay to buses operating initially in a general traffic lane ("before" condition) and the less delay with buses operating in a less congested auxiliary lane (typically right turn lane) ("after" condition). This change in delay is illustrated in the sample nomograph in Figure 1 (from *TCRP Report 118 – Bus Rapid Transit Practitioner's Guide*).

Figure 2: Effect of Queue-Jump on Intersection Delay



- Transit Signal Priority
  The bus travel time savings with transit signal priority from a general traffic lane (green/extension/red truncation treatment) was assumed to represent an increase in the g/c ratio for the approach the bus would be operating. In general, a 7 second increase in green time was assumed, which resulted in reduced delay to buses. This change in delay is illustrated in the sample nomograph in Figure 2 (*from TCRP Report 118*).

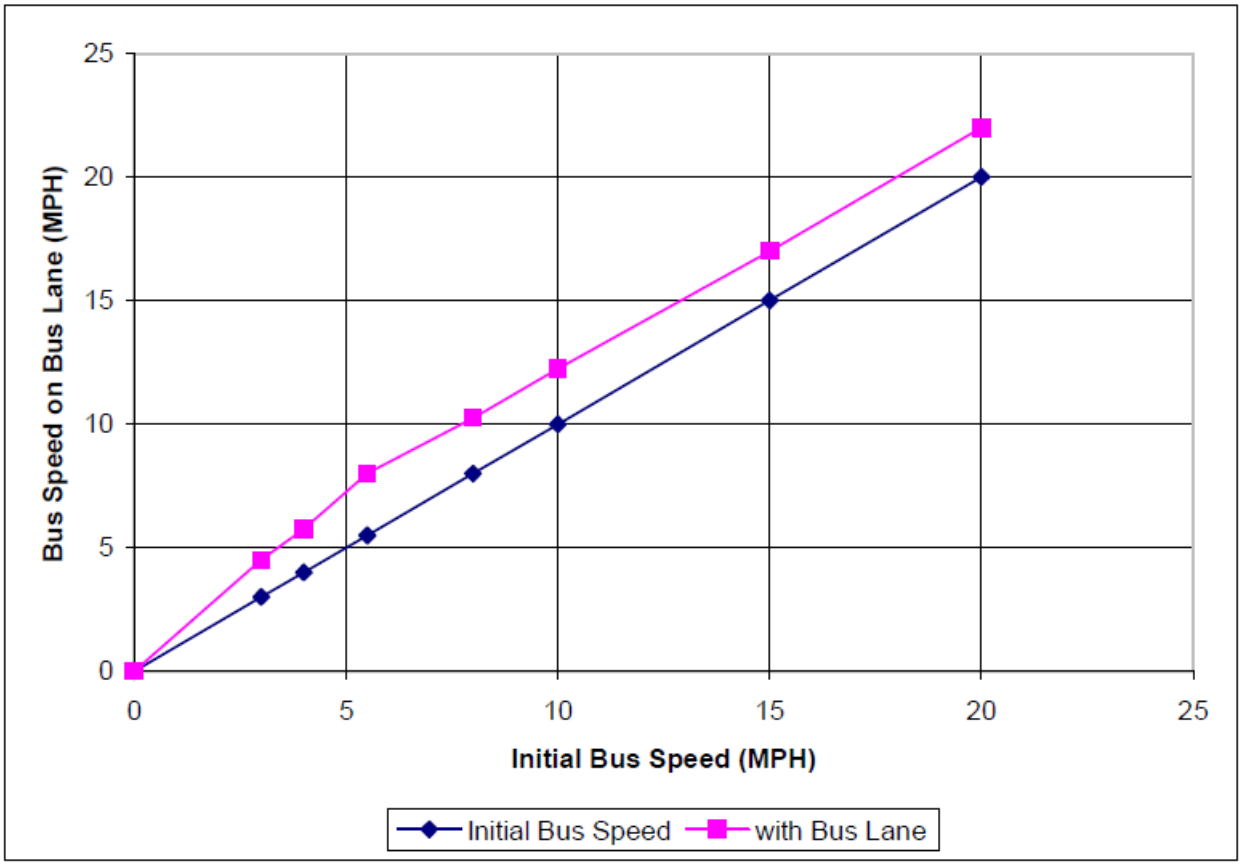
Figure 3: Effect of Transit Signal Priority on Intersection Delay (source: TCRP Report 118)



- Exclusive Bus Lane

  The bus travel time savings associated with an exclusive bus lane was estimated based on a % of base general traffic speed, then translated into travel time savings based on the length of the lane. The nomograph in Figure 3 (*from TCRP Report 118*) was used to estimate the increase in bus speed with an exclusive lane. This analysis was somewhat generic, as it didn't build in specific general traffic and conflicts which could also use a portion of the bus lane, but is felt to provide ballpark results.

Figure 4: Arterial Speeds With and Without Bus Lanes (source: TCRP Report 118)



It should be mentioned that the bus travel time savings specifically estimated aassociated with identified intersection priority treatments reflects an isolated traffic operations analysis using Synchro, and does not take into account the impact of extended queueing through a series of signalized intersections that might aggregqte existing bus delay. This impact could aonly be evaluated through much more estensive microsimulation modeling, in some cases needing to address multiple signals and a larger study area if extended queues though multiple intersections is apparent. Bus Operating Cost Savings

To translate bus travel time into operating cost savings, the peak period bus travel time savings was multiplied by the hourly bus "platform cost" from WMATA. This platform cost reflects the cost in revenue operation. The resultant calculations identify only weekday peak hour bus operating cost savings. As mentioned previously, because of a lack of traffic operations data outside of the weekday peak periods, total daily operating cost savings could not be estimated with any accuracy. Also the operating cost savings just related to a particular hot spot location, and thus it would not necessarily be reflective of overall route operating cost savings (particularly given any driver labor cost savings) given the entire route was not evaluated. Certainly the operating cost savings identified for a specific location

reflect some savings in fuel and indirectly vehicle maintenance costs. It should be reiterated that operating cost savings which were identified in the study are very conservative, as they were derived from travel time savings identified through use of isolated intersection relationships for queue jump signals and transit signal priority in the general traffic lanes, as well as use of base solated Synchro data to establish before and after traffic conditions.

3 EVALUATION RESULTS

3.1 DC Sites

3.1.1 14th Street

Layout Plan

The hot spot improvement on 14th Street focuses on development of a northbound bus lane between Corcoran Street and Irving Street. It was assumed that parking would need to be maintained on both sides of 14th, hence this limited the opportunity to develop a bus lane in only one direction. The northbound direction was deemed more critical for an exclusive bus lane treatment given the higher traffic volumes and greater congestion in that direction, particularly during the weekday PM peak period.

Two options for a northbound bus lane were developed. In the first option (refer to Figures A-1 through A-7), a full-time bus lane would be provided outside of the existing parking lane between Corcoran Street and Florida Avenue. North of Florida to Columbia Street, the bus lane would move next to the curb, as there is no parking lane. North of Columbia, the bus lane would replace the right general traffic lane to Irving Street, with a left turn lane drop developed at Columbia to carry one general traffic lane through that intersection. North of Irving, the bus lane would end and buses would merge back into a single general traffic lane which would continue north. Bikes would operate in the bus lane throughout the project corridor.

The second option (refer to Figures A-8 through A-14) would provide a wider 12.5-foot bus lane adjacent to the curb between Corcoran and Florida during weekday peak hours, then have this lane be used as a bike lane and for parking during off-peak periods, with buses operating in general traffic. North of Florida, a full-time bus lane would be developed with parking adjacent to the curb all the way to Irving Street. The outside general traffic lane would be converted to a bus lane in this segment. Bikes would operate in the bus lane with buses in this segment.

Capital Cost Estimate

The breakdown of capital costs for options 1 and 2 are presented in Tables A-1 and A-3. Option 1 would cost $281,000, and option 2 would cost $315,000. All of the costs relate to pavement marking removal, and new pavement markings and signage to designate the exclusive bus lanes.

Impact Assessment

A. Traffic Level of Service

The existing travel speeds for vehicles in the 14th Street study corridor, based on the existing Synchro model data for this corridor, is summarized in Table 1. The speed in the weekday AM peak hour is slowest in the inbound (southbound) direction, and in the weekday PM hour is slowest in the outbound (northbound) direction. All intersections in the corridor operate a level of service C or better, with the exception of Park Road, which operates at a level of service F in both peak hours.

Table 1: Existing General Traffic Speeds – 14th Street – Corcoran to Irving

Corridor	Peak Time Period	Avg Speed (mi/hr)
North Capitol St	AM	SB 10.2, NB 11.3
	PM	SB 13.0, NB 9.6

An evaluation of the impact of dropping one travel lane along the segment of 14th between Florida Avenue and Columbia Street where there is no bike lane was also assessed (see Table 2). The preliminary analysis does show some impact (LOS E) particularly in the affected direction.

Table 2: Traffic Operations Analysis – Creation of Transit-only Lane on 14th Street

Florida	HCM Avg. Control Delay (sec.)	HCM V/C Ratio	HCM LOS
Existing AM	12.2	0.52	B
After removal of 1 travel lane - AM	12.5	0.52	B
Existing PM	19.3	0.53	B
After removal of 1 travel lane - PM	21.3	0.72	C
Clifton - South Leg	**HCM Avg. Control Delay (sec.)**	**HCM V/C Ratio**	**HCM LOS**
Existing AM	5.6	0.34	A
After removal of 1 travel lane - AM	7	0.34	A

Existing PM	4.5	0.31	A
After removal of 1 travel lane - PM	7.7	0.56	A
Clifton - North Leg	**HCM Avg. Control Delay (sec.)**	**HCM V/C Ratio**	**HCM LOS**
Existing AM	5.4	0.32	A
After removal of 1 travel lane - AM	5.4	0.32	A
Existing PM	5.9	0.3	A
After removal of 1 travel lane - PM	6.1	0.53	A
Euclid	**HCM Avg. Control Delay (sec.)**	**HCM V/C Ratio**	**HCM LOS**
Existing AM	10.4	0.59	B
After removal of 1 travel lane - AM	10.7	0.59	B
Existing PM	13.2	0.52	B
After removal of 1 travel lane - PM	15.8	0.78	B
Fairmont	**HCM Avg. Control Delay (sec.)**	**HCM V/C Ratio**	**HCM LOS**
Existing AM	4.9	0.41	A
After removal of 1 travel lane - AM	5.3	0.41	A
Existing PM	8.1	0.37	A
After removal of 1 travel lane - PM	15.8	0.66	B
Girard	**HCM Avg. Control Delay (sec.)**	**HCM V/C Ratio**	**HCM LOS**
Existing AM	9.4	0.39	A
After removal of 1 travel lane - AM	9.6	0.39	A
Existing PM	4.3	0.35	A
After removal of 1 travel lane - PM	9.3	0.64	A
Harvard	**HCM Avg. Control Delay (sec.)**	**HCM V/C Ratio**	**HCM LOS**
Existing AM	8	0.5	A
After removal of 1 travel lane - AM	8	0.5	A
Existing PM	8.2	0.45	A
After removal of 1 travel lane - PM	11.4	0.7	B
Columbia	**HCM Avg. Control Delay (sec.)**	**HCM V/C Ratio**	**HCM LOS**
Existing AM	12.4	0.62	B
After removal of 1 travel lane - AM	12.5	0.67	B

Existing PM	21.5	0.67	C
After removal of 1 travel lane - PM	57.4	0.95	E

B. Bus Travel Time/Operating Cost Savings

Through use of Figure 3, an estimated travel time savings of 2.1 miles per hour with the identified 14th Street bus lane options was identified. Applying this unit of travel time savings, the breakdown of travel time and operating cost savings for options 1 and 2 are presented in Tables A-2 and A-4. Based only on weekday peak-hour bus volumes, Option 1 (NB all-day bus lane – Corcoran to Irving) was estimated to yield an annual time savings of 317.2 platform hours, while option 2 was estimated to yield an annual time savings of about 630 hours. This translates into a 20-year cost savings (discounted) of about $530,000 for option 1 and about $1,055,000 for option 2 (See Table 3). All of the savings are based on a conservative estimate utilizing WMATA's 2013 per-platform hour cost for non-regional service.

Table 3: Estimated Bus Travel Time/Operating Cost Savings for 14th Street Bus Lane Options (from Synchro Data)

Improvement	Annual Time Savings (platform hr)	Annual Cost Savings	5-year cost savings (discounted)	20-year cost savings (discounted)
Option 1 – NB All-Day Bus Lane, Corcoran to Irving	**317.2**	**$34,952**	**$164,586**	**$531,514**
Option 2 – NB All-Day Bus Lane, Florida to Irving; 2-Way Peak Period Bus Lane, Corcoran to Florida	**629.9**	**$69,406**	**$326,822**	**$1,055,441**

It should be noted that the identified bus travel time savings did not account for specific local driveway and right turn traffic in the lane nor any interference between buses operating in the lane, as this information was not available. Further evaluation of specific conditions in a 14th Street bus lane would warrant further study. A new bus lane capacity analysis tool being developed for the Third Edition of the TRB Transit Capacity and Quality of Service Manual would be oe tool which could be used for this analysis when available.

3.1.2 North Capitol Street

Layout Plan

The hot spot improvement developed for North Capitol Street consists of conversion of the outside through lane in the southbound direction on the North Capitol Road frontage road to a bus-only lane, from Q Street to New York Avenue. The layout plan is presented in Figure B-1. The bus lane would have an 11-foot width. At New York Avenue, a queue jump signal would be provided to get southbound buses back into the through lane south of the intersection.

Capital Cost Estimate

The breakdown of capital costs is presented in Table B-1. The estimated total cost is $397,000. Most of the construction cost would be associated with development of the queue jump signal at New York Avenue.

Impact Assessment

A. Traffic Operations

Two alternatives were modeled for North Capitol Street. Adjusting the splits to favor the North Capitol approaches – 10 seconds were shifted – failed to produce significant improvement to those approaches. The effect on the intersection as a whole was negligible in the weekday AM peak but detrimental in the PM peak. The conversion of the right turn lane into a bus only lane with a bus only phase resulted in minor changes for the intersection as a whole. It was assumed the bus lane would extend the entire length of the North Capitol St service road to north of O Street (460 ft), confining all general purpose traffic to one lane. The results for the existing and alternative conditions are summarized in Table 3.

Table 4: Traffic Operations Analysis – North Capitol Street

New York /N. Capitol SB RAMP	HCM Avg. Control Delay (sec.)	HCM V/C Ratio	HCM LOS	SB Approach LOS
Existing AM	9	0.61	A	D
Queue Jump & Bus Lane Conversion AM	11.6	0.67	B	D
Split Adjustment AM	8.9	0.61	A	D
Existing PM	14.2	0.75	B	D
Queue Jump & Bus Lane Conversion PM	16.9	0.87	B	D
Split Adjustment PM	61.3	0.8	E	D

New York/N. Capitol NB RAMP	HCM Avg. Control Delay (sec.)	HCM V/C Ratio	HCM LOS
Existing AM	9.7	0.61	A
Queue Jump & Bus Lane Conversion AM	12	0.66	B
Split Adjustment AM	9.6	0.61	A
Existing PM	14.3	0.83	B
Queue Jump & Bus Lane Conversion PM	9.3	0.82	A
Split Adjustment PM	65.7	0.89	E

B. Bus Travel Time/Operating Cost Savings

The bus travel time savings identified was much less than what might be expected with the the bus delays observed in the field, which showed bus delays ranging from 5 to 11 minutes during the AM peak and 3 to 11 minutes during the PM peak on the southbound service road approach. This is reflective of the extended queuing on New York Avenue that blocked bus movements on the service road for multiple cycles, precluding buses from turning onto New York Avenue or going through the intersection. In addition, buses turning onto New York Avenue were delayed waiting for pedestrians to cross the major street, as well as some semi-trailer trucks using both service road lanes to make their turns onto New York Avenue. Thus a broader subarea analysis would be an appropriate follow up to this study to identify what signal timing and added improvements could be achieved to reduce the New York Avenue queuing and hence reduce delay for North Capitol buses. This assessment would be facilitated through use of microsimulation.

3.2 Maryland Sites

3.2.1 Wheaton Station Area

Layout Plan

The hot spot improvements in the Wheaton Metrorail Station area consist of: 1) mid-block pedestrian signal on Reedie Drive at Triangle Lane 2) protected left turn phase from Veirs Mill Road to Reedie Avenue 3) extension of the eastbound left turn lane on Veirs Mill to the Wheaton station bus loop and 4) provision of new southbound bus stop on Georgia Avenue south of Reedie to better serve the adjacent Wheaton station. The concept plan drawing on Figure C-1 illustrates two of the improvements – the Veirs Mill turn lane modification and the new bus stop on Georgia.

Capital Cost Estimates

The breakdown of capital costs is presented in Table C-1. The estimated total cost is $563,000. Most of the construction cost would be associated with development of the new bus stop on Georgia and the id-block pedestrian signal on Reedie.

Impact Assessment

A. Traffic Operations

Several improvements were tested for the Wheaton/ Veirs Mill network. The first improvement would add a pedestrian signal at the midblock crossing on Reedie Drive Pedestrians were given 40 seconds to cross out of a 120 second cycle. The signal was assumed to be coordinated with the two adjacent signals at Veirs Mill/ Reedie and Georgia/ Reedie. This improvement actually resulted in a minor decrease in delay at the intersection of Reedie Driveand Veirs Mill Road - some WB vehicles on Reedie Drive are now queuing at the new pedestrian signal instead of waiting at the signals at Veirs Mill Road and Georgia Ave on each end of the street.

The second improvement would add a left turn phase from WB Reedie Drive to SB Viers Mill Road. This additional phase can be accommodated without any impact to level of service.

The third improvement would lengthen the turn lane from SB Veirs Mill Road to the bus loop from 140 ft to 240 ft and shorten the turn lane from NB Veirs Mill Rd to the mall from 315 ft to 215 ft. No operational impact to level of service occurred as a result of this change, and no queue spillback out of the turn lanes was noted.

The results for the existing and improvement conditions are summarized in Table 6.

Table 5: Wheaton Station Area Traffic Operations Analysis

Reedie/Wheaton Access at Veirs Mill Rd	HCM Avg. Control Delay (sec.)	V/C Ratio	HCM LOS
Existing AM	11.4	0.44	B
Reedie Crossing AM	11.1	0.44	B
Reedie Left Turn AM	13.6	0.48	B
Veirs Lane Extension AM	11.4	0.44	B
Existing PM	25.4	0.58	C
Reedie Crossing PM	25	0.58	C
Reedie Left Turn PM	38.5	0.61	D
Veirs Lane Extension PM	25.4	0.58	C

Bus Stop/Wheaton Access at Veirs Mill Rd	HCM Avg. Control Delay (sec.)	V/C Ratio	HCM LOS
Existing AM	3.2	0.36	A
Reedie Crossing AM	3.2	0.36	A
Reedie Left Turn AM	3.4	0.36	A
Veirs Lane Extension AM	3.2	0.36	A
Existing PM	17.5	0.41	B
Reedie Crossing PM	17.5	0.41	**B**
Reedie Left Turn PM	14.4	0.41	B
Veirs Lane Extension PM	17.5	0.41	B

Reedie Dr. at MD 97	HCM Avg. Control Delay (sec.)	V/C Ratio	HCM LOS
Existing AM	8.6	0.55	A
Reedie Crossing AM	8.5	0.55	A
Reedie Left Turn AM	7.5	0.55	A
Veirs Lane Extension AM	8.6	0.55	A
Existing PM	22.8	0.65	C
Reedie Crossing PM	22.7	0.65	C
Reedie Left Turn PM	22.6	0.65	C
Veirs Lane Extension PM	22.8	0.65	C

B. Bus Travel Time/Operating Cost Savings

The bus travel time savings associated with the signal modifications on Reedie Drive focus on a reduction in time buses are stopped waiting for random pedestrian crossings of the street and with the new protected left turn phase at Veirs Mill, and some reduction in delay associated with providing a protected left turn phase for buses on Reedie Drive at Veirs Mill Road. On Veirs Mill Road, the extension of the eastbound left turn lane to the bus loop intersection would reduce bus travel time by getting buses around the peak period general traffic on this approach. The specific travel time savings with these improvements were difficult to measure using Synchro, as like North Capitol Street, the impact of multiple closely spaced signals is causing some extended queue backup. Use of microsimulation to more closely evaluate bus travel time and operating cost savings would be appropriate in further operational analysis.

3.2.2 Piney Branch Road

Layout Plan

The hot spot improvements along the Piney Branch Road corridor are focused in the northbound direction, and include new queue jump signals at Thayer Place, Flower Avenue, and University Drive, and right turn lane extensions at Thayer and University. Transit signal priority is also provided at five intersections: Sligo Avenue, Dale Avenue, Sligo Creek Parkway, Greenwood Avenue, Arliss Street, and Barron Street. The layout plans are illustrated in Figures D-1 through D-5.

Capital Cost Estimates

The breakdown of capital costs is presented in Table D-1. The estimated total cost is $1,933,000. Most of the construction cost would be associated with the two right turn lane extensions and transit signal priority/queue jump signal treatments at nine intersections.

Impact Assessment

A. Traffic Operations

Along Piney Branch Road, the first improvement modeled includes queue jumps and Transit Signal Priority (bus only phases) along Piney Branch where right turn lanes currently exist – northbound at Dale Dr, northbound at Flower Ave, and southbound at University Blvd.

For the second improvement, in addition to the queue jumps and bus only phases, an added right turn/queue jump lane and bus only phase going northbound on Piney Branch at University Blvd was modeled. The maximum queue observed for the right turn lane being added was 250 ft.

Table 8 summarizes the results for the existing and improvement conditions. There are no traffic operational issues at any intersections under the improvement conditions, with the exception of University Blvd. At that location, the extension rightturn lane improves operations, but the queue jump signal bus phase hurts.

Table 6: Traffic Operations Analysis – Piney Branch Road

Sligo Ave	HCM Avg. Control Delay (sec.)	HCM V/C Ratio	HCM LOS
Existing AM	17.2	0.72	B
TSP Along Piney Branch – AM	17.4	0.72	B
Existing PM	19	0.54	B
TSP Along Piney Branch - PM	19	0.54	B

Dale Dr	HCM Avg. Control Delay (Sec.)	HCM V/C Ratio	HCM LOS
Existing AM	10.8	0.56	B
NB Queue Jump Along Piney Branch – AM	11.9	0.59	B
Existing PM	6.3	0.56	A
NB Queue Jump Along Piney Branch - PM	8.8	0.59	A

Sligo Creek Pkwy	HCM Avg. Control Delay (sec.)	HCM V/C Ratio	HCM LOS
Existing AM	31.8	0.65	C
TSP Along Piney Branch – AM	31.7	0.65	C
Existing PM	26.2	0.66	C
TSP Along Piney Branch - PM	25.1	0.66	C

Flower Ave	HCM Avg. Control Delay (sec.)	HCM V/C Ratio	HCM LOS
Existing AM	26.7	0.4	C
NB Queue Jump Along Piney Branch - AM	25.8	0.4	C

Existing PM	30	0.45	C
NB Queue Jump Along Piney Branch - PM	29	0.46	C

Greenwood Ave	HCM Avg. Control Delay (sec.)	HCM V/C Ratio	HCM LOS
Existing AM	1.5	0.28	A
TSP Along Piney Branch – AM	1.5	0.28	A
Existing PM	7.4	0.27	A
TSP Along Piney Branch - PM	7.4	0.27	A

Arliss St	HCM Avg. Control Delay (sec.)	HCM V/C Ratio	HCM LOS
Existing AM	16.1	0.48	B
TSP Along Piney Branch – AM	16.9	0.48	B
Existing PM	21.4	0.46	C
TSP Along Piney Branch - PM	21.7	0.46	C

Barron St	HCM Avg. Control Delay (sec.)	HCM V/C Ratio	HCM LOS
Existing AM	8.7	0.49	A
TSP Along Piney Branch – AM	8.9	0.49	A
Existing PM	7.6	0.46	A
TSP Along Piney Branch - PM	7.8	0.46	A

University Blvd	HCM Avg. Control Delay (sec.)	HCM V/C Ratio	HCM LOS
Existing AM	78.5	0.85	E
Queue Jump Along Piney Branch - AM	85.9	0.89	F
Queue Jumps plus extended right turn lane at University Blvd – AM	89.6	0.94	F
Existing PM	71	0.9	E

Queue Jump Along Piney Branch - PM	78.3	0.95	E
Queue Jump plus extended right turn lane at University Blvd – PM	71	0.87	E

Piney Branch Rd	Arterial Travel Time EB (sec.)	Arterial Travel Time WB (sec.)
Existing AM	302.4	338.8
Queue Jumps Along Piney Branch - AM	317.7	351.8
Queue Jumps plus new turn lane at University Blvd - AM	328.8	357.7
Existing PM	346.4	338.3
Queue Jumps Along Piney Branch - PM	355.7	346.9
Queue Jumps plus new turn lane at University Blvd - PM	326.8	346.9

B. Bus Travel Time/Operating Cost Savings

The breakdown of operating cost savings for the proposed queue-jumps and transit signal priority along Piney Branch Road are detailed in Tables D-2 and D-3, and summarized in Table D-9. Based only on weekday peak-hour bus volumes, the identified improvements are estimated to reduce today bus travel time by 639 hours, with an operating cost savings of roughly $1.07 million over the next 20 years. Most of the savings occurs at Arliss Avenue, University Blvd., Sligo Avenue, and Sligo Creek Parkway. All of the savings are based on a conservative estimate utilizing WMATA's 2013 per-platform hour cost for non-regional service.

Table 9: Estimated Bus Travel Time/Operating Cost Savings for Piney Branch Road (from Synchro Data)

Improvement	Annual Platform Hour Savings	Annual Operating Cost Savings	5-year cost savings (discounted)	20-year cost savings (discounted)
Queue-Jumps				
At Devon/Dale (NB only)	0.6	$62	$294	$948
At Flower Ave (NB only)	37.4	$4,117	$19,387	$62,609
At University Boulevard	135.0	$14,879	$70,062	$226,260
Subtotals	*173.0*	*$19,058*	*$89,743*	*$289,817*
Transit Signal Priority				
At Arliss	192.4	$21,201	$99,831	$322,817
At Devon/Dale	15.1	$1,663	$7,833	$25,296
At Barron	51.2	$5,641	$26,562	$85,778
At Greenwood	15.4	$1,699	$8,003	$25,844

At Sligo Creek Pkwy	92.6	$10,201	$48,037	$155,131
At Sligo Ave	99.6	$10,972	$51,668	$166,857
Subtotals	*466.3*	*$51,378*	*$241,933*	*$781,301*
Totals	**639.2**	**$70,436**	**$331,676**	**$1,071.118**

3.3 Virginia Sites

3.3.1 Van Dorn Street

Layout Plan

The hot spot improvements along Van Dorn Street from Franconia Road to Eisenhower Avenue in Alexandria initially were identified as northbound queue jump treatments from existing left turn lanes at Chrysanthemum Drive, Crown Royal Drive, and Oakwood Road, a new inside northbound bus-only lane at the north I-95 ramp, and construction of a second southbound left turn lane sat Eisenhower Avenue. The bus-only lane at the I-95 ramp would be developed in the existing gore area between the dual left turn lanes and through lanes, which would be converted into a queue jump lane of 240 ft. However, when evaluating the impact on bus operations of the use of existing left turn lanes for queue jumps at the three intersections, a major increase in bus delay was identified. This led to a downscaling of physical improvements to just include the new bus-only lane at the I-95 ramp, and the left turn lane addition at Eisenhower. At the other intersections, transit signal priority is assumed. The resultant concept plan drawings for the Van Dorn corridor are presented in Figures E-1 through E-5.

Capital Cost Estimate

The breakdown of capital costs is presented in Table E-1. The total cost estimate is $1,059,000. Most of the cost is in new signalization and development of the second southbound left turn lane at Eisenhower.

Impact Assessment

A. Traffic Operations

For the Van Dorn/Eisenhower intersection, a second SB left turn lane was modeled, and in both weekday peak periods it proves to be of operational benefit. Multiple simulation runs were undertaken to determine the lengths for the average and 95th percentile queue lengths. The worst case scenario was

a maximum queue of 312 feet in the AM peak. Based on the length of the existing SB left turn lane of 400 feet, the second left turn lane should be the same length.

The Van Dorn corridor between Chrysanthemum and the I-95 ramps was initially modeled to evaluate implementing TSP for buses using the left-turn or new auxiliary lanes in the northbound direction. The results show minor degradation of the northbound through movement due to the adjusted phasing/timing. However, as mentioned previously, a major increase in bus ldeay was observed. Given this, the Chrysanthemmum, Crown Royal and Oakwood intersections were evaluated assuming buses would stay in the general traffic lanes at those locations and transit signal priority would be implemented.

The transit signal priority assessment revealed a net reduction in bus delay but greater increase in general traffic delay. The results of the existing and alternative conditions are summarized in Table 7.

Table 7: Traffic Operations Analysis – Van Dorn Street

Van Dorn & Eisenhower	HCM Avg. Control Delay (sec.)	HCM V/C Ratio	HCM LOS
Existing AM (Van Dorn & Eisenhower)	57.3	0.96	E
2nd turn lane addition AM (Van Dorn & Eisenhower)	49.6	0.92	D
Existing PM (Van Dorn & Eisenhower)	42.6	0.74	D
2nd turn lane addition PM (Van Dorn & Eisenhower)	40.6	0.74	D

Van Dorn	HCM Avg. Control Delay (sec.)	HCM V/C Ratio	HCM LOS
Existing AM (Van Dorn & I-95 Ramps)	32.5	0.7	C
TSP AM (Van Dorn & I-95 Ramps)	33.7	0.68	C
Existing AM (Van Dorn & Oakwood Rd)	24.6	0.77	C
TSP AM (Van Dorn & Oakwood Rd)	27.6	0.78	C
Existing AM (Van Dorn & Crown Royal Dr)	12.1	0.63	B
TSP AM (Van Dorn & Crown Royal Dr)	12.5	0.66	B
Existing AM (Van Dorn & Chrysanthemum Dr)	9.3	0.62	A
TSP AM (Van Dorn & Chrysanthemum Dr)	10.6	0.67	B
Existing PM (Van Dorn & I-95 Ramps)	56.4	1.01	E
TSP PM (Van Dorn & I-95 Ramps)	58.1	1.01	E
Existing PM (Van Dorn & Oakwood Rd)	15.5	0.84	B
TSP PM (Van Dorn & Oakwood Rd)	16.2	0.84	B
Existing PM (Van Dorn & Crown Royal Dr)	9.6	0.86	A
TSP PM (Van Dorn & Crown Royal Dr)	9.9	0.86	A
Existing PM (Van Dorn & Chrysanthemum Dr)	6.7	0.73	A

TSP PM (Van Dorn & Chrysanthemum Dr)	7.9	0.73	A

B. Bus Travel Time/Operating Cost Savings

The breakdown of estimated bus travel time and operating cost savings for the TSP and queue jump improvements at the I-95, Chrysanthemum Drive, Oakwood Road, and Crown Royal Drive intersections are presented in Tables E-2 and E-3, and summarized in Table 12. Based solely on a review of Synchro model data with changes in signal timing to institute queue jump and transit signal priority treatments, the total estimated bus travel time savings is estimated today at about 70 hours annually, with an estimated 20-year bus operating cost savings of approximately $207,000. It is realized that because of some extended queueing on Van Dorn Street, that the full impact of bus travel time and operating cost savings might not be reflective of the Synchro data and isolated intersection assessment. Like at North Capitol Street, to more closely evaluate bus benefits, microsimulation could be applied. Also a longer green extension would further reduce bus delay, but could have a greater impact on general traffic delay for the more minor traffic movements.

Table 8: Estimated Bus Travel Time/Operating Cost Savings for Van Dorn Street (from Synchro Data)

Improvement	Annual Platform Hour Savings	Annual Operating Cost Savings	5-Year cost Savings (discounted)	20-Yesr Cost Savings (discounted)
Transit Signal Priority at Glebe Road and Arlington Boulevard EB ramp (NB only)	123.6	$13,617	$64,122	$207,075

3.3.2 Glebe Road/Arlington Road

Layout Plan

The hot spot improvement initially identified for Glebe Road at Arlington Blvd. was the conversion of the existing northbound bus pullout on the south side of the south Arlington ramp intersection to a bus queue jump lane. However, when obtaining the conceptual plans developed by VDOT for this interchange improvement, the pullout is shown to be integrated into a second through lane across a widened Glebe Road bridge over Arlington Blvd. Thus the original treatment was no longer applicable. Given this, an alternate bus priority treatment was identified, which would move the northbound bus stop to far side of the south Arlington ramp intersection, and provide a transit signal priority treatment at this location. The concept plan drawing for the improvement is identified in Figure F-1.

Capital Cost Estimate

The breakdown of capital costs is presented in Table F-1. The estimated total cost is $134,000, focused on the new transit signal priority treatments and new bus stop.

Impact Assessment

A. Traffic Operations

At the Glebe Rd/Arlington Blvd intersection, the extension of the green phase to give bus signal priority in the northbound direction caused only minor changes to the performance of the intersection (see Table 13).

Table 9: Traffic Operations Analysis – Glebe Road

Arlington EB & Glebe	HCM Avg. Control Delay (sec.)	HCM V/C Ratio	HCM LOS
Existing AM	15.5	0.7	B
TSP AM	19	0.76	B
Existing PM	11.7	0.67	B
TSP PM	14.1	0.72	B

Arlington WB & Glebe	HCM Avg. Control Delay (sec.)	HCM V/C Ratio	HCM LOS
Existing AM	14.3	0.56	B
TSP AM	14.7	0.56	B
Existing PM	16.8	0.69	B
TSP PM	18.7	0.7	B

B. Bus Travel Time/Operating Cost Savings

The breakdown of operating cost savings for the proposed transit signal priority on Glebe Road is detailed in Table F-2, and summarized in Table 14. Based only on weekday peak-hour bus volumes, this improvement is estimated to reduce bus travel time today by about 39 hours annually, with a 20-year bus operating cost savings of about $65,000. All of the savings are based on a conservative estimate utilizing WMATA's 2013 per-platform hour cost for non-regional service.

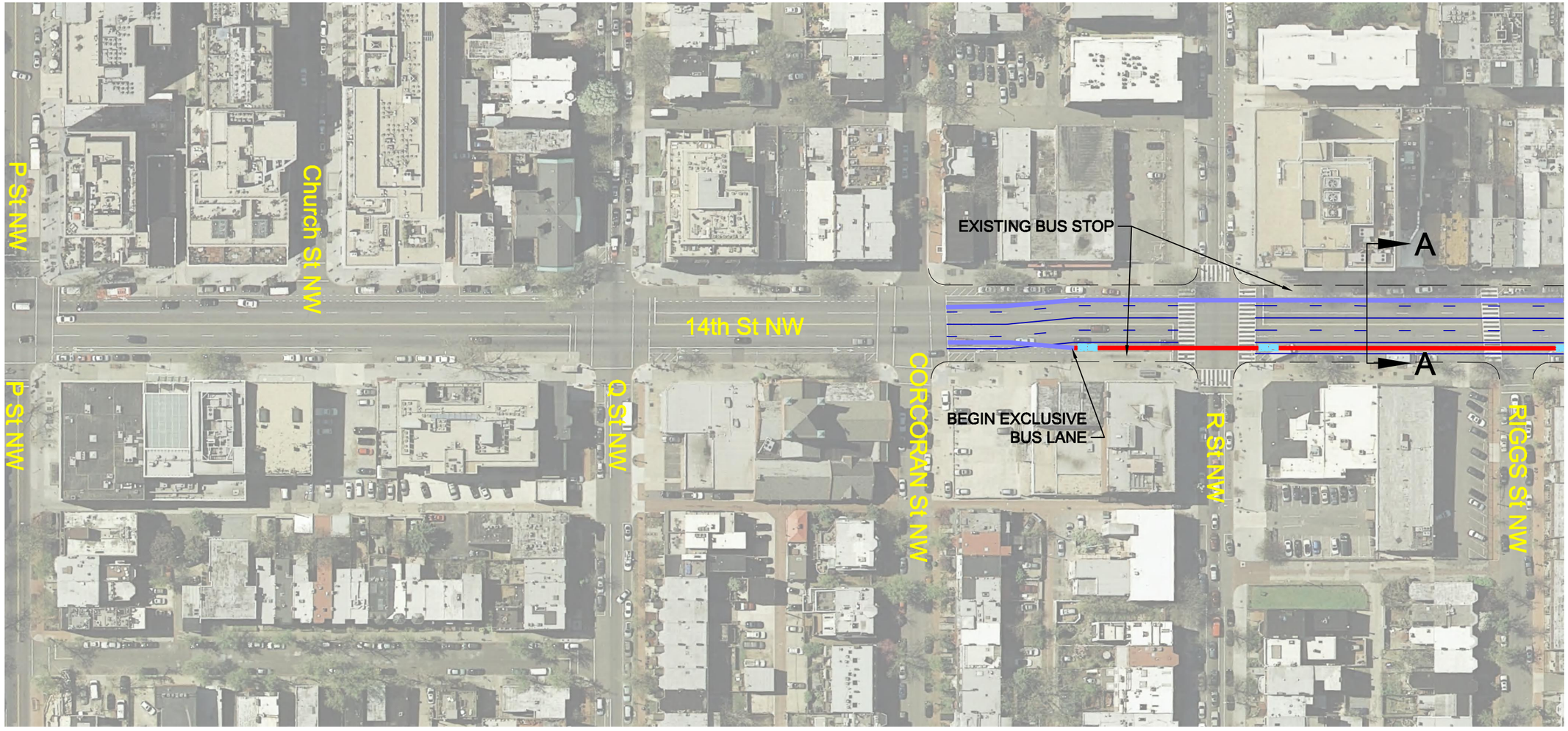
Table 10: Estimated Bus Travel Time/Operating Cost Savings for Glebe Road (from Synchro Data)

Improvement	Annual Platform Hour Savings	Annual Operating Cost Savings	5-Year cost Savings (discounted)	20-Yesr Cost Savings (discounted)
Transit Signal Priority at Glebe Road and Arlington Boulevard EB ramp (NB only)	38.9	$4,289	$20,197	$65,225

4.0 CONCLUSIONS

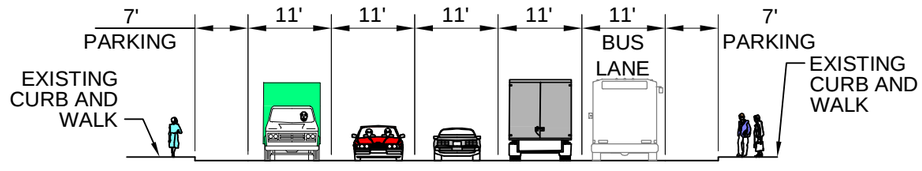
The Task 4 concept design analysis and impact assessment was intended to provide insights into the configuration, capital costs and potential benefits to bus operations of a number of different transit priority treatments and overall signal timing modifications at the six refined hot spots identified in Task 3 for such analysis. The development of the concept plans and capital costs at each site was a straight forward exercise. However, the impact assessment in certain locations, in particular at North Capitol Street, Wheaton Station Area, and Van Dorn Street may have underestimated bus travel time and operating cost savings given isolated intersection operations data from Sychro model files were applied, and the impact of extended queuing in establishing base bus delay was not fully identified. Further evaluation of the bus travel time and operating cost savings for all six sites is certainly warranted in further study, and consideration should be given to applying microsimulation to look at the impact of queuing and signal timing modifications to implement queue jump signals and transit signal priority in further detail.

APPENDIX A: 14TH STREET PLAN DRAWINGS AND DETAILED TABLES



LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
- BUS IN MIXED TRAFFIC
- QUEUE JUMP SIGNAL
- EXISTING SIGNAL PRIORITY UPGRADE
- RETAINING WALL
- X X X X DRIVEWAY CLOSED
- RIGHT IN/RIGHT OUT DRIVEWAY OR INTERSECTION
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE



SECTION A-A

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Figure A-1

14th Street NW, Otis Street to Corcoran Street

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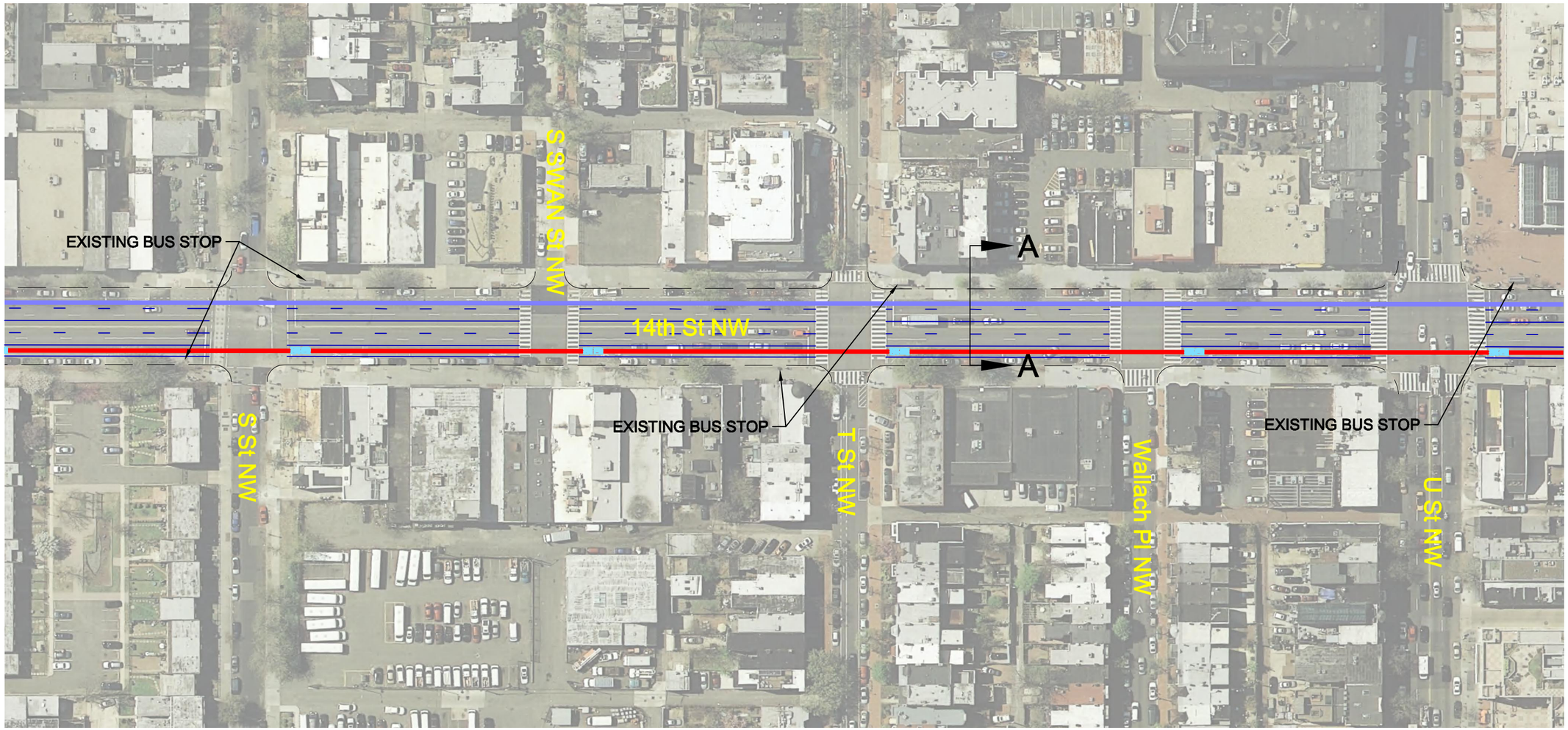
PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots



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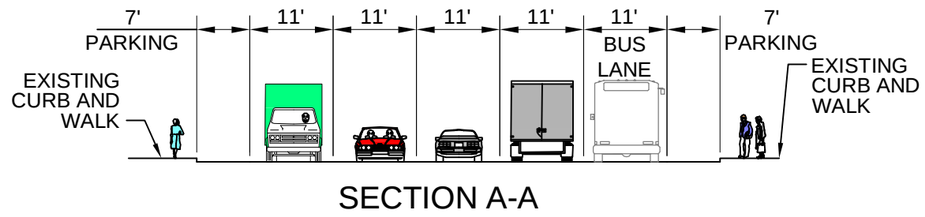
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE



SECTION A-A

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Figure A-2

14th Street NW, Otis Street to Corcoran Street

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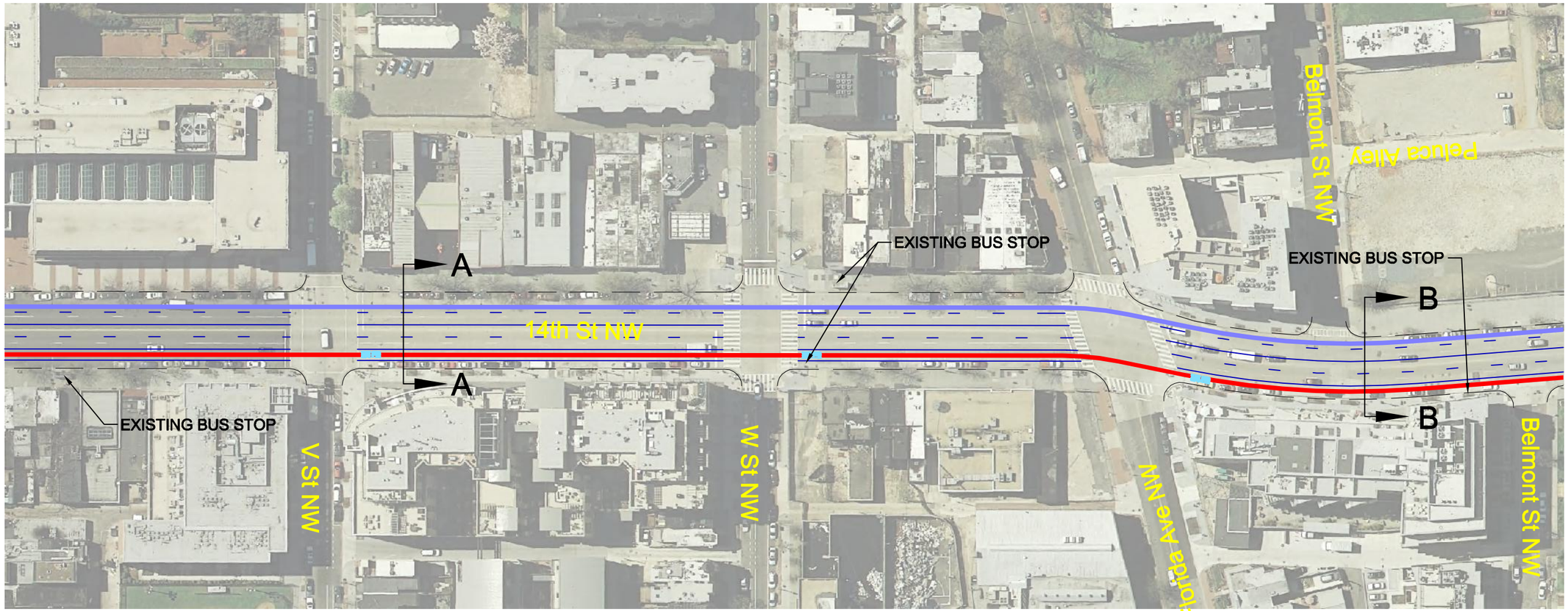
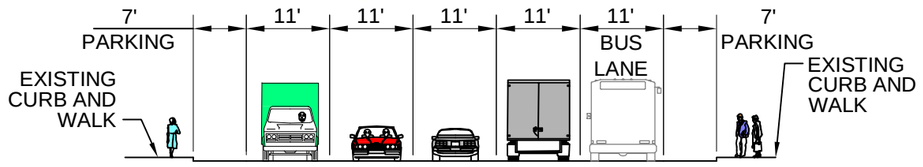
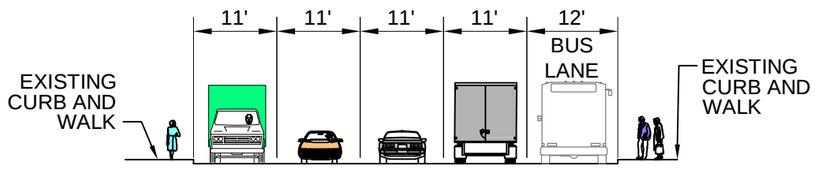
Multimodal Coordination For Bus Priority Hot Spots





SECTION A-A



SECTION B-B

LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
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- BIKE LANE

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Figure A-3

14th Street NW, Otis Street to Corcoran Street

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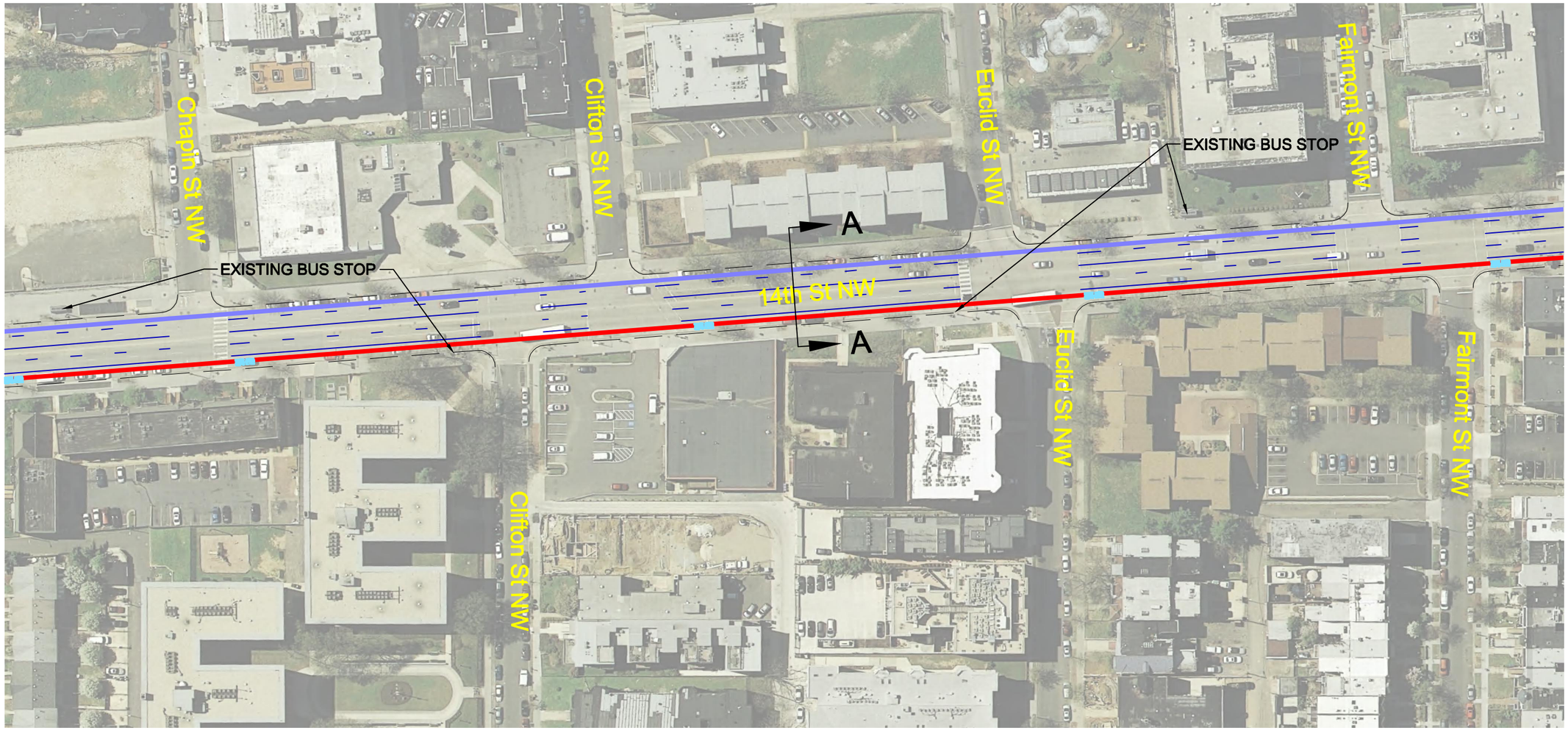
Multimodal Coordination For Bus Priority Hot Spots



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- AUTO DIRECTION OF TRAVEL
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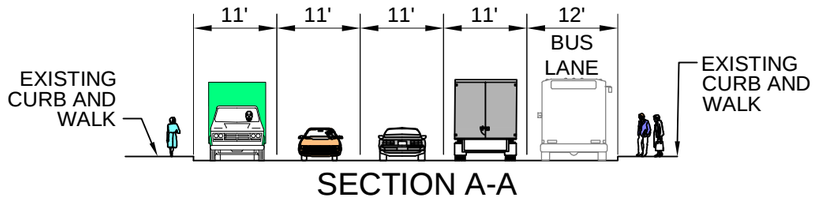

SECTION A-A

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Figure A-4

14th Street NW, Otis Street to Corcoran Street

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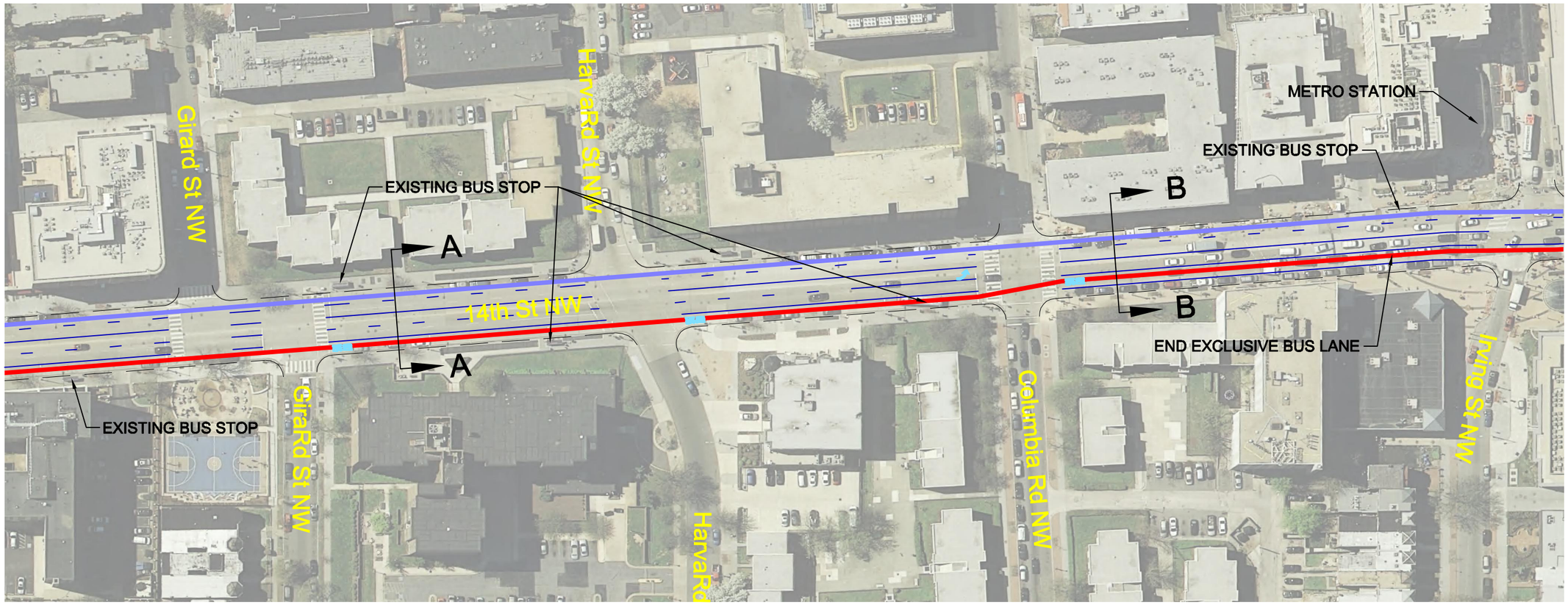
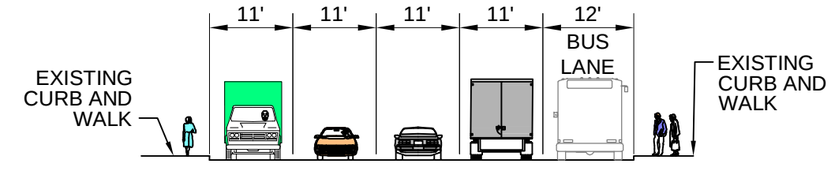
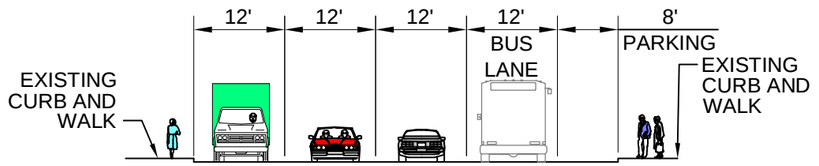
Multimodal Coordination For Bus Priority Hot Spots





SECTION A-A



SECTION B-B

LEGEND

- NEW CURB
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- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

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Figure A-5

14th Street NW, Otis Street to Corcoran Street

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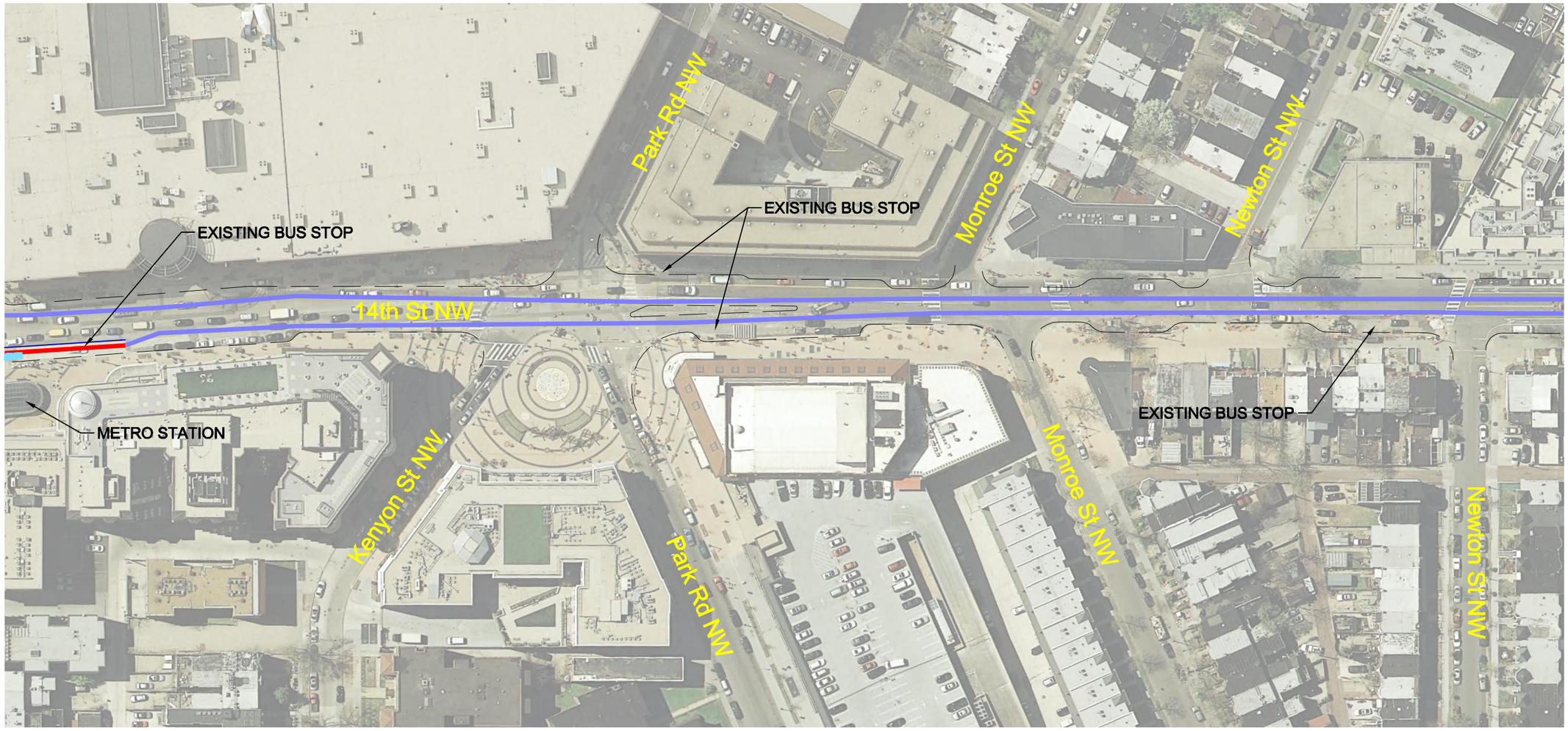
Multimodal Coordination For Bus Priority Hot Spots



LEGEND

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- BRT DIRECTION OF TRAVEL
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- BIKE LANE

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Figure A-6

14th Street NW, Otis Street to Corcoran Street

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Multimodal Coordination For Bus Priority Hot Spots

LEGEND

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- BIKE LANE

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Figure A-7

14th Street NW, Otis Street to Corcoran Street

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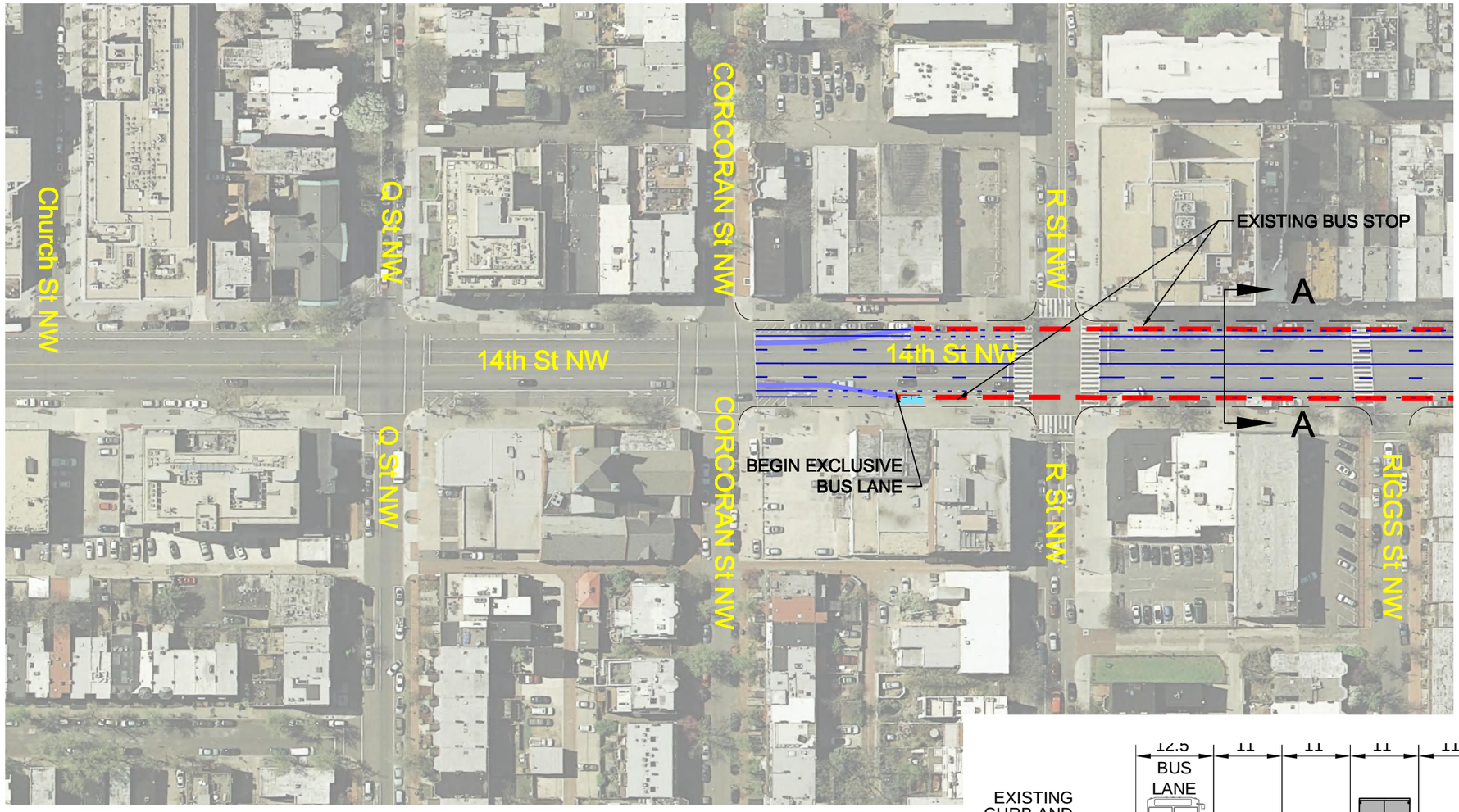
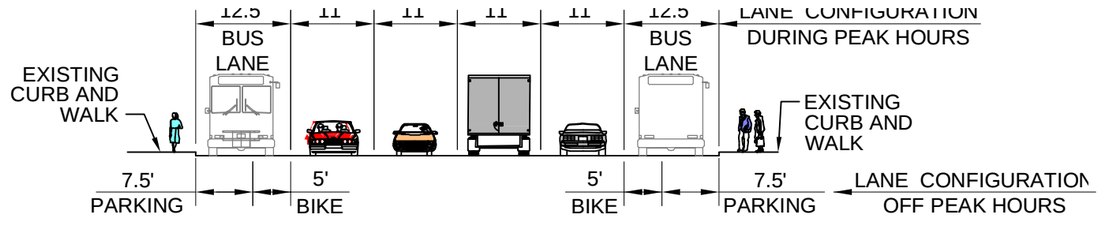
Multimodal Coordination For Bus Priority Hot Spots





SECTION A-A

LEGEND

- NEW CURB
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- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

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Figure A-8

14th Street NW, Otis Street to Corcoran Street Opt 2

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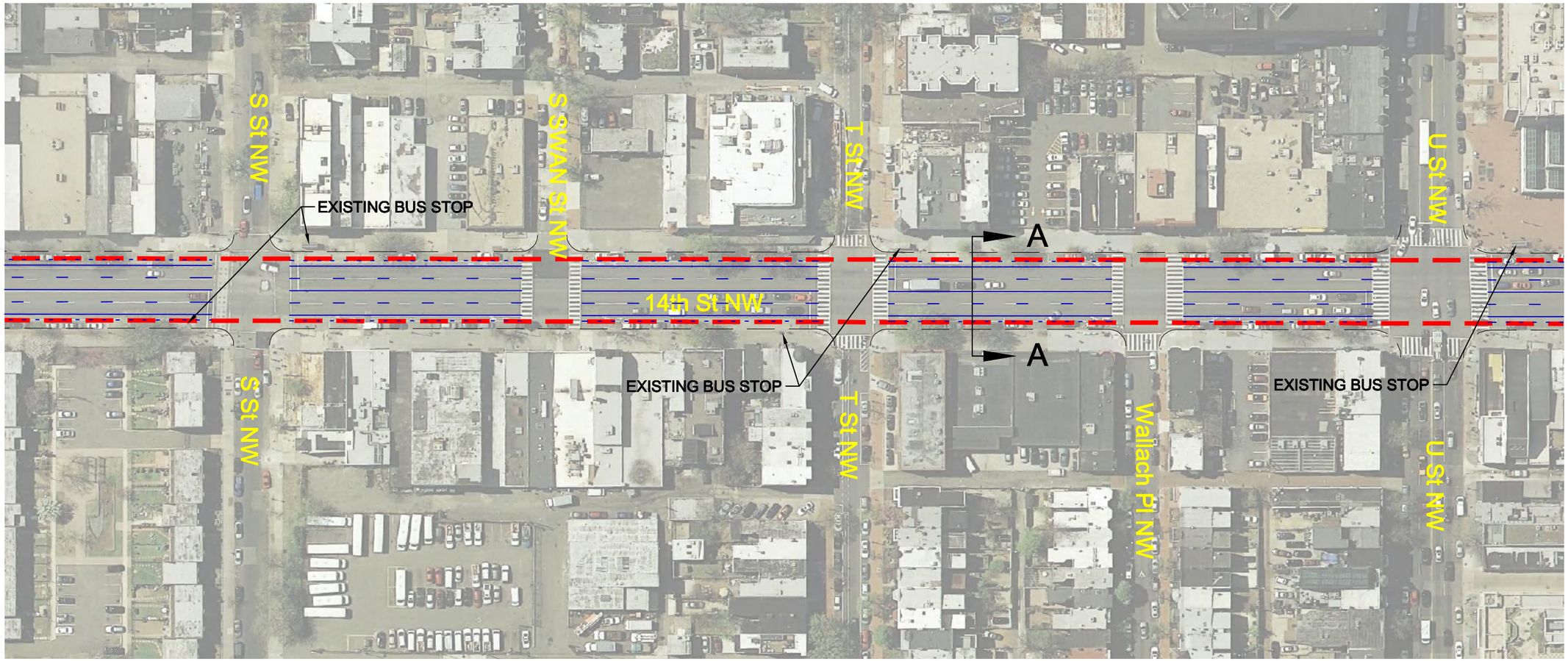
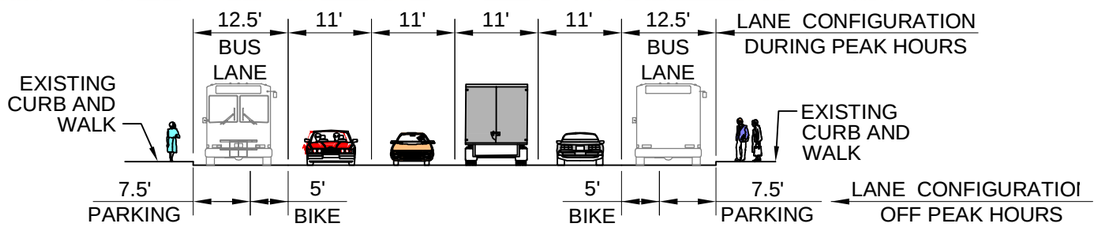
Multimodal Coordination For Bus Priority Hot Spots





SECTION A-A

LEGEND

- NEW CURB
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- NEW STRIPING
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- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
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- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 50' 100'

Figure A-9

14th Street NW, Otis Street to Corcoran Street Opt 2

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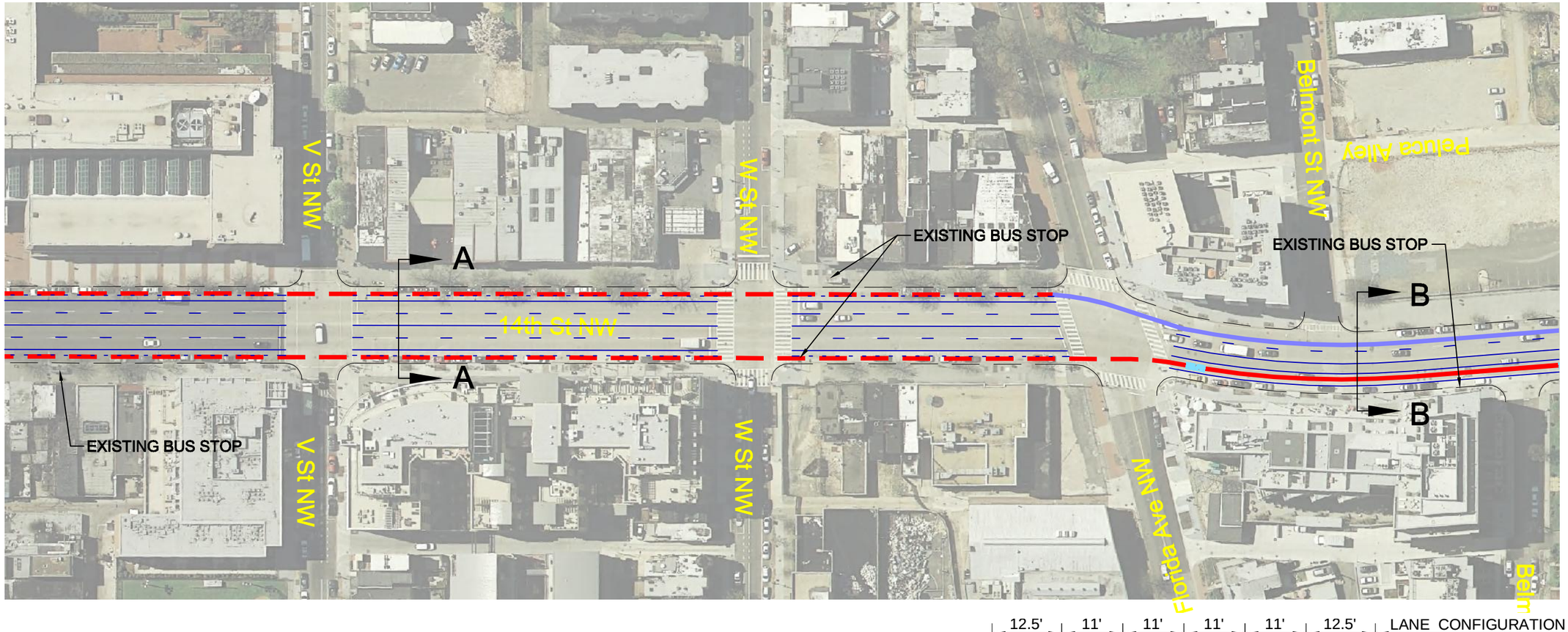
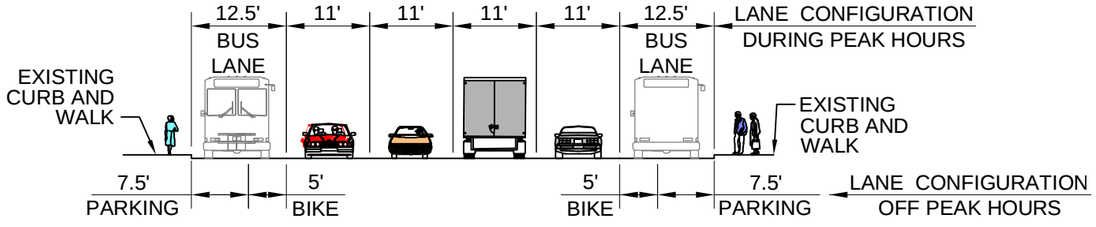
PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots





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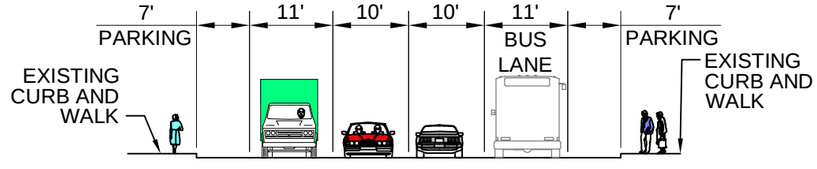

SECTION B-B

LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
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- RETAINING WALL
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- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

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Figure A-10

14th Street NW, Otis Street to Corcoran Street Opt 2

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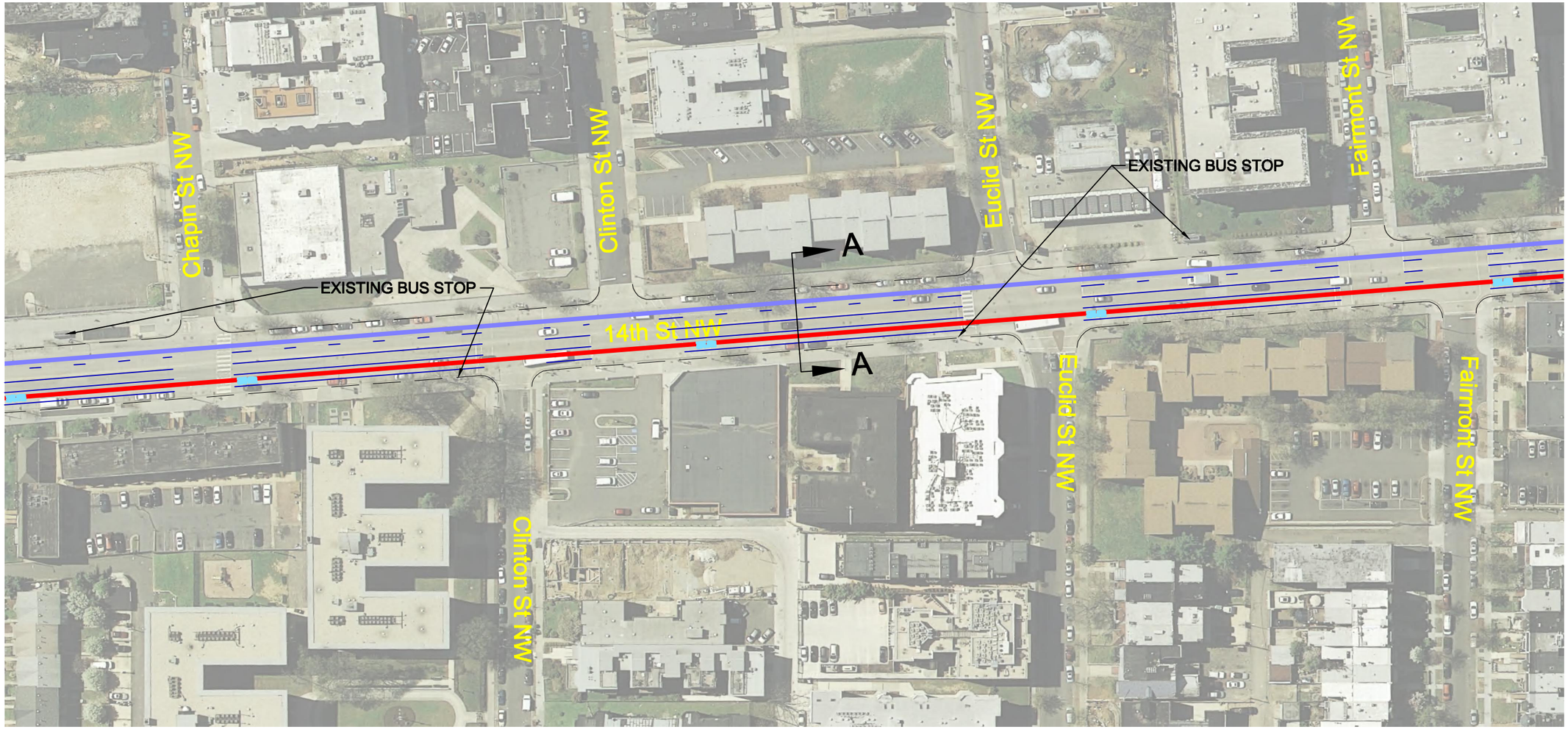
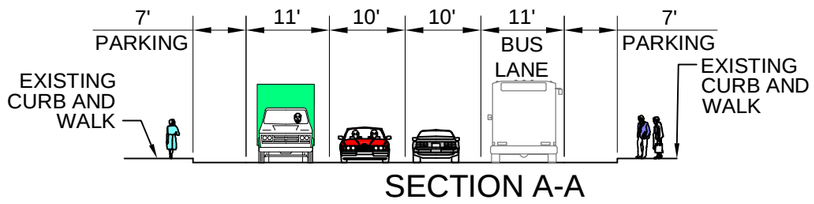
PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots



LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
- BUS IN MIXED TRAFFIC
- QUEUE JUMP SIGNAL
- EXISTING SIGNAL PRIORITY UPGRADE
- RETAINING WALL
- X X X X DRIVEWAY CLOSED
- RIGHT IN/RIGHT OUT DRIVEWAY OR INTERSECTION
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE



SECTION A-A

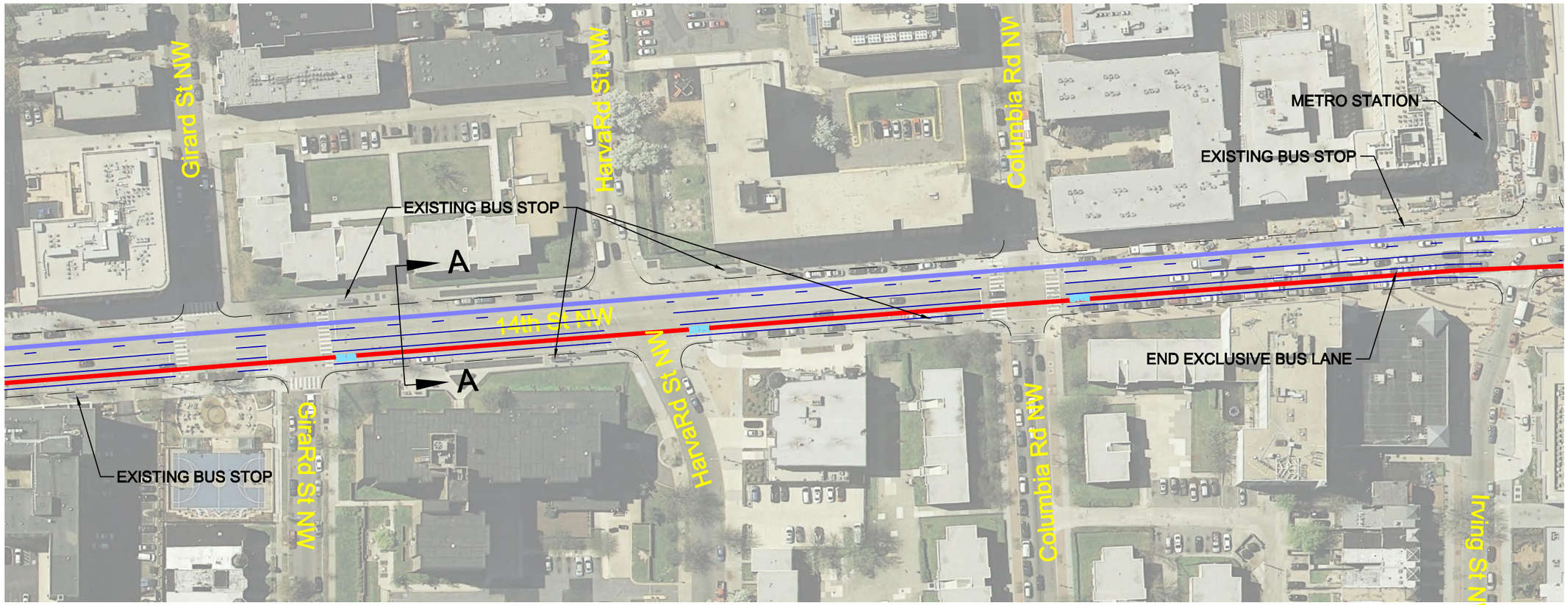
0 50' 100'

Figure A-11

14th Street NW, Otis Street to Corcoran Street Opt 2

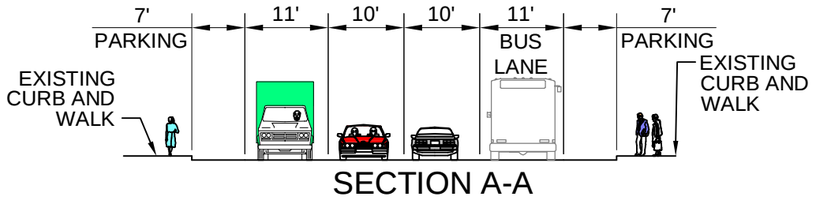
PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots



LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
- BUS IN MIXED TRAFFIC
- QUEUE JUMP SIGNAL
- EXISTING SIGNAL PRIORITY UPGRADE
- RETAINING WALL
- X X X X DRIVEWAY CLOSED
- RIGHT IN/RIGHT OUT DRIVEWAY OR INTERSECTION
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE



SECTION A-A

0 50' 100'

Figure A-12

14th Street NW, Otis Street to Corcoran Street Opt 2

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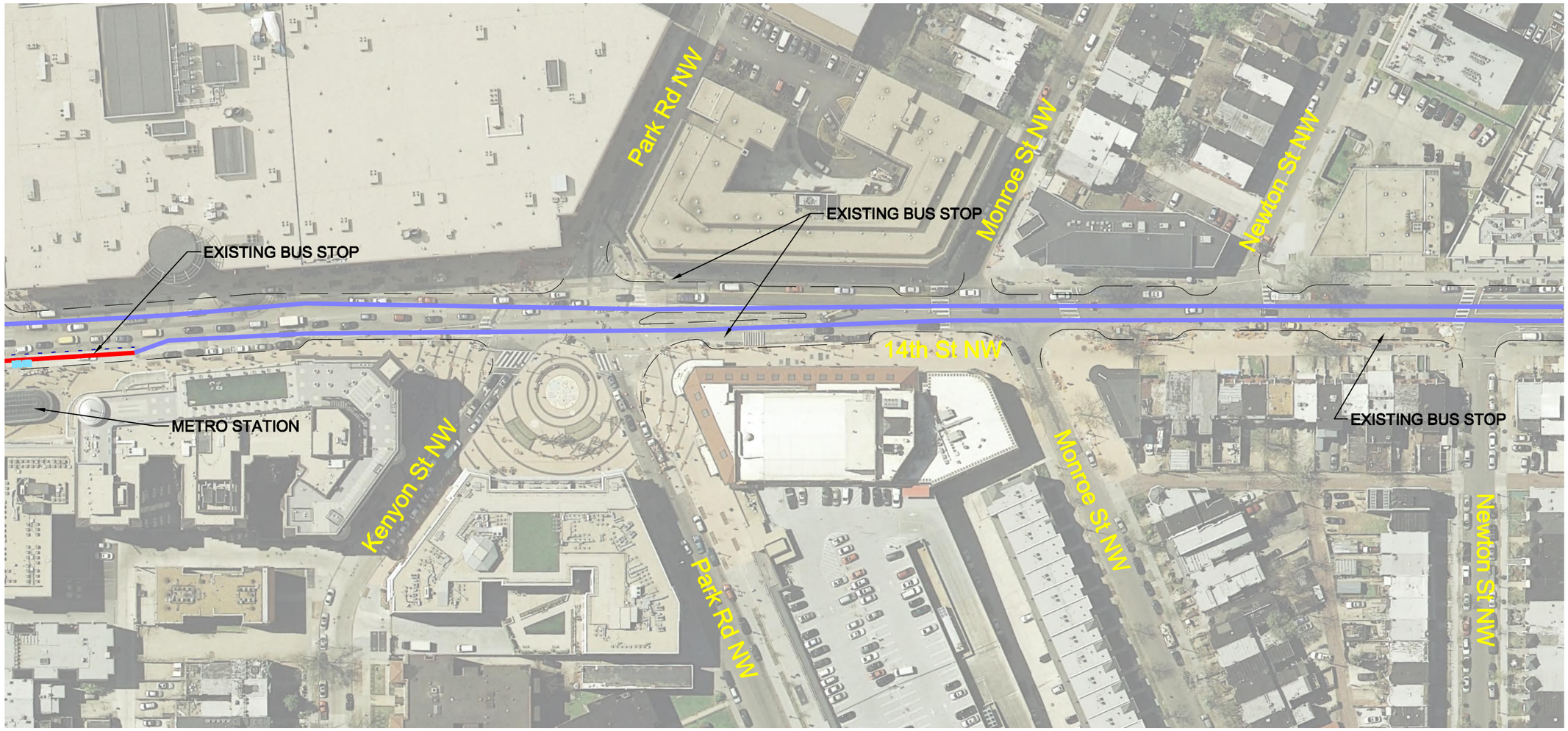
PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots



LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
- BUS IN MIXED TRAFFIC
- QUEUE JUMP SIGNAL
- EXISTING SIGNAL PRIORITY UPGRADE
- RETAINING WALL
- X X X X DRIVEWAY CLOSED
- RIGHT IN/RIGHT OUT DRIVEWAY OR INTERSECTION
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 50' 100'

Figure A-13

14th Street NW, Otis Street to Corcoran Street Opt 2

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PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots

LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
- BUS IN MIXED TRAFFIC
- QUEUE JUMP SIGNAL
- EXISTING SIGNAL PRIORITY UPGRADE
- RETAINING WALL
- X X X X DRIVEWAY CLOSED
- RIGHT IN/RIGHT OUT DRIVEWAY OR INTERSECTION
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 50' 100'

Figure A-14

14th Street NW, Otis Street to Corcoran Street Opt 2

K:\173294A-MWCOG-DC-BUS\CAD\CIVIL\14TH-STREET-OPT2 - 6/14/2012 8:45 AM

PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots

Table A-1: Capital Cost Estimate for 14th Street Option 1

Item	Quantity	Units	Unit Cost	TOTAL COST	Methodology
DEMOLITION					----------
Pavement Demolition		SY	$10	$0	
Striping Removal	20,950	LF	$1.50	$31,425	
PAVEMENT/EARTHWORK					----------
Clearing and Grubbing		AC	$50,000	$0	
Aggr. Base		TON	$25	$0	12" Depth
Asphalt Concrete - Base Course		TON	$70	$0	10" Depth
Asphalt Concrete - Wearing Course		TON	$90	$0	2" Depth
Dowelled PCC Concerte		SY	$75	$0	12" Depth, 4000 PSI
Remove/Backfill Unsuitable Matls		CY	$60	$0	
Pavement Planing		SY	$5	$0	Mill 1.5" for the section of pavement being overlayed
Sidewalk		SF	$5	$0	
Curb & Gutter		LF	$25	$0	
Excavation		CY	$25	$0	
TRAFFIC					----------
Traffic Signal - bus priority		EA	$32,500	$0	Includes signal priority parts and controller logic/programming incl controller and/or software upgrade
Traffic Signal - queue jump		EA	$32,500	$0	Includes traffic signal priority, bus signal heads, wiring
Striping	21,760	LF	$4	$87,040	
Pavement Legends	41	EA	$400	$16,400	
Signs	27	EA	$500	$13,500	
OTHER					----------
Grassed Median		SF	$8	$0	
Landscaping Area		SF	$5	$0	
Trees		EA	$800	$0	
Storm Sewer Pipe		LF	$70	$0	
No of Inlets		EA	$6,000	$0	
Streetlights		EA	$10,000	$0	

Item	Quantity	Units	Unit Cost	TOTAL COST	Methodology
Utility Pole Relocation		EA	$7,500	$0	
Retaining Wall		SF	$50	$0	
Bus Shelter		EA	$15,000	$0	
MOBILIZATION	1	LS	$15,000	$15,000	
Subtotal				**$163,000**	
Contingency	**35%**			**$57,000**	
Total Construction Estimate				**$220,000**	

SUPPORTING COSTS

Description	Percent		Total
PRELIMINARY ENGINEERING	2.50%		$6,000
FINAL DESIGN	6.00%		$13,000
CONSTRUCTION ENGINEERING	8.00%		$18,000
CHANGES DURING CONSTRUCTION	10.00%		$22,000
PUBLIC INVOLVEMENT	0.75%		$2,000
SUBTOTAL			**$61,000**

GRAND TOTAL	**$281,000**

ASSUMPTIONS

-Contingency covers unknown costs including MOT, E&S controls

-Date of Estimate: May 23, 2012

NOT INCLUDED

-Environmental Mitigation

-Permits

-Contract Incentives

-Utility Relocation

-Right of Way Acquisition

-Grade Separated Interchanges

Table A-2: Operating Cost Estimate for 14th Street Option 1

			Hotspot avg. speed (mph)	Speed w/ bus lane (mph)	Improvement (mph)						
		NB AM Peak	11.2	13.3	2.1						
		NB PM Peak	13	15.1	2.1						
	Segment			Time savings/bus (min)							
	From	To	Distance (miles)	NB AM Peak	NB PM Peak	AM bus volumes - NB	PM bus volumes - NB	Total daily time savings - NB (pl hr)	Annual time savings (pl hr)	FY13 non-regional platform hour cost	Annual operating cost savings (FY13 $$$)
Peak Hours	mid-block between Corcoran & R	Columbia	1.06	0.89	0.68	14	18	0.41	102.61	$110.19	$11,306.53
	Columbia	mid-block between Irving & Kenyon	0.11	0.10	0.07	8	12	0.03	6.82		$751.90
Peak Shoulders	mid-block between Corcoran & R	Columbia	1.06	0.72	0.54	27	51	0.78	194.99		$21,485.82
	Columbia	mid-block between Irving & Kenyon	0.11	0.08	0.06	15	33	0.05	12.78		$1,408.03
	Totals:		**2.34**	**1.78**	**1.35**			**1.27**	**317.20**		**$34,952.27**

Table A-3: Capital Cost Estimate for 14th Street Option 2

Item	Quantity	Units	Unit Cost	TOTAL COST	Methodology
DEMOLITION					----------
Pavement Demolition		SY	$10	$0	
Striping Removal	20,950	LF	$1.50	$31,425	
PAVEMENT/EARTHWORK					----------
Clearing and Grubbing		AC	$50,000	$0	
Aggr. Base		TON	$25	$0	12" Depth
Asphalt Concrete - Base Course		TON	$70	$0	10" Depth
Asphalt Concrete - Wearing Course		TON	$90	$0	2" Depth
Dowelled PCC Concerte		SY	$75	$0	12" Depth, 4000 PSI
Remove/Backfill Unsuitable Matls		CY	$60	$0	
Pavement Planing		SY	$5	$0	Mill 1.5" for the section of pavement being overlayed

Item	Quantity	Units	Unit Cost	TOTAL COST	Methodology
Sidewalk		SF	$5	$0	
Curb & Gutter		LF	$25	$0	
Excavation		CY	$25	$0	
TRAFFIC					----------
Traffic Signal - bus priority		EA	$32,500	$0	Includes signal priority parts and controller logic/programming incl controller and/or software upgrade
Traffic Signal - queue jump		EA	$32,500	$0	Includes traffic signal priority, bus signal heads, wiring.
Striping	26,770	LF	$4	$107,080	
Pavement Legends	20	EA	$400	$8,000	
Signs	39	EA	$500	$19,500	
OTHER					----------
Grassed Median		SF	$8	$0	
Landscaping Area		SF	$5	$0	
Trees		EA	$800	$0	
Storm Sewer Pipe		LF	$70	$0	
No of Inlets		EA	$6,000	$0	
Streetlights		EA	$10,000	$0	
Utility Pole Relocation		EA	$7,500	$0	
Retaining Wall		SF	$50	$0	
Bus Shelter		EA	$15,000	$0	
MOBILIZATION	1	LS	$17,000	$17,000	
Subtotal				**$183,000**	
Contingency	**35%**			**$64,000**	
Total Construction Estimate				**$247,000**	

SUPPORTING COSTS

Description	Percent		Total
PRELIMINARY ENGINEERING	2.50%		$6,000
FINAL DESIGN	6.00%		$15,000
CONSTRUCTION ENGINEERING	8.00%		$20,000
CHANGES DURING CONSTRUCTION	10.00%		$25,000

Item	Quantity	Units	Unit Cost	TOTAL COST	Methodology
PUBLIC INVOLVEMENT		0.75%		$2,000	
SUBTOTAL				**$68,000**	
GRAND TOTAL				**$315,000**	

ASSUMPTIONS

-Contingency covers unknown costs including MOT, E&S controls

-Date of Estimate: May 23, 2012

NOT INCLUDED

-Environmental Mitigation

-Permits

-Contract Incentives

-Utility Relocation

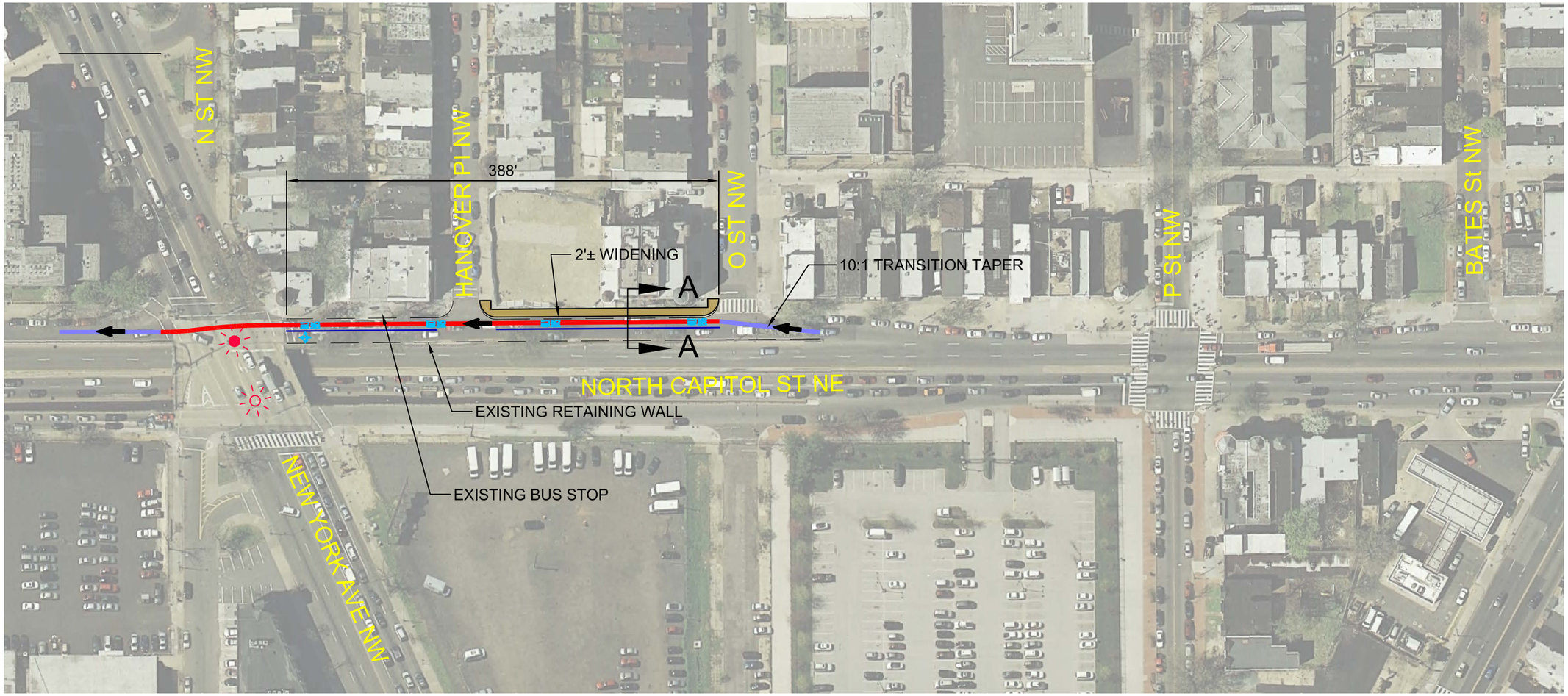
-Right of Way Acquisition

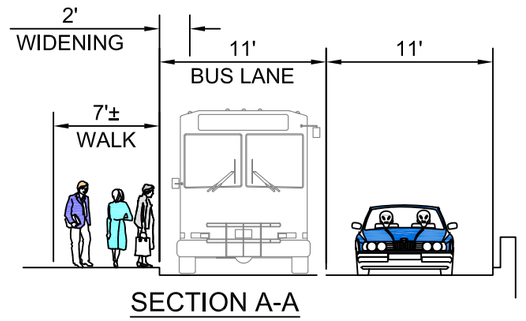
-Grade Separated Interchanges

Table A-4: Operating Cost Estimate for 14th Street Option 2

			Hotspot avg. speed (mph)	Speed w/ bus lane (mph)	Improvement (mph)			AM Peak bus hour volumes - NB	AM Peak hour bus volumes - SB	PM Peak bus hour volumes - NB	PM Peak hour bus volumes - SB	Total daily time savings - NB (pl hr)	Total daily time savings - SB (pl hr)	Combined daily time savings (pl hr)	Annual time savings (pl hr)	FY13 non-regional platform hour cost	
		NB AM Peak	11.2	13.3	2.1												
		NB PM Peak	13	15.1	2.1												
		SB AM Peak	10.2	12.3	2.1												
		SB PM Peak	9.6	11.7	2.1												
	Segment			Time savings/bus (min)													
	From	To	Distance (miles)	NB AM Peak	SB AM Peak	NB PM Peak	SB PM Peak										Annual operating cost savings (FY13 $$$)
Peak Hours	mid-block between Corcoran & R	Florida	0.54	0.46	0.46	0.35	0.35	14	20	18	14	0.21	0.23	0.45	110.82		$12,211.36
	Florida	Columbia	0.51	0.44	0.44	0.33	0.33	14	20	18	14	0.20	0.22	0.42	105.32		$11,605.06
	Columbia	mid-block between Irving & Kenyon	0.11	0.10	n/a	0.07	n/a	8	n/a	12	n/a	0.03	n/a	0.03	6.82		$751.90
Peak Shoulders	mid-block between Corcoran & R	Florida	0.54	0.37	0.37	0.28	0.28	27	33	51	45	0.40	0.41	0.81	202.08	$110.19	$22,267.42
	Florida	Columbia	0.51	0.35	0.35	0.26	0.26	27	33	51	45	0.38	0.39	0.77	192.05		$21,161.84
	Columbia	mid-block between Irving & Kenyon	0.11	0.08	n/a	0.06	n/a	15	n/a	33	n/a	0.05	n/a	0.05	12.78		$1,408.03
	Totals:		**1.17**									**1.27**	**1.26**	**2.53**	**629.87**		**$69,405.59**

APPENDIX B: NORTH CAPITOL STREET PLAN DRAWINGS AND DETAILED TABLES





LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
- BUS IN MIXED TRAFFIC
- QUEUE JUMP SIGNAL
- EXISTING SIGNAL PRIORITY UPGRADE
- RETAINING WALL
- X X X X DRIVEWAY CLOSED
- RIGHT IN/RIGHT OUT DRIVEWAY OR INTERSECTION
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 50' 100'

Figure B-1

North Capitol Street, New York Ave. to P Street

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PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots

Table B-1: Capital Cost Estimate for North Capitol Street

Item	Quantity	Units	Unit Cost	TOTAL COST	Methodology
DEMOLITION					----------
Pavement Demolition	200	SY	$10	$2,000	
Striping Removal	0	LF	$1.50	$0	Minor work removing conflicting legends, covered in contingency
PAVEMENT/EARTHWORK					----------
Clearing and Grubbing		AC	$50,000	$0	
Aggr. Base	28	TON	$25	$700	12" Depth
Asphalt Concrete - Base Course	27	TON	$70	$1,890	10" Depth
Asphalt Concrete - Wearing Course	59	TON	$90	$5,310	2" Depth
Dowelled PCC Concerte		SY	$75	$0	12" Depth, 4000 PSI
Remove/Backfill Unsuitable Matls		CY	$60	$0	
Pavement Planing	450	SY	$5	$2,250	Mill 1.5" for the section of pavement being overlayed
Sidewalk	1,565	SF	$5	$7,825	
Curb & Gutter	235	LF	$25	$5,875	
Excavation	53	CY	$25	$1,325	Assumes 2' exavation paved areas, 4" excavation at replaced sidewalk
TRAFFIC					----------
Traffic Signal - bus priority	1	EA	$32,500	$32,500	Includes signal priority parts and controller logic/programming incl controller and/or software upgrade
Traffic Signal - queue jump	1	EA	$32,500	$32,500	Includes traffic signal priority, bus signal heads, wiring
Striping	340	LF	$4	$1,360	
Pavement Legends	9	EA	$400	$3,600	
Signs	2	EA	$500	$1,000	
OTHER					----------
Grassed Median		SF	$8	$0	(Length of Section - intersections) times 30' median width
Landscaping Area		SF	$5	$0	Length of section times 12' (8' Landscaping area on left side of Typical and 4' Landscaping area on the right side)

Item	Quantity	Units	Unit Cost	TOTAL COST	Methodology
Trees	2	EA	$800	$1,600	One tree every 50'.
Storm Sewer Pipe		LF	$70	$0	Twice the length of the section
No of Inlets		EA	$6,000	$0	Inlets every 200' at low side of pavement for each side of roadway
Streetlights		EA	$10,000	$0	100' spacing
Utility Pole Relocation		EA	$7,500	$0	
Retaining Wall		SF	$50	$0	
Bus Shelter		EA	$15,000	$0	
MOBILIZATION	1	LS	$10,000	$10,000	
Subtotal				**$110,000**	
Contingency	**35%**			**$39,000**	
Total Construction Estimate				**$149,000**	

SUPPORTING COSTS

Description	Percent		Total
PRELIMINARY ENGINEERING	2.50%		$4,000
FINAL DESIGN	6.00%		$9,000
CONSTRUCTION ENGINEERING	8.00%		$12,000
CHANGES DURING CONSTRUCTION	10.00%		$15,000
PUBLIC INVOLVEMENT	0.75%		$1,000
SUBTOTAL			**$41,000**

GRAND TOTAL	**$190,000**

ASSUMPTIONS

-Contingency covers unknown costs including MOT, E&S controls

-Date of Estimate: May 23, 2012

NOT INCLUDED

-Environmental Mitigation

-Permits

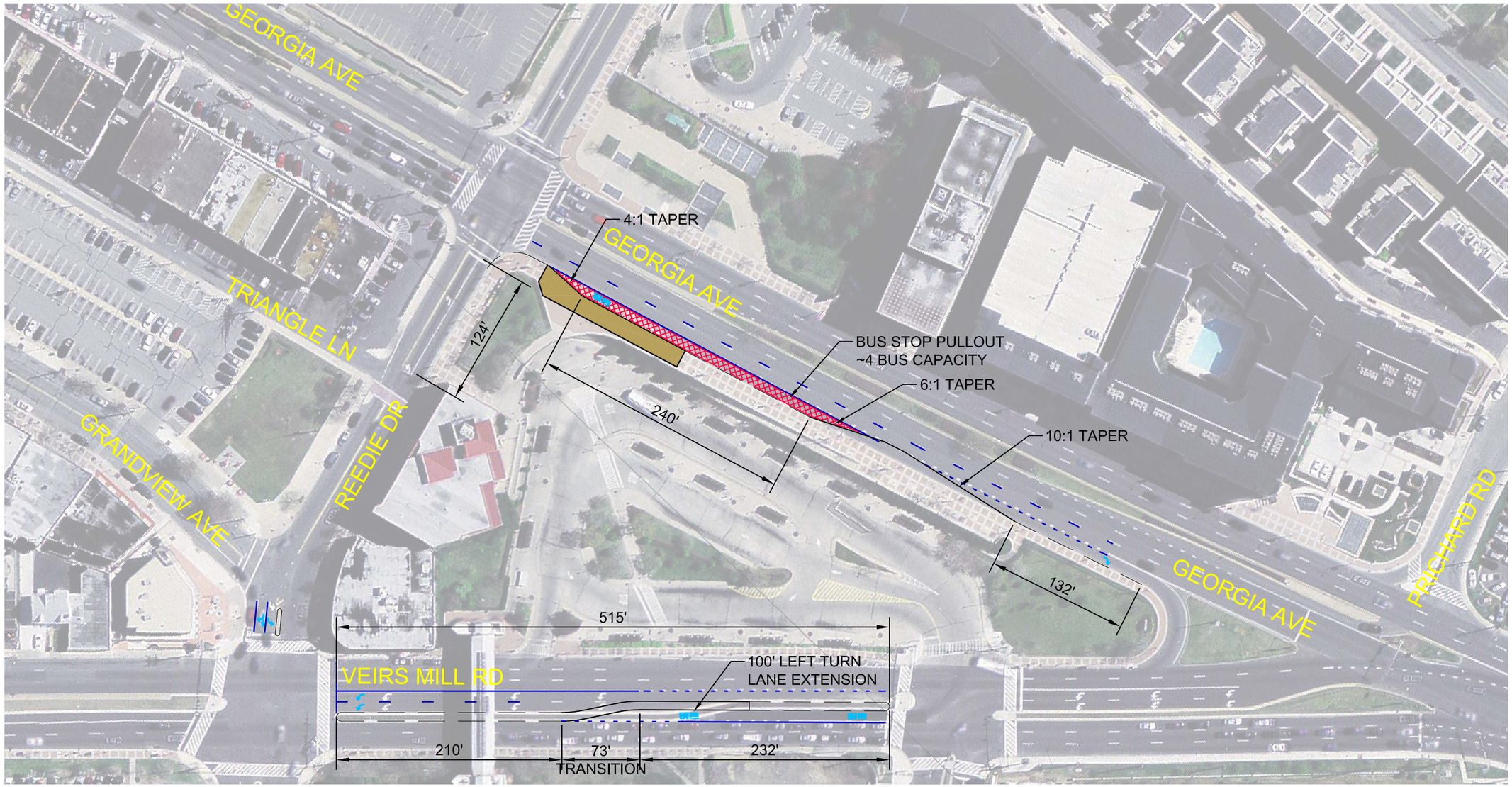
-Contract Incentives

-Utility Relocation

PARSONS BRINCKERHOFF SABRA, WANG & ASSOCIATES, INC.

-Right of Way Acquisition
-Grade Separated Interchanges

APPENDIX C: VEIRS MILL ROAD/REEDIE DRIVE/AMHERST AVENUE PLAN DRAWINGS AND DETAILED TABLES



LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
- BUS IN MIXED TRAFFIC
- QUEUE JUMP SIGNAL
- EXISTING SIGNAL PRIORITY UPGRADE
- RETAINING WALL
- X X X X DRIVEWAY CLOSED
- RIGHT IN/RIGHT OUT DRIVEWAY OR INTERSECTION
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 50' 100'

Figure C-1

Veirs Mill Road - Reedie Drive - Amherst Ave.

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PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots

Table C-1: Capital Cost Estimate for Veirs Mill Road / Reedie Drive / Amherst Avenue

Item	Quantity	Units	Unit Cost	TOTAL COST	Methodology
DEMOLITION					----------
Pavement Demolition	750	SY	$10	$7,500	
Striping Removal	2,500	LF	$1.50	$3,750	Assume remove quantity same as install quantity, see striping below
PAVEMENT/EARTHWORK					----------
Clearing and Grubbing		AC	$50,000	$0	(Width of Roadway widening plus 10' outside for grading
Aggr. Base	280	TON	$25	$7,000	12" Depth
Asphalt Concrete - Base Course	90	TON	$70	$6,300	10" Depth
Asphalt Concrete - Wearing Course	19	TON	$90	$1,710	2" Depth
Dowelled PCC Concerte	290	SY	$75	$21,750	12" Depth, 4000 PSI
Remove/Backfill Unsuitable Matls		CY	$60	$0	Removal and Backfill of 2' Depth for 25% of New Pavement Area
Pavement Planing		SY	$5	$0	Mill 1.5" for the section of pavement being overlayed
Sidewalk	2,740	SF	$5	$13,700	
Curb & Gutter	630	LF	$25	$15,750	
Excavation	365	CY	$25	$9,125	Assumes 2' exavation paved areas, 8" excavation sidewalk/landscape areas
TRAFFIC					----------
Pedestrian Signal	1	EA	$32,500	$32,500	Includes signal priority parts and controller logic/programming incl controller and/or software upgrade
Signal Modifications	1	EA	$32,500	$32,500	Includes traffic signal priority, bus signal heads, wiring
Striping	2,500	LF	$4	$10,000	
Pavement Legends	12	EA	$400	$4,800	
Signs		EA	$500	$0	
OTHER					----------
Grassed Median	875	SF	$8	$7,000	
Landscaping Area		SF	$5	$0	

Item	Quantity	Units	Unit Cost	TOTAL COST	Methodology
Trees		EA	$800	$0	One tree every 50'.
Storm Sewer Pipe		LF	$70	$0	Twice the length of the section
No of Inlets		EA	$6,000	$0	Inlets every 200' at low side of pavement for each side of roadway
Streetlights	3	EA	$10,000	$30,000	100' spacing
Utility Pole Relocation		EA	$7,500	$0	
Retaining Wall		SF	$50	$0	
Bus Shelter	4	EA	$15,000	$60,000	
MOBILIZATION	1	LS	$26,000	$26,000	
Subtotal				**$289,000**	
Contingency	**35%**			**$101,000**	
Total Construction Estimate				**$390,000**	

SUPPORTING COSTS

Description	Percent		Total
PRELIMINARY ENGINEERING	2.50%		$10,000
FINAL DESIGN	6.00%		$23,000
CONSTRUCTION ENGINEERING	8.00%		$31,000
CHANGES DURING CONSTRUCTION	10.00%		$39,000
PUBLIC INVOLVEMENT	0.75%		$3,000
SUBTOTAL			**$106,000**

GRAND TOTAL	**$496,000**

ASSUMPTIONS

-Contingency covers unknown costs including MOT, E&S controls

-Date of Estimate: May 23, 2012

NOT INCLUDED

-Environmental Mitigation

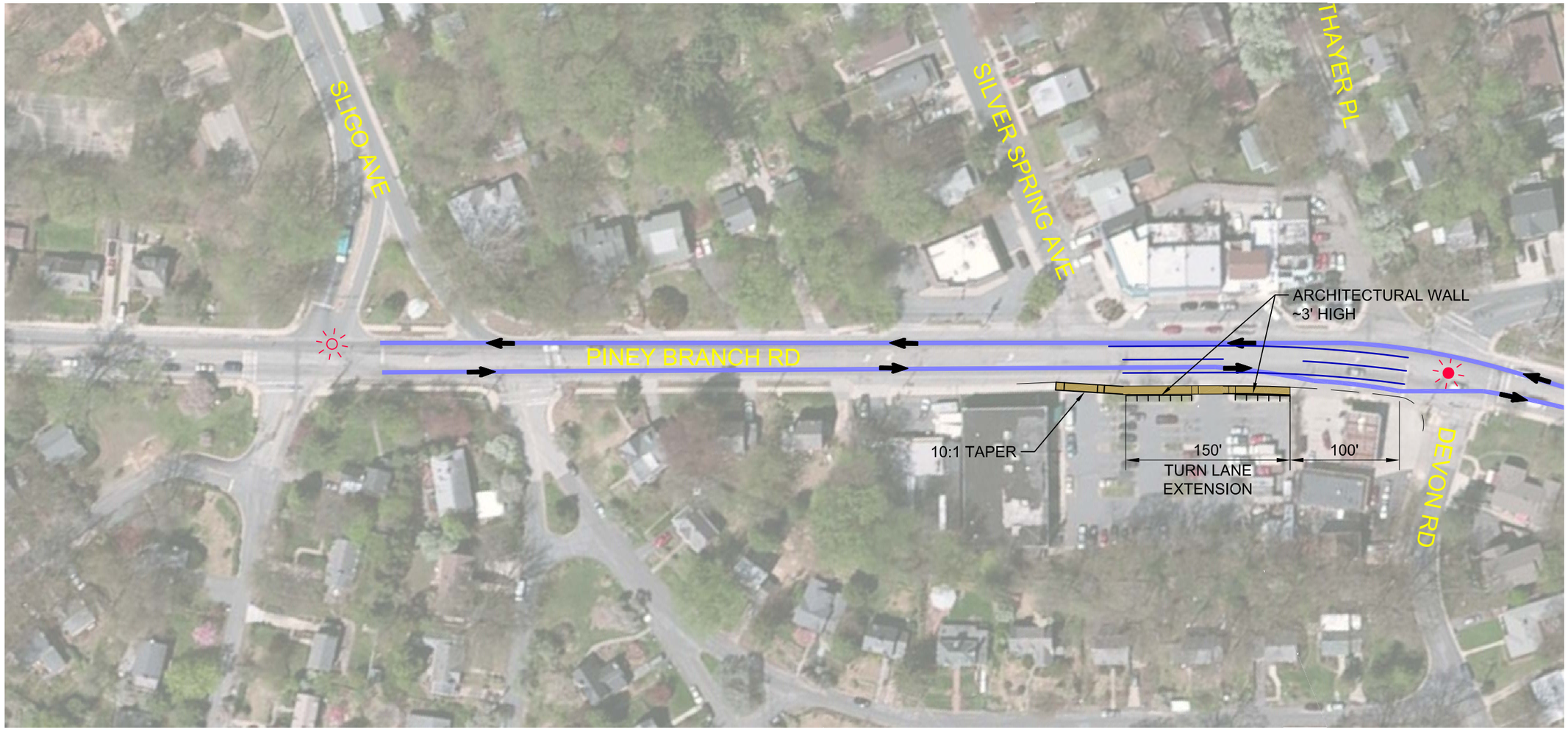
-Permits

-Contract Incentives

-Utility Relocation

-Right of Way Acquisition
-Grade Separated Interchanges

APPENDIX D: PINEY BRANCH ROAD PLAN DRAWINGS AND DETAILED TABLES



LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
- BUS IN MIXED TRAFFIC
- QUEUE JUMP SIGNAL
- EXISTING SIGNAL PRIORITY UPGRADE
- RETAINING WALL
- X X X X DRIVEWAY CLOSED
- RIGHT IN/RIGHT OUT DRIVEWAY OR INTERSECTION
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 50' 100'

Figure D-1

Piney Branch Road, Sligo Ave. to University Blvd. East

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PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots

LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
- BUS IN MIXED TRAFFIC
- QUEUE JUMP SIGNAL
- EXISTING SIGNAL PRIORITY UPGRADE
- RETAINING WALL
- X X X X DRIVEWAY CLOSED
- RIGHT IN/RIGHT OUT DRIVEWAY OR INTERSECTION
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 50' 100'

Figure D-2

Piney Branch Road, Sligo Ave. to University Blvd. East

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PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots

LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
- BUS IN MIXED TRAFFIC
- QUEUE JUMP SIGNAL
- EXISTING SIGNAL PRIORITY UPGRADE
- RETAINING WALL
- X X X X DRIVEWAY CLOSED
- RIGHT IN/RIGHT OUT DRIVEWAY OR INTERSECTION
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 50' 100'

Figure D-3

Piney Branch Road, Sligo Ave. to University Blvd. East

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PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots

LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
- BUS IN MIXED TRAFFIC
- QUEUE JUMP SIGNAL
- EXISTING SIGNAL PRIORITY UPGRADE
- RETAINING WALL
- X X X X DRIVEWAY CLOSED
- RIGHT IN/RIGHT OUT DRIVEWAY OR INTERSECTION
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 50' 100'

Figure D-4

Piney Branch Road, Sligo Ave. to University Blvd. East

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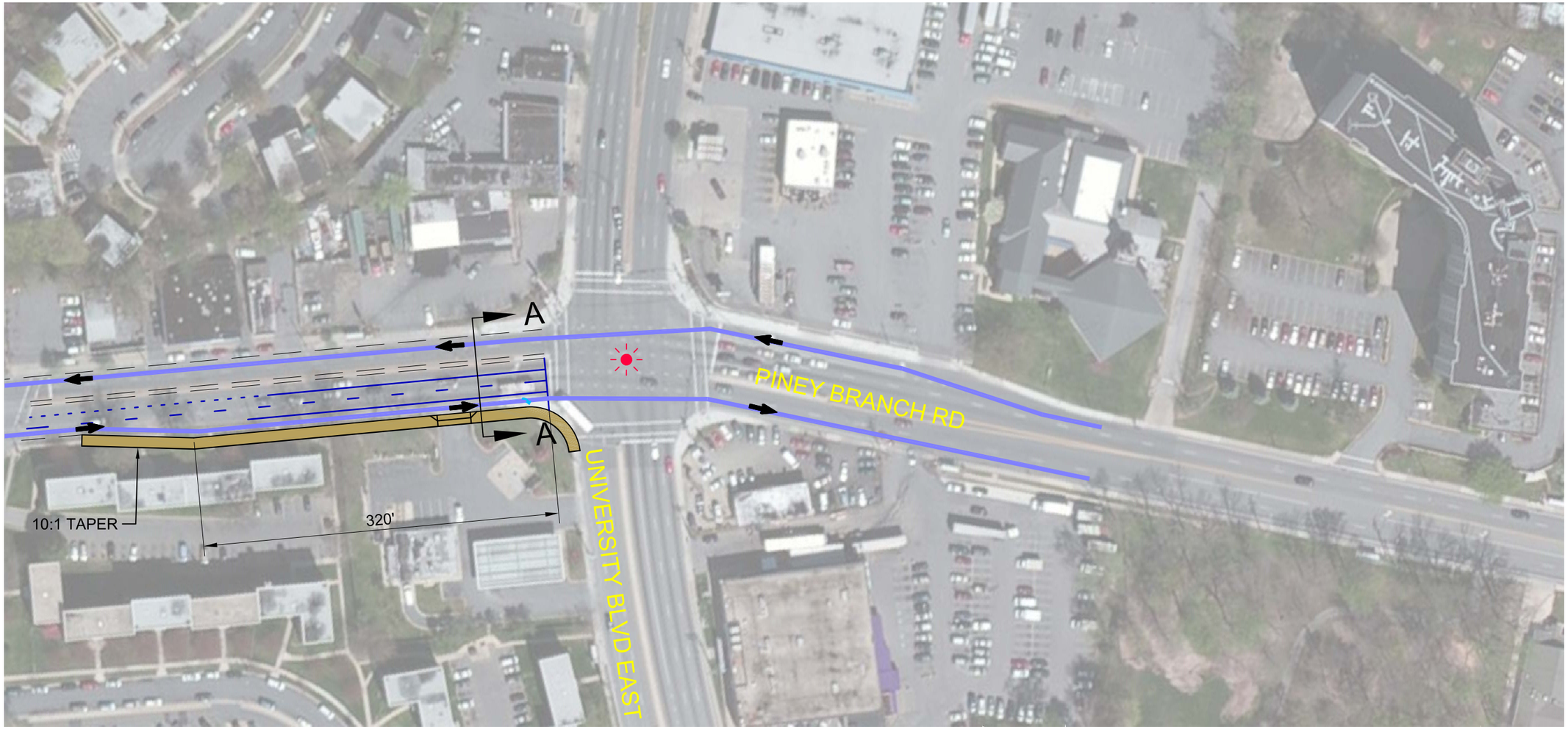
PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots



LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
- BUS IN MIXED TRAFFIC
- QUEUE JUMP SIGNAL
- EXISTING SIGNAL PRIORITY UPGRADE
- RETAINING WALL
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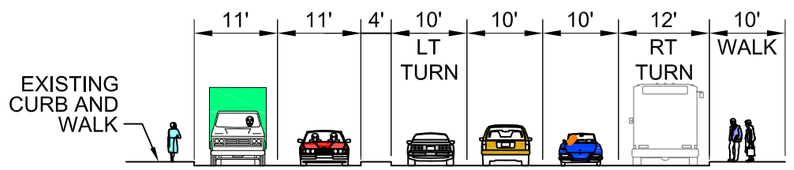
- AUTO DIRECTION OF TRAVEL
- BIKE LANE



SECTION A-A

0 50' 100'

Figure D-5

Piney Branch Road, Sligo Ave. to University Blvd. East

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PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots

Table D-1: Capital Cost Estimate for Piney Branch Road

Item	Quantity	Units	Unit Cost	TOTAL COST	Methodology
DEMOLITION					
Pavement Demolition	**790**	**SY**	**$10**	**$7,900**	Assume remove quantity same as install quantity, see striping below
Striping Removal	**100**	**LF**	**$1.50**	**$150**	
PAVEMENT/EARTHWORK					
Clearing and Grubbing	**0.12**	**AC**	**$50,000**	**$6,148**	(Width of Roadway widening plus 10' outside for grading
Aggr. Base	**484**	**TON**	**$25**	**$12,093**	12" Depth
Asphalt Concrete - Base Course	**434**	**TON**	**$70**	**$30,351**	10" Depth
Asphalt Concrete - Wearing Course	**89**	**TON**	**$90**	**$7,993**	2" Depth
Dowelled PCC Concerte	**0**	**SY**	**$75**	**$0**	12" Depth, 4000 PSI
Remove/Backfill Unsuitable Matls	**121**	**CY**	**$60**	**$7,256**	Removal and Backfill of 2' Depth for 25% of New Pavement Area
Pavement Planing	**0**	**SY**	**$5**	**$0**	Mill 1.5" for the section of pavement being overlayed
Sidewalk	**6,170**	**SF**	**$5**	**$30,850**	
Curb & Gutter	**680**	**LF**	**$25**	**$17,000**	
Excavation	**637**	**CY**	**$25**	**$15,920**	Assumes 1' exavation paved areas, 8" excavation sidewalk/landscape areas
TRAFFIC					
Traffic Signal - bus priority	**6**	**EA**	**$32,500**	**$195,000**	Includes signal priority parts and controller logic/programming incl controller and/or software upgrade
Traffic Signal - queue jump	**3**	**EA**	**$32,500**	**$97,500**	Includes traffic signal priority, bus signal heads, wiring
Striping	**520**	**LF**	**$4**	**$2,080**	
Pavement Legends	**5**	**EA**	**$400**	**$2,000**	
Signs	**2**	**EA**	**$500**	**$1,000**	
OTHER					
Grassed Median	**0**	**SF**	**$8**	**$0**	
Landscaping Area	**500**	**SF**	**$5**	**$2,500**	
Trees	**14**	**EA**	**$800**	**$11,200**	One tree every 50', and includes replacement trees near Dale.
Storm Sewer Pipe	**30**	**LF**	**$70**	**$2,100**	Twice the length of the section
No of Inlets	**2**	**EA**	**$6,000**	**$12,000**	Inlets every 200' at low side of pavement for each side of roadway

Streetlights	**8**	**EA**	**$10,000**	**$80,000**	100' spacing
Utility Pole Relocation	**1**	**EA**	**$7,500**	**$7,500**	
Retaining Wall	**330**	**SF**	**$50**	**$16,500**	
Bus Shelter	**0**	**EA**	**$15,000**	**$0**	
MOBILIZATION	**1**	**LS**	**$57,000**	**$57,000**	
Subtotal				**$622,000**	
Contingency	**35%**			**$218,000**	
Total Construction Estimate				**$840,000**	

SUPPORTING COSTS

Description	**Percent**		**Total**
PRELIMINARY ENGINEERING	2.50%		$21,000
FINAL DESIGN	6.00%		$50,000
CONSTRUCTION ENGINEERING	8.00%		$67,000
CHANGES DURING CONSTRUCTION	10.00%		$84,000
PUBLIC INVOLVEMENT	0.75%		$6,000
SUBTOTAL			**$228,000**

GRAND TOTAL	**$1,068,000**

ASSUMPTIONS

-Contingency covers unknown costs including MOT, E&S controls

-Date of Estimate: May 30, 2012

NOT INCLUDED

-Environmental Mitigation

-Permits

-Contract Incentives

-Utility Relocation

-Right of Way Acquisition (Approximate 1000 SF near Dale, 4500 SF near University)

-Grade Separated Interchanges

Table D-2: Operating Cost Savings Estimate for Queue-Jumps on Piney Branch Road

Queue-jump @ Dale/Devon								
	Before delay/bus (min)	After delay/bus (min)	Time savings/bus (min)	Bus volumes - NB	Total daily time savings - NB (pl hr)	Annual time savings (pl hr)	FY13 non-regional platform hour cost	Annual operating cost savings (FY13 $$$)
AM Peak hour	0.020	0.028	-0.008	14	-0.002	-0.482	$110.19	($53.14)
PM Peak hour	0.033	0.027	0.006	19	0.002	0.473		$52.13
AM Peak shoulders			-0.007	16	-0.002	-0.441		($48.58)
PM Peak shoulders			0.005	51	0.004	1.016		$111.94
					0.002	**0.566**		**$62.36**

Queue-jump @ Flower Ave								
	Before delay/bus (min)	After delay/bus (min)	Time savings/bus (min)	Bus volumes - NB	Total daily time savings - NB (pl hr)	Annual time savings (pl hr)	FY13 non-regional platform hour cost	Annual operating cost savings (FY13 $$$)
AM Peak hour	0.123	0.095	0.028	15	0.01	1.74	$110.19	$192.06
PM Peak hour	0.120	0.025	0.095	27	0.04	10.64		$1,172.95
AM Peak shoulders			0.022	21	0.01	1.95		$215.11
PM Peak shoulders			0.076	73	0.09	23.02		$2,537.04
					0.15	**37.36**		**$4,117.15**

Queue-jump @ University Blvd	Northbound			Southbound										
	Before delay/bus (min)	After delay/bus (min)	Time savings/bus (min)	Before delay/bus (min)	After delay/bus (min)	Time savings/bus (min)	Bus volumes - NB	Bus volumes - SB	Total daily time savings - NB (pl hr)	Total daily time savings - SB (pl hr)	Combined daily time savings (pl hr)	Annual time savings (pl hr)	FY13 non-regional platform hour cost	Annual operating cost savings (FY13 $$$)
AM Peak hour	1.095	1.095	0.000	1.075	0.955	0.120	15	25	0.00	0.05	0.05	12.45	$110.19	1,371.87
PM Peak hour	1.185	1.070	0.115	1.135	0.873	0.262	27	18	0.05	0.08	0.13	32.46		3,576.45
AM Peak shoulders			0.000			0.096	21	58	0.00	0.09	0.09	23.11		2,546.18
PM Peak shoulders			0.092			0.210	73	45	0.11	0.16	0.27	67.01		7,384.29
									0.16	**0.38**	**0.54**	**135.03**		**$14,878.80**

Table D-3: Operating Cost Savings Estimate for Transit Signal Priority on Piney Branch Road

TSP @ Arliss	NB Time savings/bus (min)	SB Time savings/bus (min)	Bus volumes - NB	Bus volumes - SB	Total daily time savings - NB (pl hr)	Total daily time savings - SB (pl hr)	Combined daily time savings (pl hr)	Annual time savings (pl hr)	FY13 non-regional platform hour cost	Annual operating cost savings (FY13 $$$)
AM Peak hour	0.065	0.202	15	25	0.02	0.08	0.10	25.00	$110.19	2,755.16
PM Peak hour	0.260	0.142	27	18	0.12	0.04	0.16	39.74		4,378.99
AM Peak shoulders	0.052	0.162	21	58	0.02	0.16	0.17	43.43		4,785.43
PM Peak shoulders	0.208	0.114	73	45	0.25	0.09	0.34	84.23		9,281.13
					0.40	**0.37**	**0.77**	**192.40**		**$21,200.72**

TSP @ Dale/Devon						
	SB Time savings/bus (min)	Bus volumes - SB	Total daily time savings - SB (pl hr)	Annual time savings (pl hr)	FY13 non-regional platform hour cost	Annual operating cost savings (FY13 $$$)
AM Peak hour	0.055	16	0.01	3.65	$110.19	402.41
PM Peak hour	0.028	14	0.01	1.63		179.26
AM Peak shoulders	0.044	39	0.03	7.12		784.71
PM Peak shoulders	0.022	29	0.01	2.70		297.05
			0.06	**15.10**		**$1,663.43**

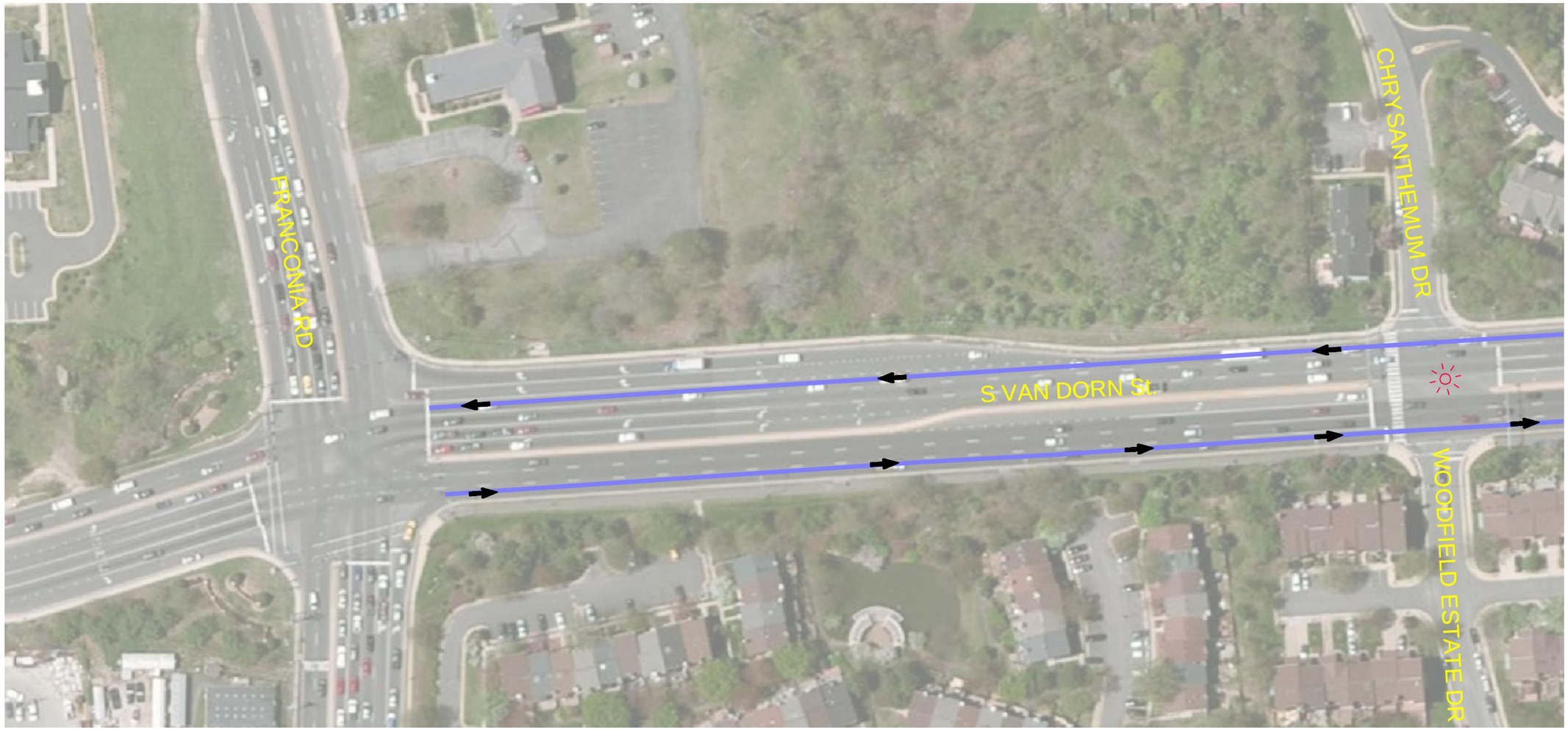
TSP @ Barron										
	NB Time savings/bus (min)	SB Time savings/bus (min)	Bus volumes - NB	Bus volumes - SB	Total daily time savings - NB (pl hr)	Total daily time savings - SB (pl hr)	Combined daily time savings (pl hr)	Annual time savings (pl hr)	FY13 non-regional platform hour cost	Annual operating cost savings (FY13 $$$)
AM Peak hour	0.052	0.032	15	25	0.01	0.01	0.03	6.56	$110.19	722.52
PM Peak hour	0.092	0.010	27	18	0.04	0.00	0.04	11.06		1,218.22
AM Peak shoulders	0.042	0.026	21	58	0.01	0.02	0.04	9.79		1,078.47
PM Peak shoulders	0.074	0.008	73	45	0.09	0.01	0.10	23.79		2,621.54
					0.16	**0.05**	**0.21**	**51.19**		**$5,640.75**

TSP @ Greenwood										
	NB Time savings/bus (min)	SB Time savings/bus (min)	Bus volumes - NB	Bus volumes - SB	Total daily time savings - NB (pl hr)	Total daily time savings - SB (pl hr)	Combined daily time savings (pl hr)	Annual time savings (pl hr)	FY13 non-regional platform hour cost	Annual operating cost savings (FY13 $$$)
AM Peak hour	0.003	0.005	15	25	0.001	0.002	0.003	0.706	$110.19	77.74
PM Peak hour	0.030	0.013	27	18	0.014	0.004	0.017	4.333		477.41
AM Peak shoulders	0.002	0.004	21	58	0.001	0.004	0.005	1.172		129.14
PM Peak shoulders	0.024	0.010	73	45	0.029	0.008	0.037	9.213		1,015.18
					0.044	**0.018**	**0.062**	**15.423**		**$1,699.47**

TSP @ Sligo Creek Pkwy										
	NB Time savings/bus (min)	SB Time savings/bus (min)	Bus volumes - NB	Bus volumes - SB	Total daily time savings - NB (pl hr)	Total daily time savings - SB (pl hr)	Combined daily time savings (pl hr)	Annual time savings (pl hr)	FY13 non-regional platform hour cost	Annual operating cost savings (FY13 $$$)
AM Peak hour	0.080	0.122	12	16	0.02	0.03	0.05	12.08	$110.19	1,331.62
PM Peak hour	0.170	0.120	19	14	0.05	0.03	0.08	20.38		2,245.29
AM Peak shoulders	0.064	0.098	15	39	0.02	0.06	0.08	19.78		2,179.62
PM Peak shoulders	0.136	0.096	51	29	0.12	0.05	0.16	40.34		4,444.84
					0.20	**0.17**	**0.37**	**92.58**		**$10,201.37**

TSP @ Sligo Ave										
	NB Time savings/bus (min)	SB Time savings/bus (min)	Bus volumes - NB	Bus volumes - SB	Total daily time savings - NB (pl hr)	Total daily time savings - SB (pl hr)	Combined daily time savings (pl hr)	Annual time savings (pl hr)	FY13 non-regional platform hour cost	Annual operating cost savings (FY13 $$$)
AM Peak hour	0.110	0.175	14	16	0.03	0.05	0.07	18.01	$110.19	1,984.63
PM Peak hour	0.167	0.070	19	16	0.05	0.02	0.07	17.82		1,963.14
AM Peak shoulders	0.088	0.140	16	39	0.02	0.09	0.11	28.50		3,140.66
PM Peak shoulders	0.134	0.056	51	30	0.11	0.03	0.14	35.25		3,884.03
					0.22	**0.18**	**0.40**	**99.58**		**$10,972.45**

APPENDIX E: VAN DORN STREET PLAN DRAWINGS AND DETAILED TABLES



LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
- BUS IN MIXED TRAFFIC
- QUEUE JUMP SIGNAL
- EXISTING SIGNAL PRIORITY UPGRADE
- RETAINING WALL
- X X X X DRIVEWAY CLOSED
- RIGHT IN/RIGHT OUT DRIVEWAY OR INTERSECTION
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 50' 100'

Figure E-1

Van Dorn Street, Eisenhower Ave. to Fanconia Road

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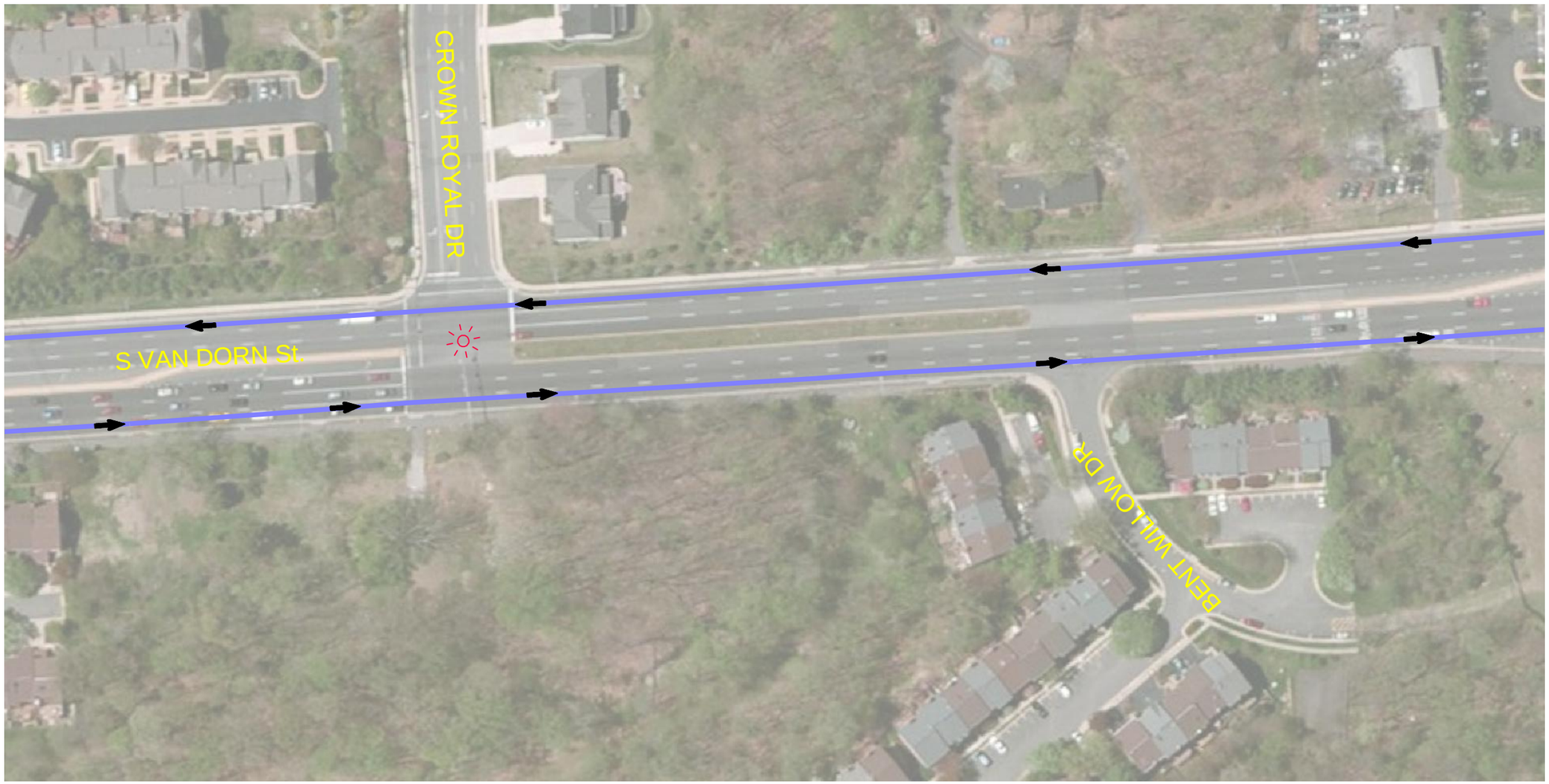
PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots



LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
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- CONCRETE TRANSIT LANE
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- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 50' 100'

Figure E-2

Van Dorn Street, Eisenhower Ave. to Fanconia Road

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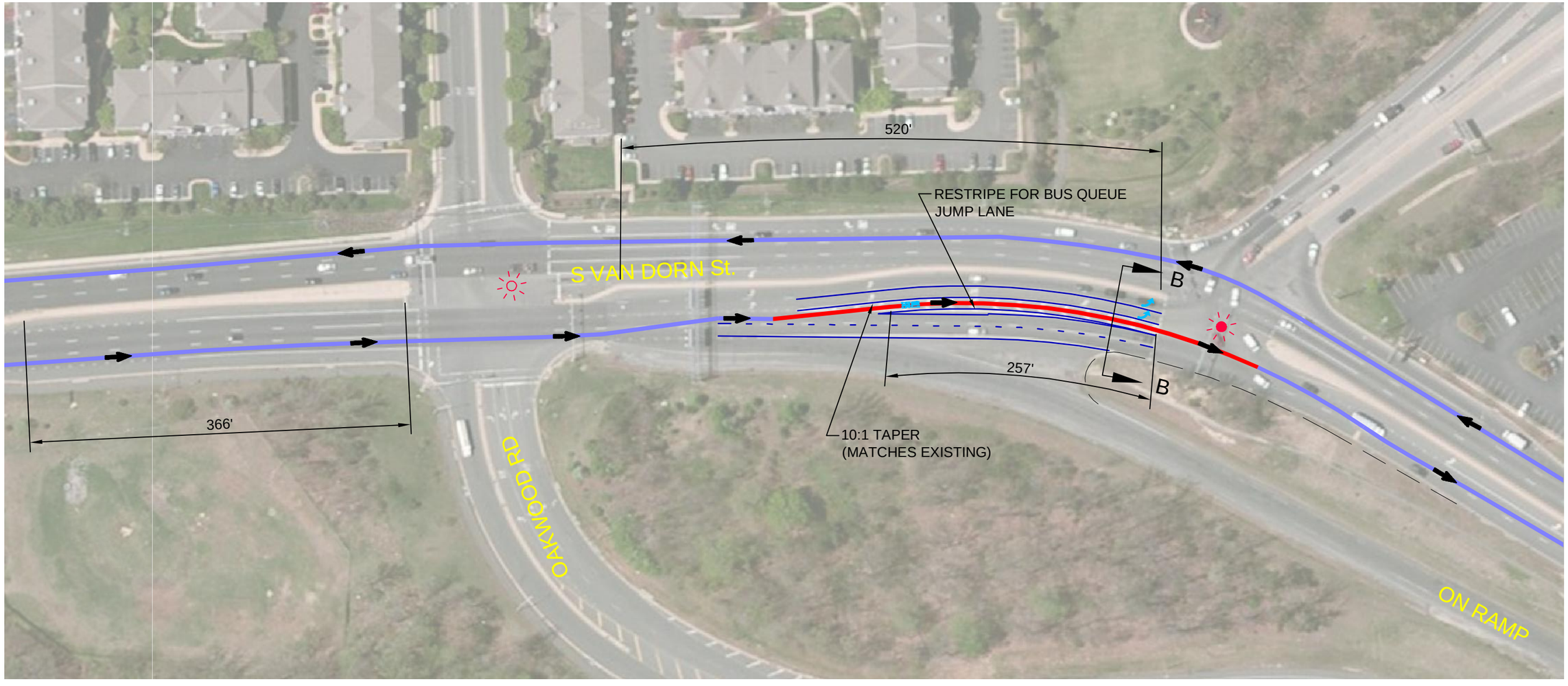
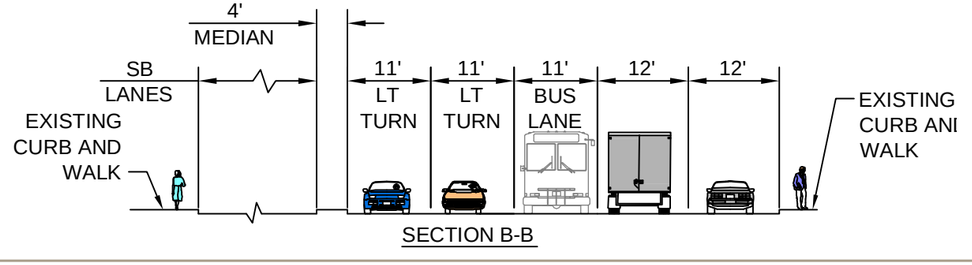
PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots





LEGEND

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- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 50' 100'

Figure E-3

Van Dorn Street, Eisenhower Ave. to Fanconia Road

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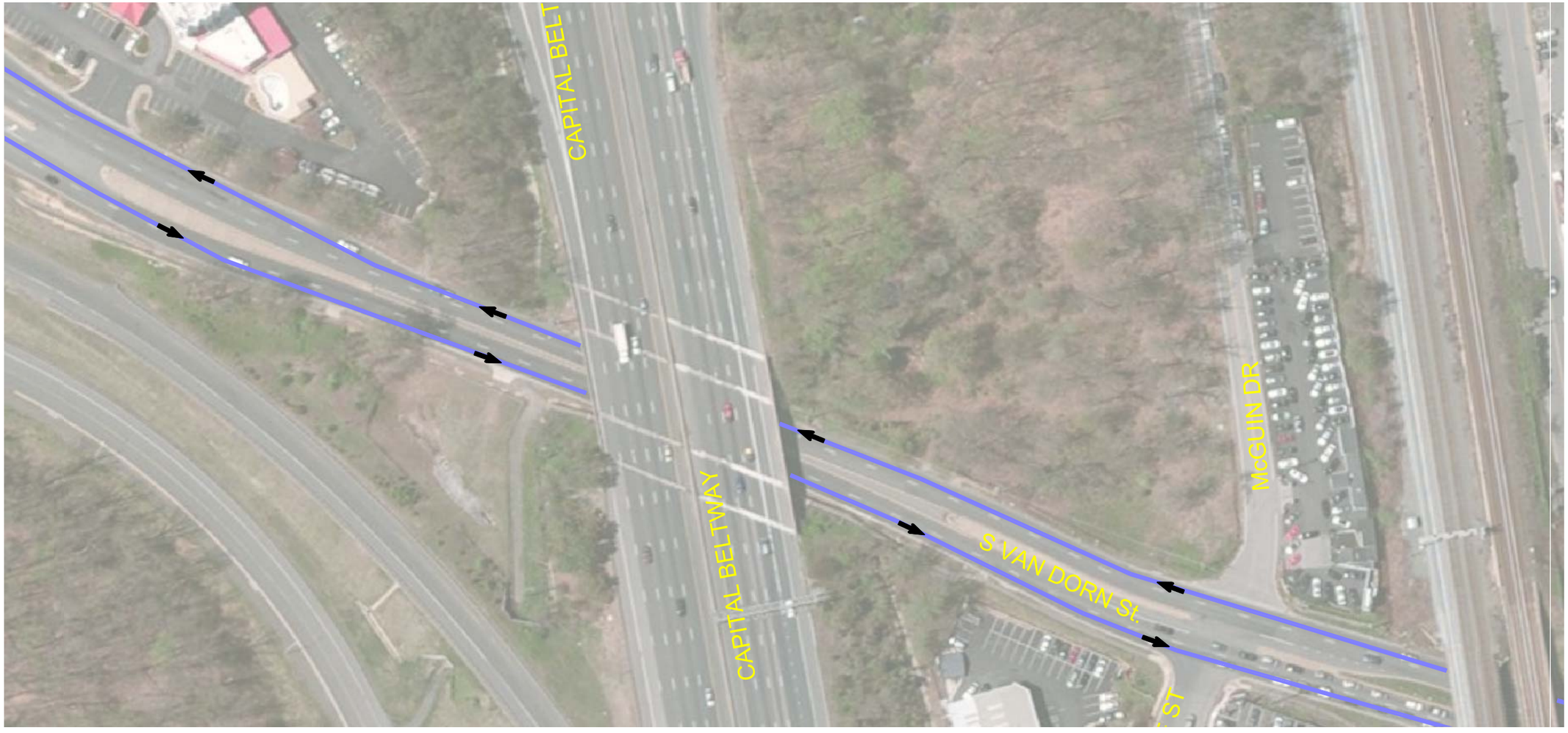
PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots



LEGEND

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- NEW SIDEWALK
- NEW STRIPING
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- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 50' 100'

Figure E-4

Van Dorn Street, Eisenhower Ave. to Fanconia Road

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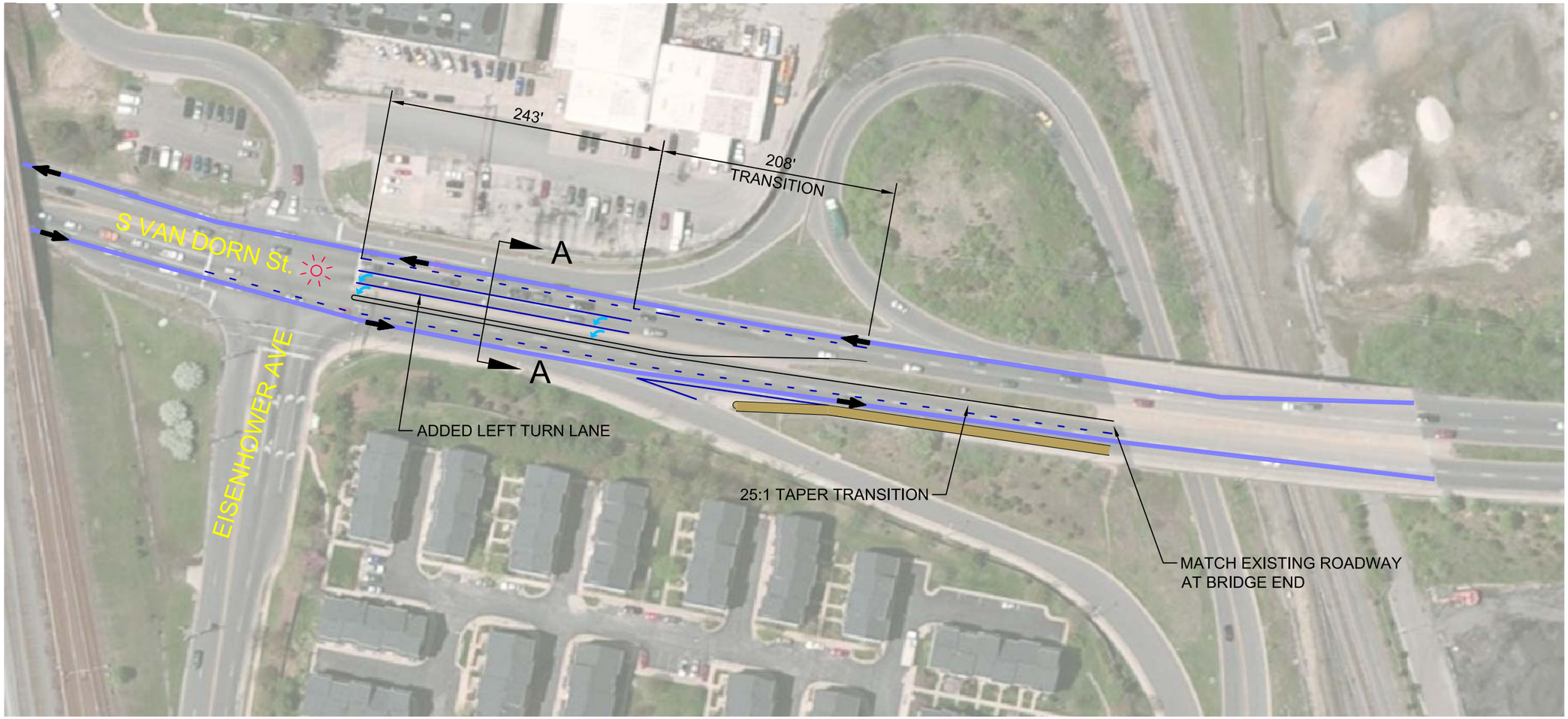
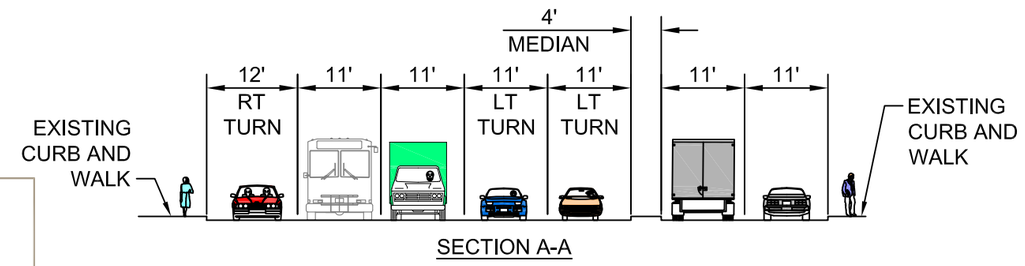
PARSONS BRINCKERHOFF

Multimodal Coordination For Bus Priority Hot Spots





LEGEND

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- NEW SIDEWALK
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- RIGHT IN/RIGHT OUT DRIVEWAY OR INTERSECTION
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 50' 100'

Figure E-5

Van Dorn Street, Eisenhower Ave. to Fanconia Road

Table E-1: Capital Cost Estimate for Van Dorn Street

Item	Quantity	Units	Unit Cost	TOTAL COST	Methodology
DEMOLITION					
Pavement Demolition	**690**	**SY**	**$10**	**$6,900**	
Striping Removal	**4,015**	**LF**	**$1.50**	**$6,023**	Assume remove quantity same as install quantity, see striping below
PAVEMENT/EARTHWORK					
Clearing and Grubbing		**AC**	**$50,000**	**$0**	(Width of Roadway widening plus 10' outside for grading
Aggr. Base	**425**	**TON**	**$25**	**$10,625**	12" Depth
Asphalt Concrete - Base Course	**400**	**TON**	**$70**	**$28,000**	10" Depth
Asphalt Concrete - Wearing Course	**82**	**TON**	**$90**	**$7,380**	2" Depth
Dowelled PCC Concerte		**SY**	**$75**	**$0**	12" Depth, 4000 PSI
Remove/Backfill Unsuitable Matls		**CY**	**$60**	**$0**	Removal and Backfill of 2' Depth for 25% of New Pavement Area
Pavement Planing		**SY**	**$5**	**$0**	Mill 1.5" for the section of pavement being overlayed
Sidewalk	**2,640**	**SF**	**$5**	**$13,200**	
Curb & Gutter	**1,430**	**LF**	**$25**	**$35,750**	
Excavation	**295**	**CY**	**$25**	**$7,375**	Assumes 1' exavation paved areas, 8" excavation sidewalk/landscape areas
TRAFFIC					
Traffic Signal - bus priority	**3**	**EA**	**$32,500**	**$97,500**	Includes signal priority parts and controller logic/programming incl controller and/or software upgrade
Traffic Signal - queue jump	**2**	**EA**	**$32,500**	**$65,000**	Includes traffic signal priority, bus signal heads, wiring
Striping	**4,015**	**LF**	**$4**	**$16,060**	
Pavement Legends	**8**	**EA**	**$400**	**$3,200**	
Signs		**EA**	**$500**	**$0**	
OTHER					
Grassed Median		**SF**	**$8**	**$0**	(Length of Section - intersections) times 30' median width
Landscaping Area		**SF**	**$5**	**$0**	Length of section times 12' (8' Landscaping area on left side of Typical and 4' Landscaping area on the right side)
Trees		**EA**	**$800**	**$0**	One tree every 50'.
Storm Sewer Pipe		**LF**	**$70**	**$0**	Twice the length of the section

No of Inlets		**EA**	**$6,000**	**$0**	Inlets every 200' at low side of pavement for each side of roadway
Streetlights		**EA**	**$10,000**	**$0**	100' spacing
Utility Pole Relocation		**EA**	**$7,500**	**$0**	
Retaining Wall		**SF**	**$50**	**$0**	
Bus Shelter		**EA**	**$15,000**	**$0**	
MOBILIZATION	**1**	**LS**	**$30,000**	**$30,000**	
Subtotal				**$327,000**	
Contingency	**35%**			**$114,000**	
Total Construction Estimate				**$441,000**	

SUPPORTING COSTS

Description	**Percent**		**Total**
PRELIMINARY ENGINEERING	2.50%		$11,000
FINAL DESIGN	6.00%		$26,000
CONSTRUCTION ENGINEERING	8.00%		$35,000
CHANGES DURING CONSTRUCTION	10.00%		$44,000
PUBLIC INVOLVEMENT	0.75%		$3,000
SUBTOTAL			**$119,000**

GRAND TOTAL	**$560,000**

ASSUMPTIONS

-Contingency covers unknown costs including MOT, E&S controls

-Date of Estimate: May 30, 2012

NOT INCLUDED

-Environmental Mitigation

-Permits

-Contract Incentives

-Utility Relocation

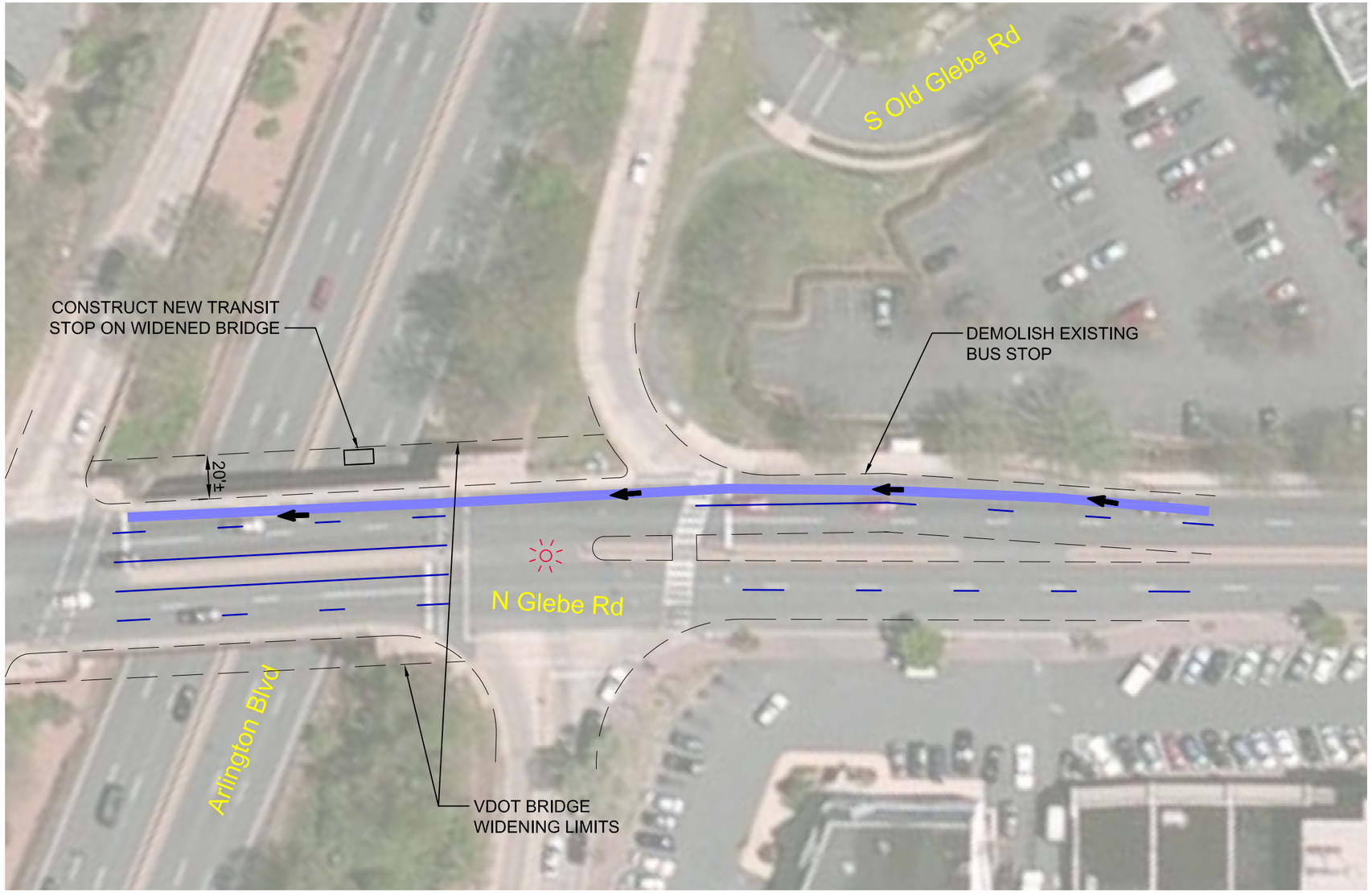
-Right of Way Acquisition

-Grade Separated Interchanges

Table E-2: Operating Cost Savings Estimate for Van Dorn Street

	NB Time savings/bus (min)	SB Time savings/bus (min)	Bus volumes - NB	Bus volumes - SB	Total daily time savings - NB (pl hr)	Total daily time savings - SB (pl hr)	Combined daily time savings (pl hr)	Annual time savings (pl hr)	FY13 non-regional platform hour cost	Annual operating cost savings (FY13 $$$)
AM Peak hour	0.175	0.210	9	12	0.026	0.042	0.068	16.994	$110.19	1,872.60
AM Peak shoulders	0.140	0.168	16	12	0.037	0.034	0.071	17.662		1,946.22
PM Peak hour	0.150	0.177	6	10	0.015	0.030	0.045	11.081		1,220.96
PM Peak shoulders	0.120	0.142	26	19	0.052	0.045	0.097	24.113		2,657.03
					0.131	**0.150**	**0.281**	**69.850**		**$7,696.81**

APPENDIX F: GLEBE ROAD PLAN DRAWINGS AND DETAILED TABLES



LEGEND

- NEW CURB
- NEW SIDEWALK
- NEW STRIPING
- TRANSIT LANE
- TRANSIT LANE (PEAK HOURS ONLY)
- CONCRETE TRANSIT LANE
- BUS IN MIXED TRAFFIC
- QUEUE JUMP SIGNAL
- EXISTING SIGNAL PRIORITY UPGRADE
- RETAINING WALL
- X X X X DRIVEWAY CLOSED
- RIGHT IN/RIGHT OUT DRIVEWAY OR INTERSECTION
- BRT DIRECTION OF TRAVEL
- AUTO DIRECTION OF TRAVEL
- BIKE LANE

0 25' 50'

Figure F-1

Glebe Road Queue Jump

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PARSONS BRINCKERHOFF

Table F-1: Capital Cost Estimate for Glebe Road

Item	Quantity	Units	Unit Cost	TOTAL COST	Methodology
DEMOLITION					----------
Pavement Demolition	0	SY	$10	$0	
Striping Removal	0	LF	$1.50	$0	Assume remove quantity same as install quantity, see striping below
PAVEMENT/EARTHWORK					----------
Clearing and Grubbing		AC	$50,000	$0	(Width of Roadway widening plus 10' outside for grading
Aggr. Base	0	TON	$25	$0	12" Depth
Asphalt Concrete - Base Course	0	TON	$70	$0	10" Depth
Asphalt Concrete - Wearing Course	0	TON	$90	$0	2" Depth
Dowelled PCC Concerte		SY	$75	$0	12" Depth, 4000 PSI
Remove/Backfill Unsuitable Matls		CY	$60	$0	Removal and Backfill of 2' Depth for 25% of New Pavement Area
Pavement Planing		SY	$5	$0	Mill 1.5" for the section of pavement being overlayed
Sidewalk	0	SF	$5	$0	
Curb & Gutter	0	LF	$25	$0	
Excavation	0	CY	$25	$0	Assumes 1' exavation paved areas, 8" excavation sidewalk/landscape areas
TRAFFIC					----------
Traffic Signal - bus priority	1	EA	$32,500	$32,500	Includes signal priority parts and controller logic/programming incl controller and/or software upgrade
Traffic Signal - queue jump	0	EA	$32,500	$0	Includes traffic signal priority, bus signal heads, wiring
Striping	0	LF	$4	$0	
Pavement Legends	0	EA	$400	$0	
Signs		EA	$500	$0	
OTHER					----------
Grassed Median		SF	$8	$0	
Landscaping Area		SF	$5	$0	

Item	Quantity	Units	Unit Cost	TOTAL COST	Methodology
Trees		EA	$800	$0	One tree every 50'.
Storm Sewer Pipe		LF	$70	$0	Twice the length of the section
No of Inlets		EA	$6,000	$0	Inlets every 200' at low side of pavement for each side of roadway
Streetlights		EA	$10,000	$0	100' spacing
Utility Pole Relocation		EA	$7,500	$0	
Retaining Wall		SF	$50	$0	
Bus Shelter	1	EA	$15,000	$15,000	
MOBILIZATION	1	LS	$5,000	$5,000	
Subtotal				**$53,000**	
Contingency	**35%**			**$19,000**	
Total Construction Estimate				**$72,000**	

SUPPORTING COSTS

Description	Percent		Total
PRELIMINARY ENGINEERING	2.50%		$2,000
FINAL DESIGN	6.00%		$4,000
CONSTRUCTION ENGINEERING	8.00%		$6,000
CHANGES DURING CONSTRUCTION	10.00%		$7,000
PUBLIC INVOLVEMENT	0.75%		$1,000
SUBTOTAL			**$20,000**

GRAND TOTAL	**$92,000**

ASSUMPTIONS

-Contingency covers unknown costs including MOT, E&S controls

-Date of Estimate: May 23, 2012

NOT INCLUDED

-Environmental Mitigation

-Permits

-Contract Incentives
-Utility Relocation
-Right of Way Acquisition
-Grade Separated Interchanges

Table F-2: Operating Cost Savings Estimate for Glebe Road

	NB Time savings/bus (min)	Bus volumes - NB	Total daily time savings - NB (pl hr)	Annual time savings (pl hr)	FY13 non-regional platform hour cost	Annual operating cost savings (FY13 $$$)
AM Peak Hour	0.168	10	0.028	6.972	$110.19	768.24
PM Peak Hour	0.155	10	0.026	6.433		708.80
AM Peak shoulders	0.134	19	0.043	10.597		1,167.73
PM Peak shoulders	0.124	29	0.060	14.923		1,644.41
			0.156	**38.925**		**$4,289.18**