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Mr. Michael Stevens, AICP
Executive Director
Capitol Riverfront BID
1100 New Jersey Avenue, SE
Washington, DC 20003

Re: M Street SE/SW Corridor Cycle Track Feasibility Analysis

As requested by the Capitol Riverfront BID, Toole Design Group, LLC (TDG) is pleased to provide this cycle track feasibility analysis for the M Street SE/SW corridor in Washington, DC.

Introduction

As cycle tracks do not exist in the District of Columbia, it is important to understand the elements of their design that differentiate them from bicycle lanes and sidepaths. A cycle track is a pair of one-way bikeways placed on each side of a roadway and physically separated from motor vehicle travel lanes. Bicyclists travel in the same direction of adjacent vehicular traffic.

A cycle track differs from bicycle lanes by the provision of a physical separation throughout. Bicycle lanes utilize pavement markings to separate bicyclists from automobile traffic and bicycle lanes encourage merging of motorists with bicyclists at intersections. Due to the physical separation, cycle tracks do not allow merging of motorists into the cycle track space. Motorists are required to turn across the cycle track at all intersections and driveways similar to how they must turn across crosswalks and sidewalks.

Sidepaths are similar to cycle tracks with the exception that sidepaths are located on one side of the roadway and allow bicyclist to operate in both directions. Sidepaths also typically allow pedestrians to utilize them whereas cycle tracks are restricted to bicyclists only.

Provision of a cycle track system along M Street Corridor will greatly improve bicycling conditions in this rapidly developing area of the District. Capitalizing on the high density mixed-use development, a high quality cycle track accommodation has the potential to provide residents and visitors an appealing transportation alternative to and within the corridor. A cycle track on this corridor will also create a link between the Anacostia Riverwalk Trail and planned bicycle trail along Maine Avenue connecting to the National Mall and trail systems in Virginia and Maryland.

This memorandum details the development of a cycle track and discusses a range of considerations for its implementation.

Concept Development

Cycle tracks have been in place for many years throughout Europe. They are just beginning to be installed in North America.

It is important to note bicyclists still interact with vehicles at all driveway and roadway intersections when traveling on sidepaths and cycle tracks. In the United States sidepaths have been demonstrated to have higher rates of bicycle crashes with vehicles due to the "wrong-way" component of bicycle travel. Cycle tracks reduce this risk by operating as one-way pairs on each side of the roadway.

Toole Design Group developed four initial alternative concepts for improving bicycle accommodation on the corridor within the existing curb lines. TDG also assessed the available right-of-way block by block along the corridor to determine the available space for potential future roadway reconfigurations which

reconsidered the total space between building faces. The concepts were developed to facilitate a discussion of desired level of bicycle accommodation and the potential impact on traffic and transit operations.

The four concepts developed were:

1. Cycle Track with Mixing Zone (New York City model)
2. 16 Foot Shared Bus/Bike Lane (non cycle track)
3. 12 Foot Shared Bus/Bike Lane (non cycle track)
4. Protected Curb Cycle Track (Montreal style model)

These concepts are attached as Appendix A.

Project Coordination and Concept Selection

The Capitol Riverfront Business Improvement District (BID) convened a coordination meeting with District of Columbia City Council Member Wells and the District Department of Transportation (DDOT) staff in April 2009 to review the concepts. The group agreed that installation of a light rail system on the corridor would result in a reconstruction of the roadway. It was agreed that the bicycle improvements should be seen as an interim measure which should be implemented as soon as practicable, therefore the feasibility analysis of cycle tracks on the roadway should be confined to the interim solutions that stay within the existing curb lines. It was decided to not pursue alternative roadway reconfigurations (i.e., curb reconstruction) as part of this effort.

Council Member Wells' staff preferred options that provide maximum separation between vehicular traffic (including bus traffic) and bicycle traffic. This eliminated the shared bus/bike lane options 2 and 3. Discussion of alternatives 1 and 4 focused on the potential traffic impacts and the bicyclists operations under each scenario.

The cycle track with mixing zone provided the highest degree of bicyclist protection at locations where motorists crossed the bicyclist path. This option required the removal of two through travel lanes of vehicular traffic in each direction and the installation of left and right turn lanes throughout the corridor. It was anticipated that this type of roadway would function well at ADT's of 10,000 to 20,000. Each turn lane would be fully signalized and the bicyclist approach would be signalized to separate the vehicular turning movements from the bicyclist through movement. This option also retains parking along the corridor. It was decided that this alternative would result in unacceptable traffic conditions as traffic on the corridor ranges from 10,000 to 30,000 ADT.

The group decided the provision of a protected curb lane cycle track that eliminated one lane of traffic in each direction should be the focus of the feasibility analysis. It is anticipated that this option will allow the roadway to function at an acceptable level while providing bicyclists with a bicycle facility that will promote bicycling within and along the corridor.

Refinement of Concept 4 - Protected Curb Cycle Track

TDG developed conceptual drawings of a protected curb cycle track for the entire corridor. These are included as Appendix B. The limits of the concept are from 6th Street, SW to 11th Street, SE.

The conceptual drawings detail the following major changes which are recommended for consideration with a cycle track design:

1. Provision of a physical barrier to delineate the cycle track from the remainder of the roadway.

2. Provision of transit access at each stop (patrons must be discharged at sidewalk level, not roadway level)
3. Consolidation and relocation of transit stops to far sides of intersections
4. Enhancements to traffic signal operations to reduce conflicts between turning motorists and bicyclists
5. Elimination of parking on M Street throughout the corridor
6. Management of potential conflicts between turning motorists and bicyclists at intersections and driveway crossings

Each element is discussed in detail.

Physical Separation

Separation of the cycle track from the roadway can be accomplished by a variety of methods. The principal of separation is to create an environment that feels comfortable for cyclists and can be maintained clear of debris. To allow street sweeping equipment to clean the cycle track and to allow space for passing of cyclists a minimum clear width of 6 feet is recommended. The concept drawings depict the installation of three-foot wide granite curbed islands. The islands are designed to allow stormwater to flow to the existing curb line and the existing stormwater collection system. All interim measures of separation recommended will allow stormwater to reach the existing curb flow line. A stormwater analysis of the potential spread of water in the travel lane was not performed but should be considered before any installation of permanent curbing.

The simplest and least expensive separation method is to utilize flexible posts every 10 feet (approximately $56,000). This option is explored further in the context of the other required treatments as construction option 1.

The most expensive option is to construct granite curbed islands (approximately $1.6 million) with an extensive range of options and costs in between.

A range of options is shown below for consideration.

Figure 1 - Flex Post Separation (item 8)

Figure 2 - Temporary Curb (items 9 and 10)

Figure 3 - Curb Separation (item 11, 13 or 14)

Figure 4 - Planter Separation (item 12)

The following table details the estimated costs for each method of separation:

CYCLE TRACK TRAFFIC SEPARATION OPTIONS

Option	Item #	Item	Quantity	Measure	Note	Unit Price	Unit Total
A	8	FLEX POST DELINEATORS (10 FOOT GAPS)	1109	EA	36 inch height	$50.00	$55,450
B	9	QUICK CURB (CONTINUOUS WITH NO GAPS)	3697	EA	3 foot length piece with post	$190.00	$702,430
C	10	QUICK CURB (CONTINUOUS WITH 10 FOOT GAPS)	1109	EA	3 foot length piece with post	$190.00	$210,710
D	11	8" GRANITE CURB ISLANDS (CONTINUOUS WITH 10 FOOT GAPS)	317	EA	25 foot length	$5,000.00	$1,585,000
E	12	6' PLANTER BOX ISLANDS (CONTINUOUS WITH 10 FOOT GAPS)	694	EA	72"L x 36"W x 36"H	$1,500.00	$1,041,000
F	13	8" CONCRETE CURB ISLANDS Overlaid on Pavement - No Excavation (CONTINUOUS WITH 10 FOOT GAPS)	317	EA	25 foot length rebar on pavement surface - no excavation	$100.00	$87,150
G	14	8" CONCRETE CURB ISLANDS Full Depth (CONTINUOUS WITH 10 FOOT GAPS)	317	EA	25 foot length full depth excavation	$3,000.00	$951,000

Based upon the unknowns of future streetcar implementation along M Street, it is recommended that temporary measures be installed to allow them to be used elsewhere in the city. Should a more permanent measure be desired it is recommended concrete islands be constructed on the surface of the existing roadway to minimize costs. This option is explored further in the context of the other required treatments as construction option 2. Backup costs are included in Appendix C.

Transit Access

It is recommended transit access continue to be provided at sidewalk level to minimize disruption to transit users. This can be accomplished by either allowing the bus to enter the cycle track or to extend the sidewalk across the cycle track. The preferred option is to construct curb extensions across the cycle track for the length of the bus stop (80 feet). This will require modifications to the existing stormwater collection system to prevent ponding of water within the cycle track and across the roadway. Curb extensions are the most expensive option adding up to $750,000 to the cost.

Regardless of the method of accommodation, it is recommended that all transit stops be moved to the far side of each intersection to reduce right turning motorists encroachments into the cycle track and to minimize potential conflicts arising from motorists turning right around a stopped bus. A number of stops are proposed for consolidation to improve transit efficiency and reduce cycle track encroachments.

Figure 5 - Curb Extended Bus Stop

Figure 6 - Shared Bus Stop/Cycle Track

Parking Elimination

It is recommended that parking be initially eliminated at all hours of the day adjacent to the cycle track to maintain open sight lines between motorists and bicyclists. After a period of evaluation it may be appropriate to allow parking adjacent to the cycle track during non-peak travel periods if it is desired to provide traffic calming along the corridor and to provide additional parking capacity. Additional sight distance analysis should be performed to ensure adequate visibility at all vehicle crossings of the cycle track.

Sidewalk Widening From Half St, SW to Half St, SE

The concept developed recommends the cycle track be incorporated into the sidewalk between Half Street, SW and Half Street, SE. The existing sidewalk widths vary greatly with some in need of repair. The most intense traffic on the corridor occurs within this stretch of roadway. Additionally, the geometry of the roadway varies. Incorporating the cycle track into the sidewalk system will reduce the lane shifting demands for motorists on the east and west approaches and transitions. It will also maximize roadway capacity at this location to the greatest extent feasible. It is likely separate signal phases may be necessary to protect pedestrians and cyclists from the high volumes of right turning vehicular traffic onto South Capitol Street.

Traffic Signal Operation

To minimize conflicts between turning motorists and bicyclist, it is recommended the existing signals be retimed to provide dedicated crossing time for bicyclists at intersections while turning vehicles are stopped. The time for cyclists to cross the intersection while cars are stopped would be concurrent with the pedestrian 'walk' indication. Initially this time should equal the walk phase which is typically set for 7 seconds. Provision of this time for bicyclists will also enhance pedestrian crossings by allowing pedestrians to have a head start on turning traffic.

This time can be provided when bicyclist are present by detecting them at each interval of the signal cycle. The protected crossing time should be evaluated after installation to determine if further signal timing changes are warranted to improve operations and safety. This change of operation can initially be implemented with existing equipment by directing the cyclist to follow the pedestrian signal. It is recommended that consideration be given to installing new signal equipment which is directed specifically to turning motorists and cycle track bicyclists. An initial pilot project at the New Jersey Avenue is recommended to evaluate the effectiveness of the signal timing and new signal equipment on operations and safety.

A graphic detailing the proposed signal equipment and signal timing schemes for the intersection approach with the cycle track is shown below. It is recommended the bicyclist signal flash yellow while right turning vehicles are allowed to turn on a flashing yellow. For locations with high turning traffic it may be necessary to provide a leading or lagging green arrow to clear vehicle traffic. At all times turning traffic is provided a green arrow, cyclists should see a red display and the pedestrian signal should display a solid DON'T WALK. AASHTO and MUTCD Considerations

The AASHTO Bicycle Guide (1999) sets the design parameters for bicycle facility design in the United States. Cycle tracks are not an included facility. Bicycle signal heads are also not currently an approved traffic control device in the United States as established by the Manual on Uniform Traffic Control Devices (MUTCD).

It is recommended that permission to experiment be sought from FHWA to evaluate bicycle signal heads under the proposed conditions. DDOT is currently pursuing a request to experiment with a bicycle signal head at the intersection of 16th/U St/New Hampshire Ave, NW. It is also recommended an evaluation of the operational and safety aspects of the cycle track installation be conducted. Operational and physical changes should be implemented as necessary to correct observed deficiencies or safety concerns.

The following graphics detail an initial signal timing sequence with new equipment.

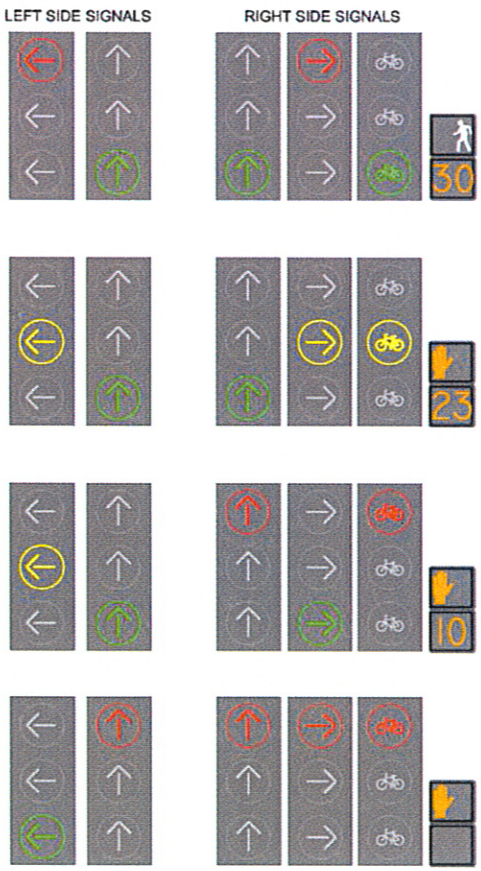

Figure 7 - Signal Sequencing

Figure 8 - Bicycle Signal

Traffic Signs

It is recommended that additional signs be located along the corridor to warn bicyclists to watch for turning traffic across the cycle track. The yellow warning sign shown at left is allowed per the MUTCD and should be installed at all approaches to intersections where turning traffic is allowed across the cycle track.

An additional sign is recommended to advise motorists to yield to pedestrians and bicyclists in adjacent crosswalks (at intersections) or sidewalks (at driveways). This is a modified version of a sign proposed in an upcoming edition of the MUTCD which advises motorists to yield to pedestrians. Evaluation of this sign is recommended.

Figure 9 - Warning Sign

Figure 10 - Modified MUTCD Regulatory Sign

Cost Estimates

The cost estimates produced for this report are preliminary. They should be used to help compare separation options while considering aesthetic features and implementation timelines. Signalization and drainage cost will change depending upon the existing conditions in the field and the required underground work. Modifications to drainage will require a topographic survey.

Recommendations

Given the unknowns of the timeline and location of streetcar on this roadway segment, it is recommended the improvements be visualized as a 5 to 10 year investment.

Option One

This design option utilizes flex posts to separate the cycle track from motor vehicle traffic. Posts are spaced at 10 foot intervals. Traffic signs recommended are installed at all intersections, a solid pavement marking stripe is located between the outside motor vehicle lane and the flex posts. All bus stops are consolidated and moved to the far sides of intersections as recommended without the construction of concrete bus pads or curb extensions. Bicycle symbols are installed in the cycle track and at all vehicle crossing locations. Existing concrete bus pads remain in place. Signals are retimed to provide a leading pedestrian interval of a minimum of 7 seconds and bicyclists are directed to follow the pedestrian signals with signs. Backup costs are included in Appendix C.

Option Two

This design option utilizes a surface mounted concrete curb (with drilled rebar posts) to separate the cycle track from motor vehicle traffic. Flexible posts are mounted to the concrete and are spaced at 30 foot intervals. Traffic signs recommended are installed at all intersections, a solid pavement marking stripe is located between the outside motor vehicle lane and the flex posts. Bicycle symbols are installed in the cycle track and at all vehicle crossing locations. All bus stops are consolidated and moved to the far sides of intersections as recommended without the construction of concrete bus pads. Concrete curb

extensions are not provided. Existing concrete bus pads remain in place. Signals are retimed to provide a leading pedestrian interval of a minimum of 7 seconds and bicyclists are directed to follow the pedestrian signals with signs. Backup costs are included in Appendix C.

Option 1 - Markings, Signs, Flex Post, Flex Curb

CYCLE TRACK TRAFFIC MARKINGS

Item #	Item	Quantity	Measure	Note	Unit Price	Unit Total
1	6" SOLID WHITE THERMOPLASTIC MARKING	12370	LF	Edge line to cycle track	$3.00	$37,110
2	4" SOLID YELLOW THERMOPLASTIC MARKING	9130	LF	new lane lines between Half St SW	$2.00	$18,260
3	REMOVE PAVEMENT MARKINGS	9130	LF	between Half St SW and Half St SE	$2.00	$18,260
4	THERMOPLASTIC PAVEMENT SYMBOLS	42	EA	located within cycle track	$250.00	$10,500
5	SIGNS	96	EA	average 6 signs per intersection	$250.00	$24,000
10	QUICK CURB (CONTINUOUS WITH 10 FOOT GAPS)	1109	EA	3 foot length piece with post	$190.00	$210,710
8	FLEX POST DELINEATORS (10 FOOT GAPS)	1109	EA	36 inch height	$50.00	$55,450
					subtotal	**$374,290**
				Engineering Costs	**5%**	**$18,715**
				Contingency Percentage	**5%**	**$18,715**
				Maintenance of Traffic	**5%**	**$18,715**
					Option 1 Total	**$430,434**

Option 2 - Markings, Signs, Flex Post, Concrete Islands

CYCLE TRACK TRAFFIC MARKINGS

Item #	Item	Quantity	Measure	Note	Unit Price	Unit Total
1	6" SOLID WHITE THERMOPLASTIC MARKING	12370	LF	Edge line to cycle track	$3.00	$37,110
2	4" SOLID YELLOW THERMOPLASTIC MARKING	9130	LF	new lane lines between Half St SW	$2.00	$18,260
3	REMOVE PAVEMENT MARKINGS	9130	LF	between Half St SW and Half St SE	$2.00	$18,260
4	THERMOPLASTIC PAVEMENT SYMBOLS	42	EA	located within cycle track	$250.00	$10,500
5	SIGNS	96	EA	average 6 signs per intersection	$250.00	$24,000
13	6" CONCRETE CURB ISLANDS Overlaid on Pavement - No Excavation (CONTINUOUS WITH 10 FOOT GAPS)	317	EA	25 foot length with 10 foot gap	$525.00	$221,875
8	FLEX POST DELINEATORS (10 FOOT GAPS)	1109	EA	36 inch height	$50.00	$55,450
					subtotal	**$385,455**
				Engineering Costs	**5%**	**$19,273**
				Contingency Percentage	**5%**	**$19,273**
				Maintenance of Traffic	**5%**	**$19,273**
					Option 1 Total	**$443,273**

Signal Pilot Project

A traffic signal pilot is recommended at the intersection of New Jersey Avenue and M Street to evaluate the bicycle signal heads and to experiment with different timing schemes before implementation is extended to the remainder of the corridor. It is recommended that up to 50 thousand dollars be allocated for the purchase and installation of the equipment and the technical evaluation. Formal FHWA approval is recommended.

Appendix A – Initial Concepts

Appendix B – Preferred Concept

Appendix C – Cost Estimates

CYCLE TRACK TRAFFIC MARKINGS

Item #	Item	Quantity	Measure	Note	Unit Price	Unit Total
1	**6" SOLID WHITE THERMOPLASTIC MARKING**	**12370**	**LF**	**Edge line to cycle track**	**$3.00**	**$37,110**
2	**4" SOLID YELLOW THERMOPLASTIC MARKING**	**9130**	**LF**	**new lane lines between Half St SW**	**$2.00**	**$18,260**
3	**REMOVE PAVEMENT MARKINGS**	**9130**	**LF**	**between Half St SW and Half St SE**	**$2.00**	**$18,260**
4	**THERMOPLASTIC PAVEMENT SYMBOLS**	**42**	**EA**	**located within cycle track**	**$250.00**	**$10,500**
5	**SIGNS**	**96**	**EA**	**average 6 signs per intersection**	**$250.00**	**$24,000**

CYCLE TRACK TRAFFIC CONFLICT AREA MARKING OPTION

Option	Item #	Item	Quantity	Measure	Note	Unit Price	Unit Total
A	6	GREEN PAINTED CONFLICT AREAS (52 CROSSINGS)	17400	SF	17 driveway, 35 roadway	$6.00	$104,400
B	7	BIKE SYMBOLS FOR GREEN PAINTED CONFLICT AREAS	174	EA	symbols spaced 10 feet apart	$250.00	$43,500

CYCLE TRACK TRAFFIC SEPARATION OPTIONS

Option	Item #	Item	Quantity	Measure	Note	Unit Price	Unit Total
A	**8**	**FLEX POST DELINEATORS (10 FOOT GAPS)**	**1109**	**EA**	**36 inch height**	**$50.00**	**$55,450**
B	9	QUICK CURB (CONTINUOUS WITH NO GAPS)	3697	EA	3 foot length piece with post	$190.00	$702,430
C	10	QUICK CURB (CONTINUOUS WITH 10 FOOT GAPS)	1109	EA	3 foot length piece with post	$190.00	$210,710
D	11	8" GRANITE CURB ISLANDS (CONTINUOUS WITH 10 FOOT GAPS)	317	EA	25 foot length	$5,000.00	$1,585,000
E	12	6' PLANTER BOX ISLANDS (CONTINUOUS WITH 10 FOOT GAPS)	694	EA	72"L x 36"W x 36"H	$1,500.00	$1,041,000
F	**13**	**6" CONCRETE CURB ISLANDS Overlaid on Pavement - No Excavation (CONTINUOUS WITH 10 FOOT GAPS)**	**317**	**EA**	**25 foot length with 10 foot gap**	**$525.00**	**$221,875**
G	14	6" CONCRETE CURB ISLANDS Full Depth Excavation (CONTINUOUS WITH 10 FOOT GAPS)	317	EA	25 foot length with 10 foot gap	$3,000.00	$951,000

CYCLE TRACK SIGNALIZATION CHANGES

Item #	Item	Quantity	Measure	Note	Unit Price	Unit Total
15	RIGHT TURN SIGNAL HEAD (16 INTERSECTIONS)	32	EA	42 inch height	$2,500.00	$80,000
16	BICYCLE SIGNAL HEAD	32	EA	3 foot length piece with post	$2,500.00	$80,000

CYCLE TRACK BUS STOP IMPROVEMENT OPTIONS

Option	Item #	Item	Quantity	Measure	Note	Unit Price	Unit Total
A	17	CONSTRUCT NEW BUS PAD (IN LANE)	16	EA	80 foot length, 10 foot width	$14,000.00	$224,000
B	18	CONSTRUCT BUS BULBOUT WITH IN LANE STOP, ADJUST DRAINAGE	16	EA	80 foot length, 10 foot width	$30,000.00	$480,000
C	19	QUICK CURB - BUS STOPS IN CYCLE TRACK ON FAR SIDE	16	EA	Use color and pavement markings	$4,800.00	$76,800

WIDENING SIDEWALK FROM HALF, SW TO HALF, SE

Item #	Item	Quantity	Measure	Note	Unit Price	Unit Total
20	WIDENING SIDEWALK FROM HALF, SW TO HALF, SE	6600	SF		$40.00	$264,000

The basic option to add surface concrete islands (item 13), traffic markings (items 1-4), signs (item 5), and flex posts (item 8) is approximately $385,455.

These costs do not include the engineering, contingency, or maintenance of traffic expenses which will also be required. These costs were utilized to compare alternatives and to develop two conceptual options.