MEMORANDUM

To: Erkin Ozberk and Rosalind Grigsby (Takoma Park)

CC: Deborah Bilek (MWCOG)

From: Michael King, Will Handsfield

Date: June 28, 2013

Subject: New Hampshire Ave Multi-way Boulevard Feasibility Study -- Bicycle Facilities

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INTRODUCTION

This memo summarizes the bicycle facilities portion of the New Hampshire Avenue Multi-way Boulevard Feasibility Study. The subject corridor is a two mile long stretch of New Hampshire Avenue from Eastern Avenue to University Boulevard (MD State Route 193). The New Hampshire Avenue Corridor Concept Plan (2008) and the Takoma Langley Crossroads Sector Plan (2010) propose to convert this corridor into a multi-way boulevard with a four or six-lane main road and one-lane side roads. The subject of this task was to explore options for bicycle facilities along the proposed multi-way boulevard.

Facilities Described in Existing Plans

Initial guidance for a bicycle facility on New Hampshire Avenue comes from the Takoma Langley Crossroads Sector Plan[1] and the New Hampshire Avenue Corridor Concept Plan[2], which both call for bike facilities through the length of the revitalized New Hampshire Ave. corridor. However, these plans differ, with the Concept Plan (see Figure 1) recommending bicycles share the side road with motor vehicle traffic traveling at 10 – 15 miles per hour (mph), while the Sector Plan shows a bike lane adjacent to the side median within the main road (see Figure 2).

[1] Takoma Langley Crossroads Sector Plan, Planning Board Draft, May 2010, P. 32

[2] New Hampshire Avenue Corridor Concept Plan, P. 36

121 WEST 27TH STREET, SUITE 705 NEW YORK, NY 10001-6207 212-242-2490 FAX 212-242-2549

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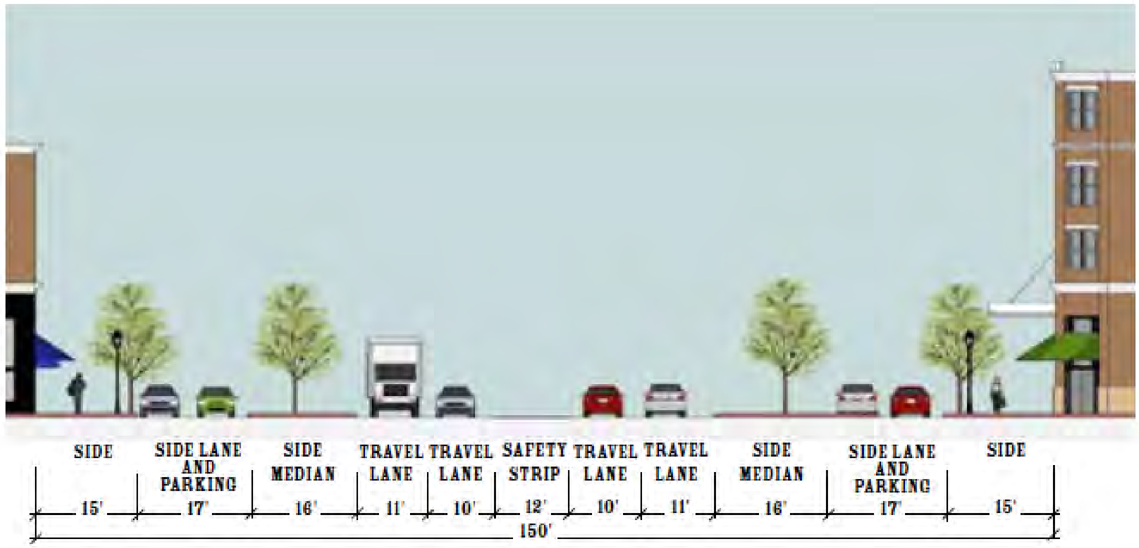
Figure 1 Cross Section from New Hampshire Avenue Corridor Concept Plan



The cross section from the New Hampshire Avenue Corridor Concept Plan (Figure 1) shows a shared nine to 10 foot wide travel lane where cyclists and automobiles travel between 10 – 15 mph. The concept plan omits some of the more technical details on how that relatively low automobile speed would be accomplished, but some combination of traffic control devices, speed humps or other tactics could be used successfully on the level-grade portions of the roadway. Maintaining this speed on the hilly portions becomes more challenging since drivers will often accelerate both up and down hills, while cyclists accelerate downhill, while their speed drops significantly uphill. The shared lane concept is analyzed in-depth as part of Option A (see Figures 3-7 and 23).

The cross section from the Takoma Langley Crossroads Sector Plan (Figure 2) shows a striped bike lane in the main roadway adjacent to the median. Its width is not articulated, but for purposes of analysis we assumed a width of five feet.

Figure 2 Bike Lane in Main Road from Takoma Langley Crossroads Sector Plan

To analyze and compare the various configurations for bicycle comfort level, the project team used the Federal Highway Administration's (FHWA) bicycle compatibility index (BCI) formula.

This formula was developed to be an analytical tool that could grade existing bicycle facility's bicycle level of service (BLOS) using an "A" through "F" letter scale. This tool allows planners to use known roadway attributes combined with hypothetical changes in order to better understand a bicycle facility's comfort level. Importantly, BLOS ratings pertain to the average adult cyclist, and do not account for adolescents, children, or the elderly, who are more sensitive to the speed and proximity of adjacent automobile facilities. Table 1 shows the various BCI grades, and their absolute values as derived from the BCI calculation worksheet.

The configuration shown in Figure 2 was run through the FHWA's BCI formula[4] and the bike lane within the main road configuration results in BLOS grade of "D-", moderately low bicycle compatibility, with an absolute value of 4.05. This BLOS rating is relatively low, and indicates that adolescents, children, or the elderly, would not be likely to use this bike facility for any reason.

Table 1[3]

Bicycle Compatibility Index (BCI) ranges associated with bicycle level of service (BLOS) designations and compatibility level qualifiers.

BLOS	BCI Range	Compatibility Level*
A	≤ 1.50	Extremely High
B	1.51 - 2.30	Very High
C	2.31 - 3.40	Moderately High
D	3.41 - 4.40	Moderately Low
E	4.41 - 5.30	Very Low
F	> 5.31	Extremely Low

*Qualifiers for compatibility level pertain to the average adult bicyclist.

The principal drawback of this lane configuration is the speed differential between cars moving at 45 mph[5] and cyclists moving between eight to 14 mph, the general range of traveling speed for cyclists in urban environments. This analysis did not extend to consideration of slip-lanes through the median or how turning movements for vehicles and cyclists would be accommodated at intersections, but in any scenario, the speed differential places the cyclist in significant danger wherever the paths of cyclists and drivers cross. For this reason, the project team does not recommend further study of this option.

SHA Bicycle Facilities

Maryland SHA has an established policy to create and expand a statewide bicycle network:

> *Creating a regional bicycle network that connects both on-road and off-road facilities to transit stops, key community destinations, and other bicycle traffic generators and destinations is critical to moving Maryland towards a complete multi-modal transportation system. As SHA develops this system, it is imperative that we make our facilities as safe and efficient as possible for all roadway users. To this end, recognizing the potential safety concerns of mixing bicycles with motor vehicle traffic, SHA endorses the creation of a statewide bikeway network to increase motorist awareness*

[3] For further information on BCI and the details of generating these calculation on the FHWA website: http://safety.fhwa.dot.gov/tools/docs/bci.pdf

[4] See BCI calculation worksheets in the Appendix for further detail

[5] 85th percentile speed from current configuration of NH Ave

> *and acceptance of bicyclists as legitimate roadway users and to actively promote safe bicycling along our highways.*[6]

With regard to specific facilities, SHA follows the guidelines of the American Association of State Highway & Transportation Officials (AASHTO). For the configuration of New Hampshire Avenue as proposed in the concept plan and sector plan, the bike lane would be between four and six feet wide within the main road – the SHA-managed portion of the roadway. In a 2012 update to the AASHTO bicycle facility guidelines, the organization intentionally remained silent on design options for cycletracks, choosing to pull a drafted section on these facilities out of their final document. While the debate on cycletracks continues at AASHTO, it has been settled for the members of the National Association of City Transportation Officials (NACTO) who have published their own guidelines on cycletracks tailored to fit within urbanized areas.

A secondary issue for SHA is that of ownership and management. SHA guidelines indicate that the agency is responsible for building this network, but there appears to be little guidance on what to do when an adjacent bicycle facility already exists, but is managed by a city or other entity, as would be the case with the side road bikeway option. The logical reading of the SHA policy is that Maryland desires a robust bicycle network, and wants SHA to facilitate building it, whether the network exists on state, county, city, or federal right-of-way should be immaterial so long as the network continues to grow and functions well for cyclists.

The key issues SHA, Montgomery County, and Takoma Park must reconcile are: 1) how to proceed on building a cycletrack option that is not specifically recommended by the AASHTO guidelines adopted by the state, but which has been adopted by NACTO and other relevant professional organizations that focus on urban bikeway design, and 2) whether the state has flexibility on how to meet its bicycle network policy goals through using another jurisdictions right-of-way and deferring management to that jurisdiction as would be the case with the side-road options.

The project team proceeded in making recommendations without assuming either of these issues will be an impassable constraint to selecting a high-quality bicycle facility.

DESCRIPTION OF OPTIONS

The Nelson/Nygaard project team attended a working group session on May 7th, 2013 to discuss various options with stakeholders from Takoma Park, Montgomery County, Prince Georges County, and Maryland State Highway Administration.

The group considered the following options for the bicycle component:

- Option A: A shared lane within the side road segment of the New Hampshire Avenue
- Option B: A separated cycletrack against the curb within the side road segment of New Hampshire Avenue
- Option C: A separated cycletrack against the median within the side road segment of New Hampshire Avenue
- Option D: A separated bi-directional cycletrack against the median within the side road segment of New Hampshire Avenue

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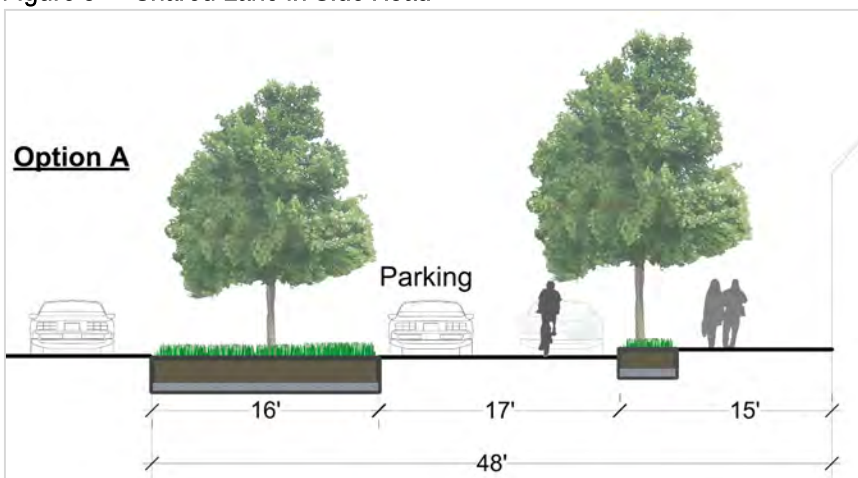
[6] MDOT SHA Policy on Marked Bicycle Lanes, November 2011

Each of these options presents various tradeoffs between bicyclist comfort and safety, motorist access and speed, and access to adjacent properties.

Option A – Shared Lane in Side Road

In the shared lane option, there is a 16 foot wide median/bioswale, with 17 feet of paved side road, and a 15 foot sidewalk. The 17 feet of side road space is shared between automobile/bicycle travel lane and a parking lane for most of its length, with parking removed near the intersection to allow turning movements. This option will require speed humps or similar to maintain lower driver speeds of 15-20 mph.

Figure 3 Shared Lane in Side Road



The shared lane option provides the most flexibility for drivers to retain access to parking and convenient access to adjacent businesses and homes. Cyclists, on the other hand, will be less comfortable due to the speed differential between 25 mph motor vehicle traffic and the eight to 12 mph a cyclist typically maintains in an urban environment. An additional factor for speed differential is the topography of the corridor, which is quite hilly. On the downhill, cyclists can easily maintain the proposed 25 mph speed limit, but on some of the uphill sections, less-able cyclists may only achieve four mph. Considering this speed difference of 21 mph or more, and the 10 foot road width, we conclude that an average adult cyclist will be very uncomfortable, and likely to either seek out other routes, or use the sidewalk for their travels. Even a very fit cyclist may only achieve 17 to 18 mph on some of these climbs, leaving a seven to eight mph speed differential with the automobiles and no room for safe passing.

Option A, the shared-lane, was rated as per the FHWA's bicycle compatibility index formula, and it results in a bicycle level of service (BLOS) grade of "D" - moderately low bicycle compatibility, with an absolute value of 3.86[7].

[7] See Figure 1 in the Appendix for a chart of BLOS from the FHWA BCI document

Figure 4 Option A Plan View at Unsignalized intersection

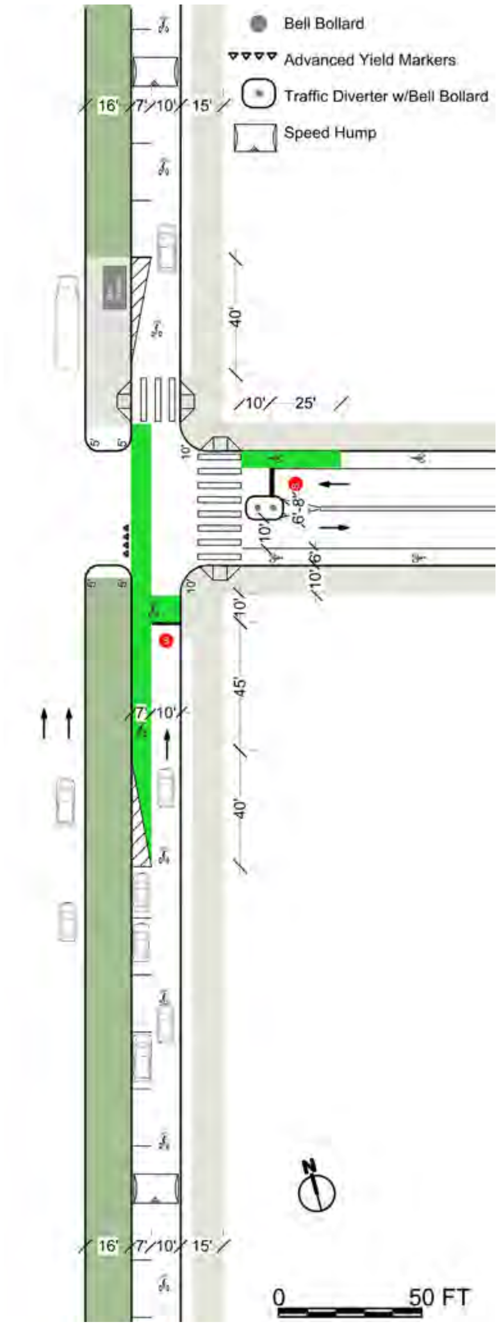
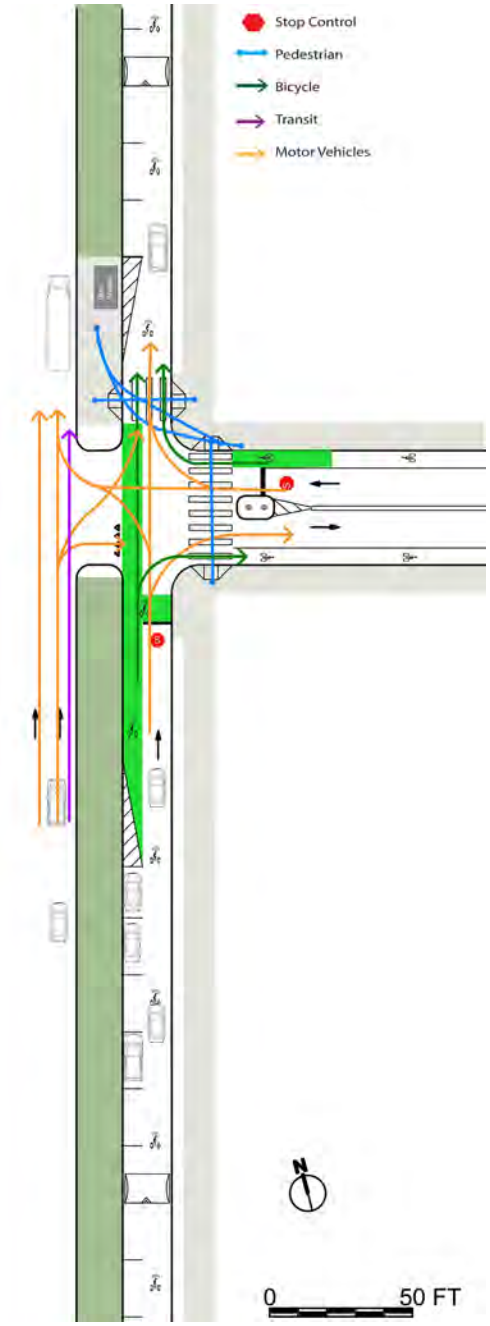


Figure 5 Option A Plan View Movements at Unsignalized Intersection



In Option A, cyclists share the side road, and have enhanced green pavement markings and dedicated space at intersections to aid in safe crossings. Bike boxes and green lane markings provide extra visibility in areas where cyclists are at risk of "right and left hook" crashes.

Figure 6 Option A Plan View at Signalized intersection

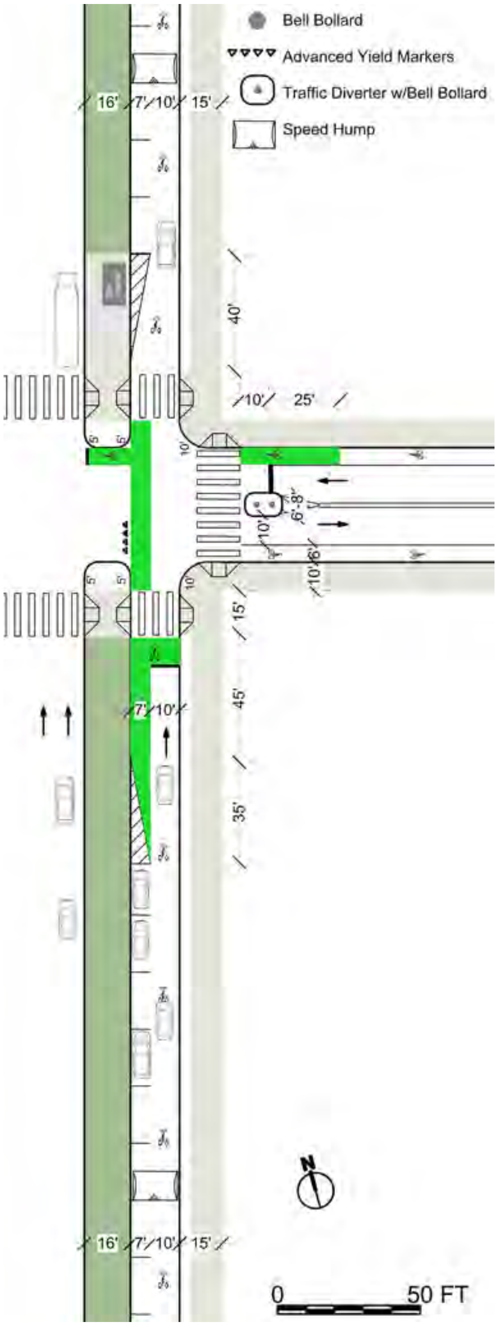
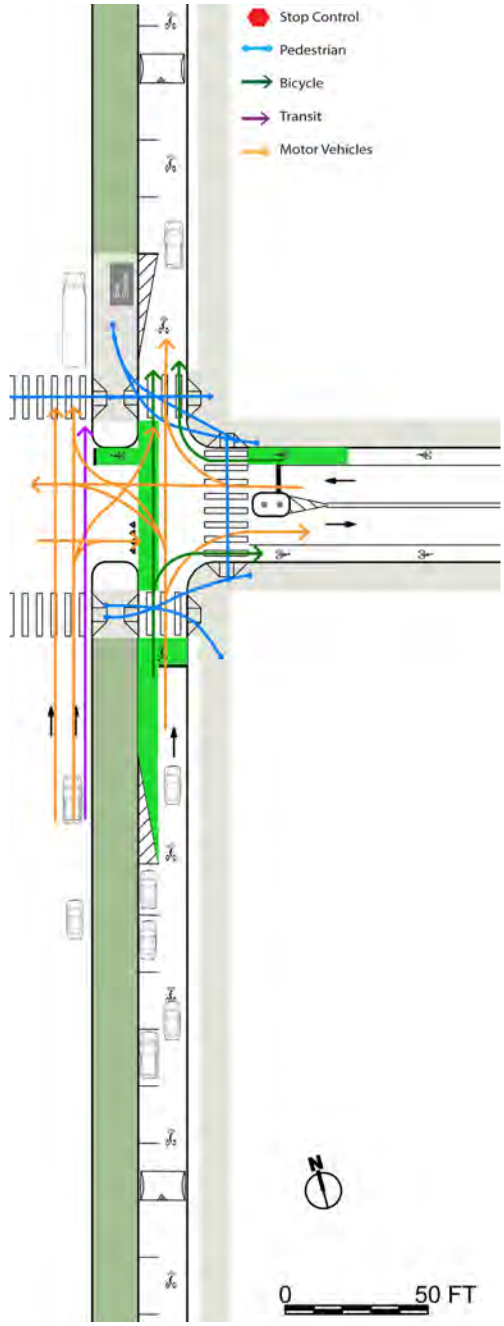


Figure 7 Option A Plan View Movements at Signalized Intersection

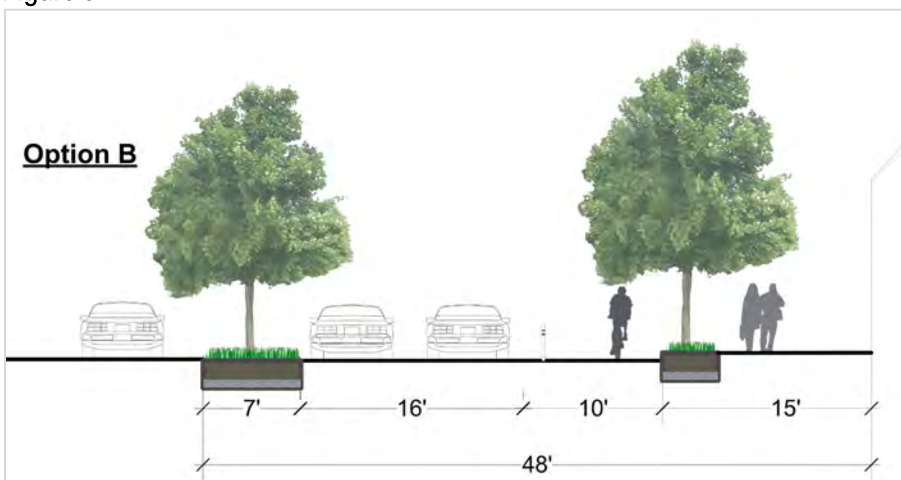


At signalized intersections, the bike lane and bike box must stop behind the near-side crosswalk to allow safe pedestrian crossings. A bike box is added to the cross street at the median to provide queuing space separated from auto queuing.

Option B – Curbside Cycletrack

A typical section of the road with this configuration, starting at the median, has a seven foot wide median bioswale, a 16 foot paved side road for parking and automobile travel, a three foot buffer zone, a seven foot one-way cycletrack running adjacent to the curb and a 15 foot wide sidewalk. The buffer zone will have vertical separation using flex posts, and it could further be separated using a curb or a slight change in elevation from the road bed[8]. At intersections and bus stops, the median would be widened into the space typically used for parking.

Figure 8



Option B separates the bicycle traffic and automobile traffic, and provides quick and convenient curbside access for cyclists. However, in locating the cycletrack next to the curb, motorists who park and exit their vehicles will need to cross the automobile travel lane and the cycletrack in order to reach businesses, homes, or other destinations on the curb side. In this configuration, vertical separation is vital to ensure vehicles don't venture into, and park in the cycletrack, thus blocking it for cyclist's use. The curbside L Street cycletrack in Washington DC has a similar configuration separated by vertical flex-posts, but as of this writing, parking within the cycletrack, remains very common, especially by delivery vehicles, creating a hazard to cyclists who must weave around stopped vehicles (parking pressures along New Hampshire Avenue are less than L Street, so this should be less of an issue).

Option B provides a superior cycling experience on the uphill portions of the roadway compared to the Option A shared lane. By contrast, in a separated cycletrack facility, the differential between an able cyclist and a less-able cyclist might be four to eight mph, a much lower differential than between cyclists and cars, and with enough lateral space for the faster cyclist to comfortably pass the slower cyclist.

One drawback is the issue of driveway access and other curb cuts. At these places, vehicles will cross the cycletrack, presenting a potential conflict and collision risk. The best practice is to eliminate, or reduce the frequency of curb cuts to the extent possible. In the Takoma Langley Crossroads Sector Plan, the long term vision for the corridor has fewer curb cuts than exist today, and if that plan is implemented, Option B could work well for cyclists. However, since the sector plan relies on private developers making these changes, the issue of staging must be considered.

[8] The roadbed drainage slope would likely be oriented toward the bioswale side, allowing for a slightly elevated cycletrack while maintaining drainage function.

If the road reconstruction precedes the redevelopment, or if there are development "hold-outs", the cycletrack design may have to accommodate long stretches of the existing conditions, which have many wide curb cuts that present significant safety hazards to cyclists.

The curbside cycletrack option was run through the FHWA's bicycle compatibility index, which results in a BLOS grade of A, with an absolute value of 1.09. Under the FHWA's rating system, this is an "extremely high" level of bicycle compatibility.

Figure 9 Option B Plan View at Unsignalized intersection

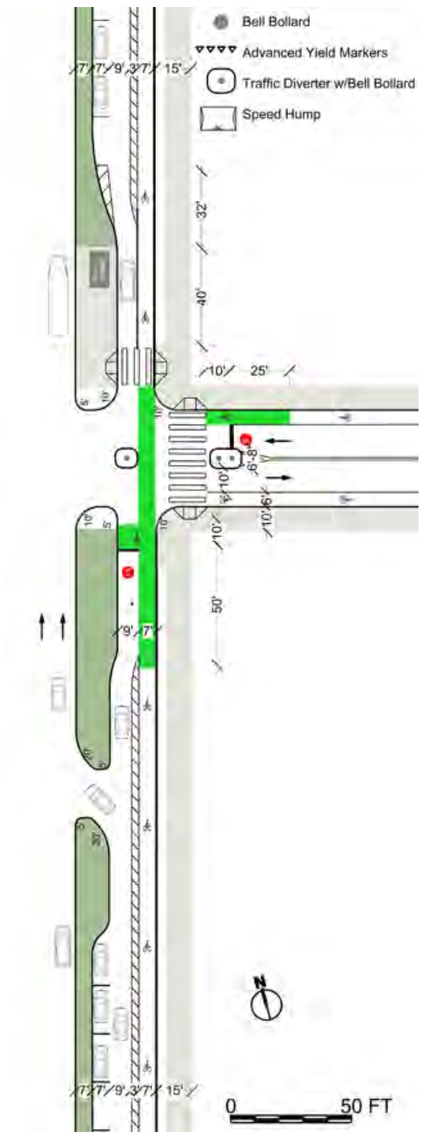
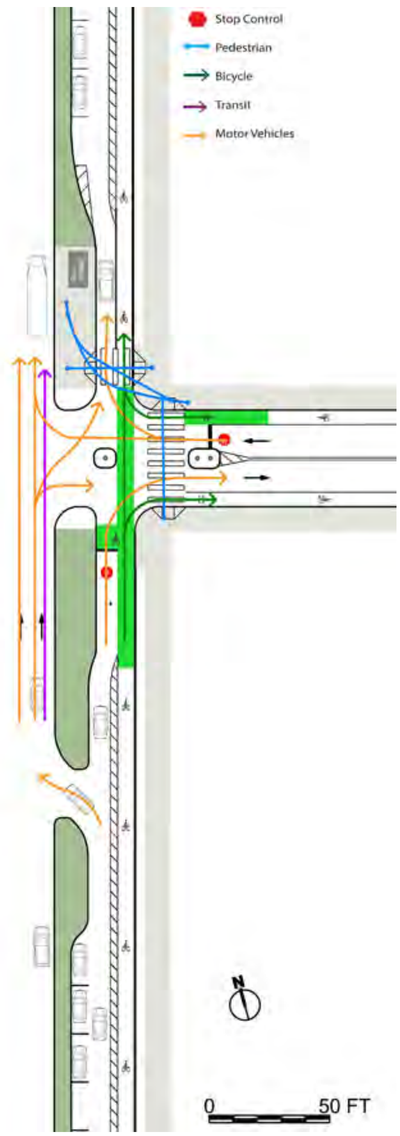


Figure 10 Option B Plan View Movements at Unsignalized Intersection



In Option B, there is a one-way curbside cycletrack with enhanced green pavement markings and bike boxes at intersection conflict zones. Bike boxes and green lane markings provide extra visibility in areas where cyclists are at risk of "right hook" crashes. The risk of "left hook" crashes is eliminated by adding a slip-lane through the median prior to the intersection.

Figure 11 Option B Plan View at Signalized Intersection

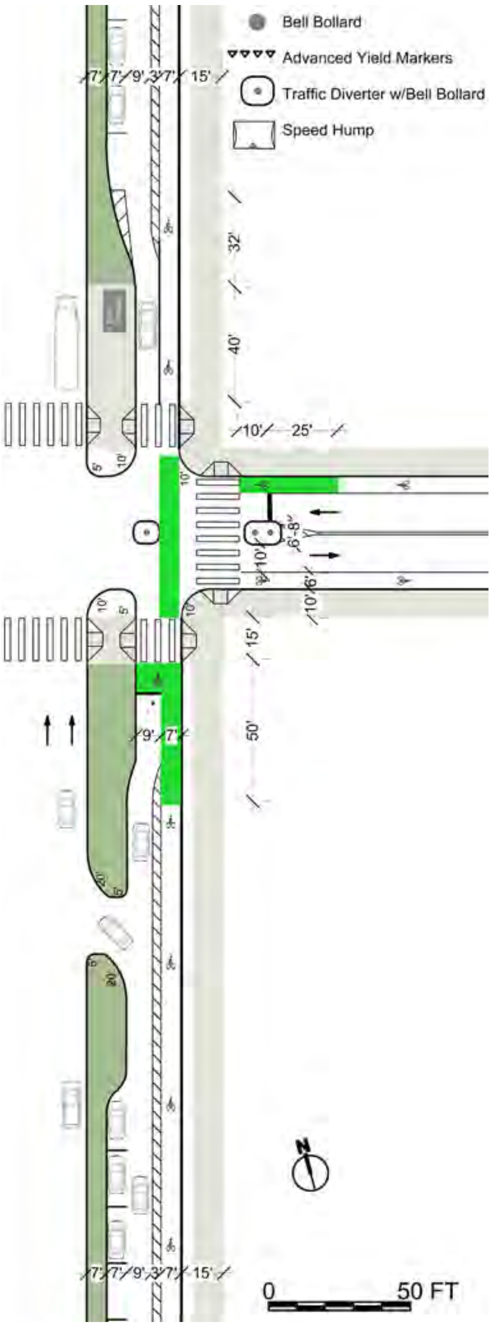
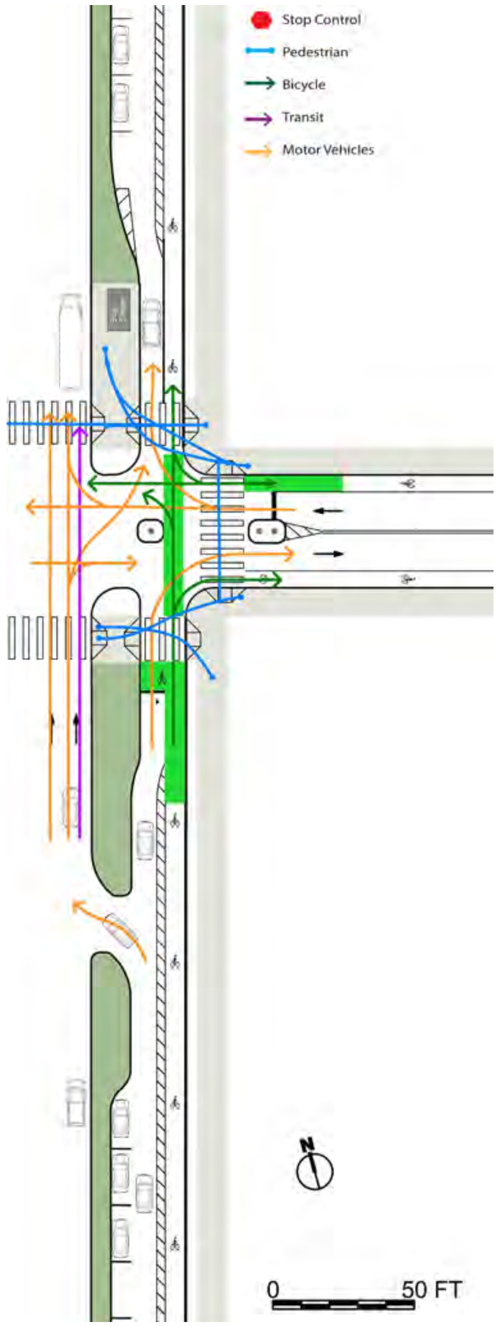


Figure 12 Option B Plan View Vehicle Movements at Signalized Intersection



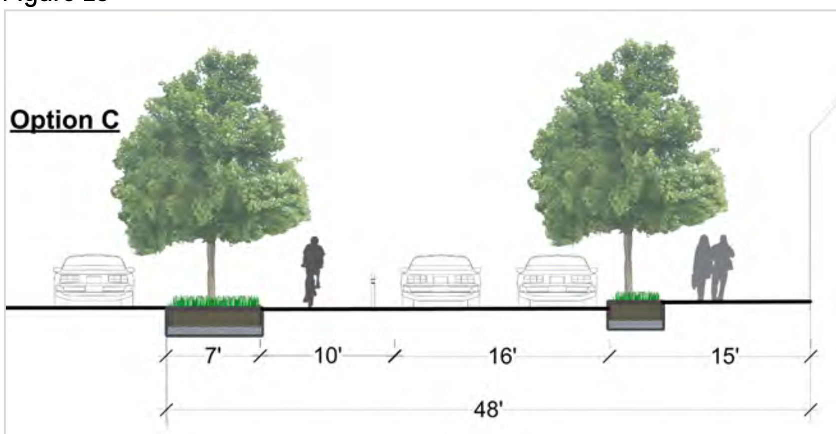
At signalized intersections, the bike lane and bike box must stop behind the near-side crosswalk to allow safe pedestrian crossings. Use of a diverter requires vehicles in the side road to turn right at the cross street, while cyclists may proceed straight in the green bike lane.

Option C – Median-side Cycletrack

There are two options for a median-side cycletrack. In both options, minimizing slip lanes and other cuts through the median is necessary to maintaining bicyclist safety.

A typical section of the road with this configuration, starting at the median, has a seven foot wide median bioswale, a seven foot one-way cycletrack, a three foot buffer zone incorporating vertical flex posts, a 16 foot paved side road for parking and automobile travel, and a 15-foot wide sidewalk. At intersections and bus stops, the median would be widened to 14 to 17 feet, and the cycletrack and auto travel lane would follow the contour of this curve.

Figure 13



Option C separates the bicycle traffic and automobile traffic, but in contrast to option B, cars are placed adjacent to the curb. This would be an improvement for motorists and a minor inconvenience for cyclists, requiring them to cross the travel lane when entering or leaving the cycletrack, especially at mid-block. The benefit is that motorists, especially delivery drivers, will not have an incentive to block the cycletrack in order to have convenient access to businesses and residential areas. In this configuration, using flex posts as the vertical separation is much more likely to be effective than in option B.

Option C provides a superior cycling experience on the uphill portions of the roadway compared to the Option A shared lane.

A critical element of the median-side cycletrack would be to not include slip lanes crossing the median from the New Hampshire Avenue main roadway. Slip lanes from the side road to the main road could be possible, but also pose a collision hazard to cyclists. To minimize the collision hazard, any median cut-throughs from the side road should approach a ninety degree angle so that the driver can see any cyclists approaching from their left as they would at a typical perpendicular intersection. However, the closer a car is to perpendicular when crossing the cycletrack, the more likely it is to physically block the cycletrack as they wait for a gap in the mainline traffic since the median is only seven feet wide – not enough for a typical 16 foot long car to queue without blocking the entire cycletrack. For this reason, if this concept is chosen, nearly all automobile movements between the main road and the side road should take place at intersections.

Regarding the redevelopment of the area, option C allows for the street reconstruction to proceed irrespective of when each parcel is redeveloped, or whether or not they conform to the land use patterns described in the Takoma Langley Crossroads Sector Plan. Existing curb cuts could stay in place by removing curbside parking in those segments.

The one-way median-side cycletrack option was run through the FHWA's bicycle compatibility index calculation, which results in a BLOS grade of A, with an absolute value of 1.09. Under the FHWA's rating system, this is an "extremely high" level of bicycle compatibility.

Figure 14 Option C Plan View at Unsignalized intersection

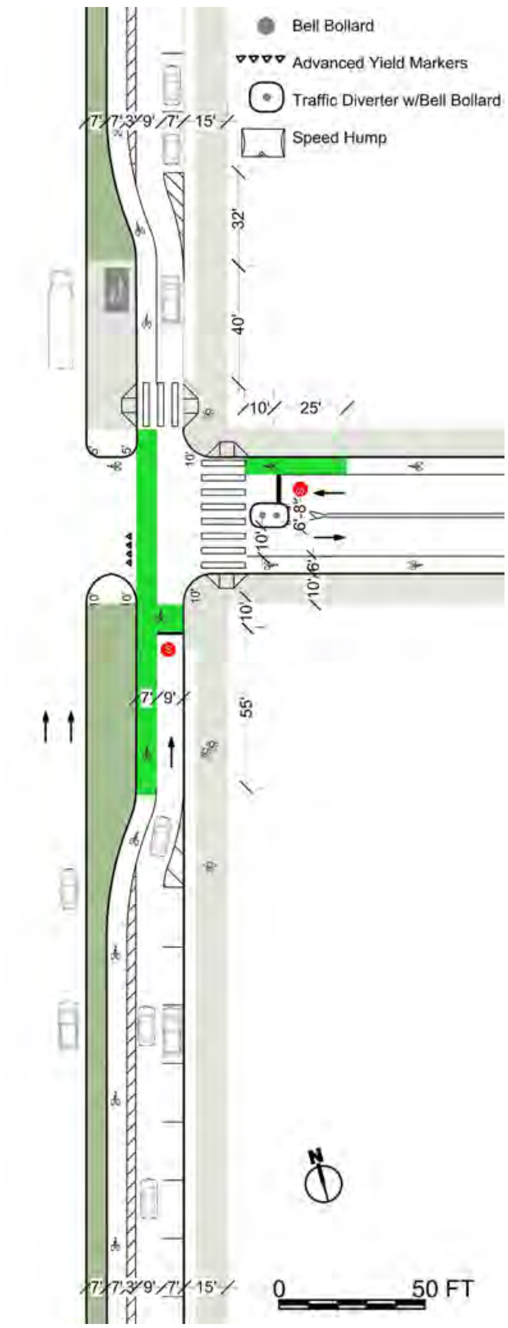
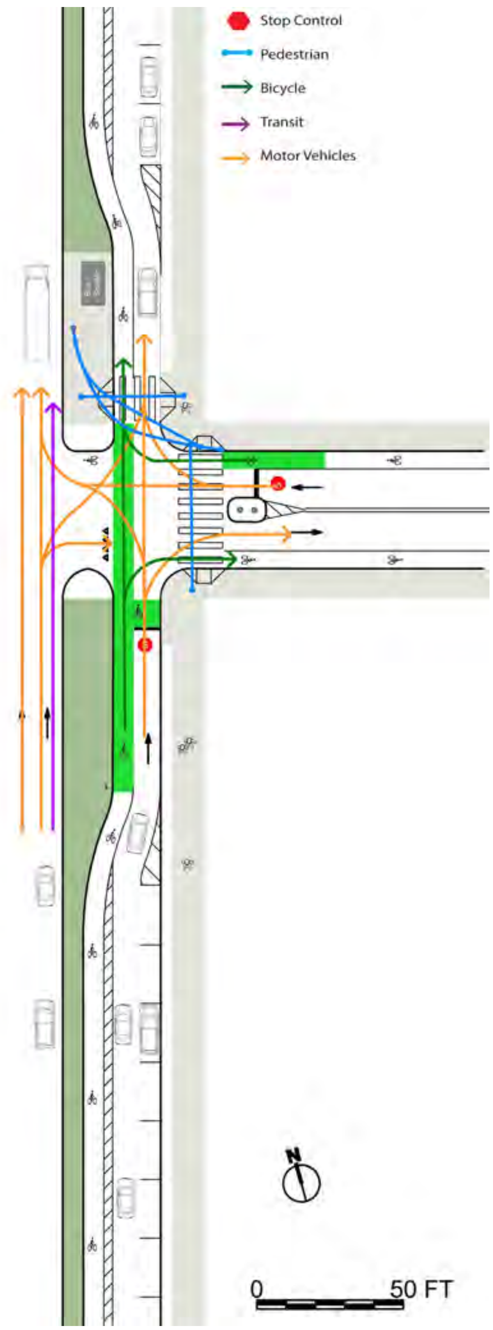


Figure 15 Option C Plan View Movements at Unsignalized Intersection



In Option C, there is a one-way median-side cycletrack with enhanced green pavement markings and bike boxes at intersection conflict zones. Bike boxes and green lane markings provide extra visibility in areas where cyclists are at risk of "right and left hook" crashes. The risk of "right hook" crashes is minimized in this design due to the bike lane position to the left of automobiles.

Figure 16 Option C Plan View at Signalized Intersection

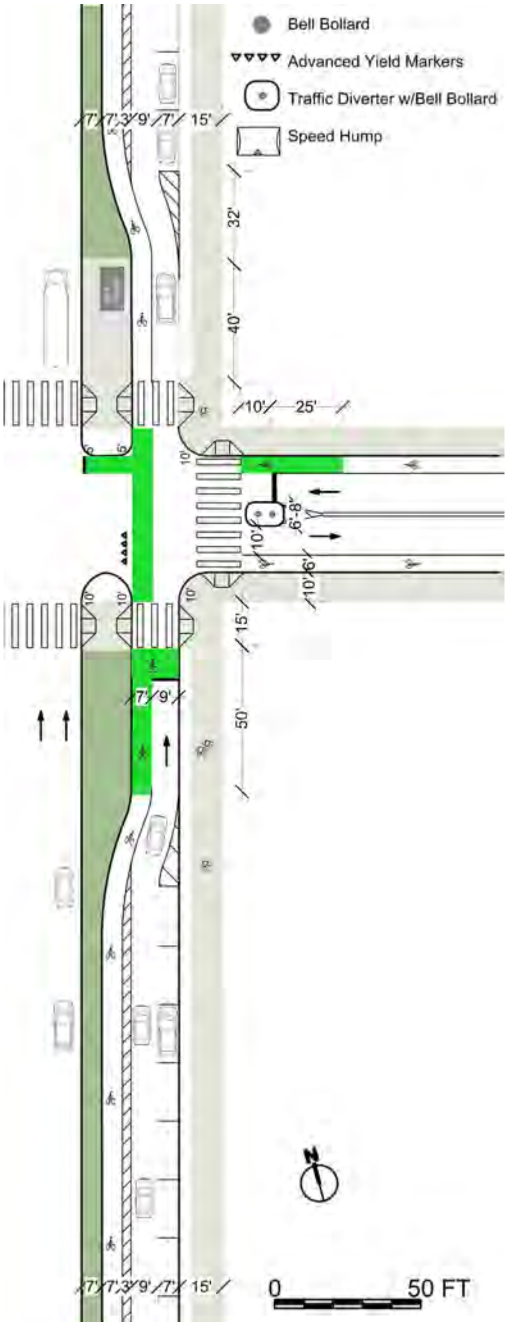
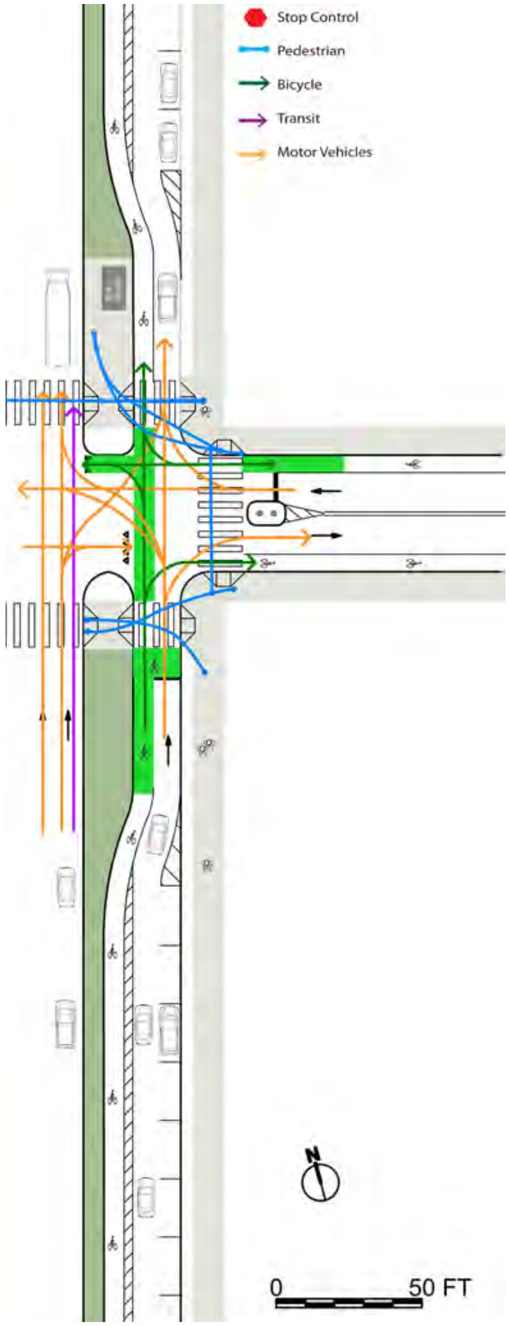


Figure 17 Option C Plan View Vehicle Movements at Signalized Intersection



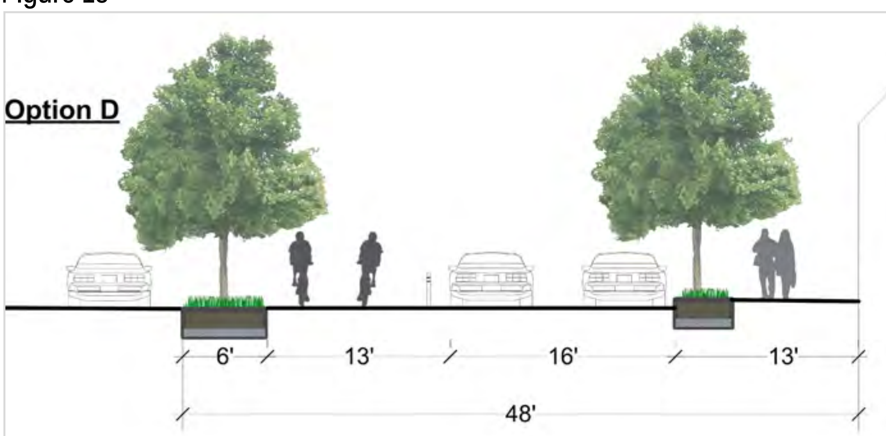
In Option C at signalized intersections, the bike lane and bike box must stop behind the near-side crosswalk to allow safe pedestrian crossings. A bike box is added to the cross street adjacent to the median to provide queuing space for turning cyclists. The paths of left-turning cars and through/left turning cyclists create a point of potential conflict which can be addressed through signalization techniques.

Option D – 2-way Median-side Cycletrack

The second median-side cycletrack is option D, which adds bi-directional bicycle travel as an option.

A typical section of the road with this configuration, starting at the median, has a six foot wide median bioswale, a 10 foot wide two-way cycletrack, a three foot buffer zone incorporating vertical flex posts, a 16 foot paved side road for parking and automobile travel, and a 13-foot wide sidewalk. At intersections and bus stops, the median would be widened along a curve to 14 to 16 feet, and the cycletrack and auto travel lane would follow the contour of this curve.

Figure 18



Option D shares many of the same elements as option C, with the principal difference being that it is a two-way bike facility with five foot widths for each direction of travel separated by a dashed yellow line. As for similarities, option D separates the bicycle traffic and automobile traffic, it places the parked automobiles against the curb, it uses flex posts for vertical delineation of the separated space, it follows the curvature of the median in places where it is widened for bus stops and intersections, it requires a continuous median strip with no slip lanes, and installation of the two-way cycletrack could precede redevelopment without having to accommodate existing curb cuts across the sidewalk.

Option D differs slightly on the uphill portions in that a passing cyclist will have only five feet of width to execute a pass within his or her own directional lane, and all cyclists would be faced with the speed differential of a downhill cyclist approaching at perhaps twenty or 25 mph on some of the steeper segments, creating a potential head-to-head closing speed in excess of 30 mph. While there is a greater chance of collision between cyclists than in the one-way options, that risk is low, and the conditions in Option D would match those of many of the regional multi-use trails which cover similar topography, and have excellent safety characteristics.

Concerning slip lanes or exits through the median, it is even more critical that any vehicle access through the median is eliminated since a driver would be faced with two-way bicycle traffic, and an even narrower median width, ensuring that the cycletrack would be blocked as a driver looked for a gap in main-line traffic.

As in option C, option D allows for the street reconstruction to proceed irrespective of when each parcel is redeveloped, or whether or not they conform to the land use patterns described in the Takoma Langley Crossroads Sector Plan. Existing curb cuts could stay in place by removing curbside parking in those segments.

The curbside cycletrack option was run through the FHWA's bicycle compatibility index which results in a BLOS grade of A+, with an absolute value of .72. Under the FHWA's rating system, this is an "extremely high" level of bicycle compatibility. From a more qualitative point of view, a BLOS in this range represents a best-in-class facility.

Figure 19 Option D Plan View at Unsignalized intersection

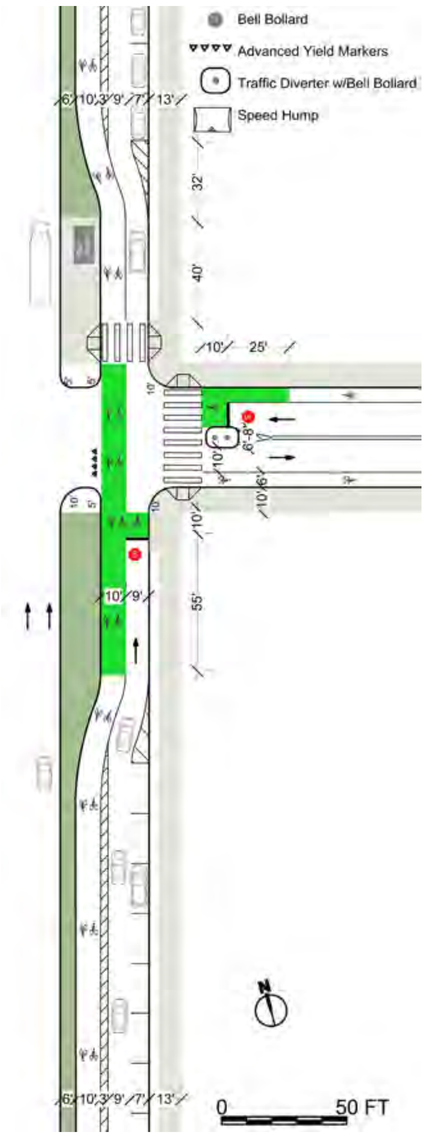
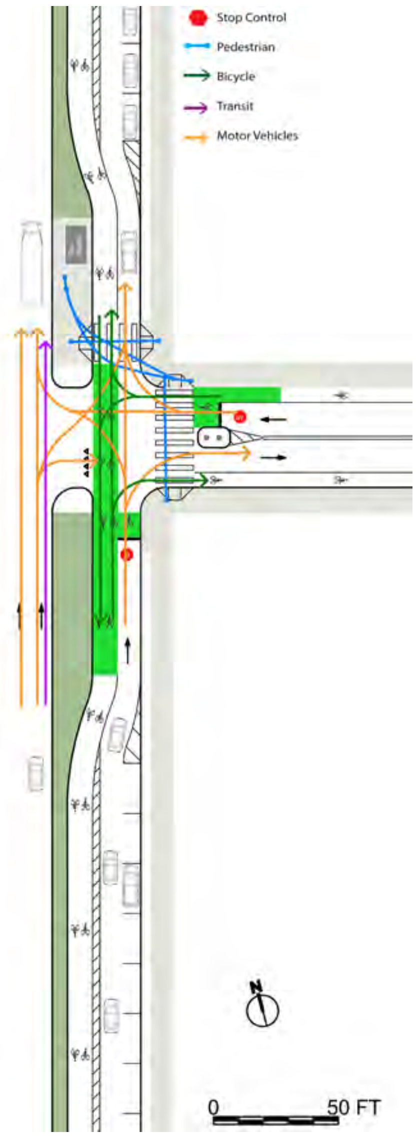


Figure 20 Option D Plan View Movements at Unsignalized Intersection



In Option D, there is a two-way median-side cycletrack with enhanced green pavement markings and bike boxes at intersection conflict zones. Bike boxes and green lane markings provide extra visibility in areas where cyclists are at risk of "right and left hook" crashes. Bike boxes on the cross street allow left turns into the cycletrack. Additional bicycle-only signage will be required for the contraflow cyclists.

Figure 21 Option D Plan View at Signalized Intersection

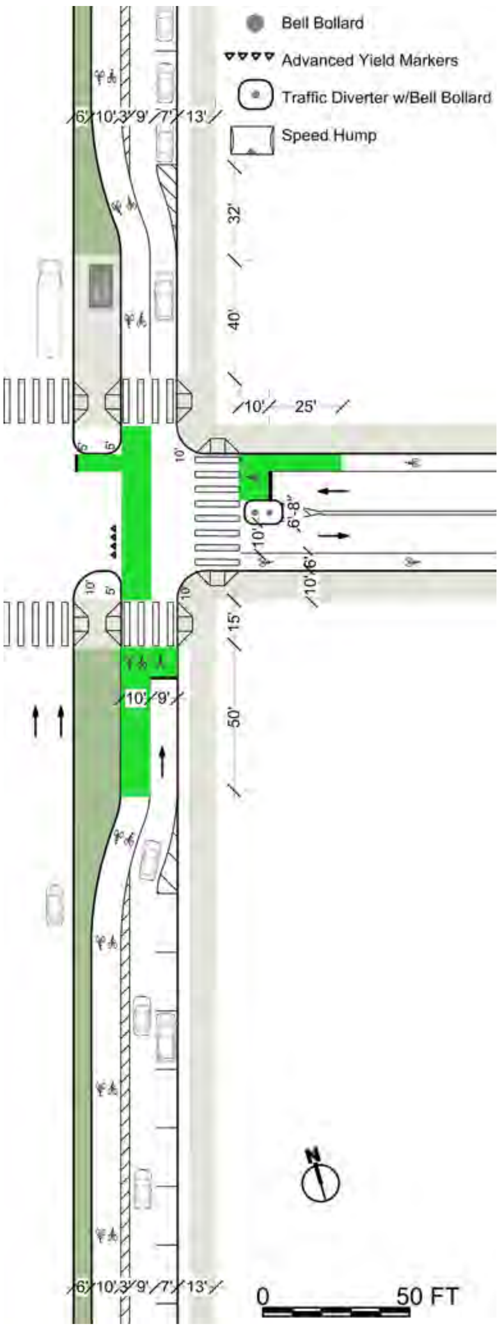
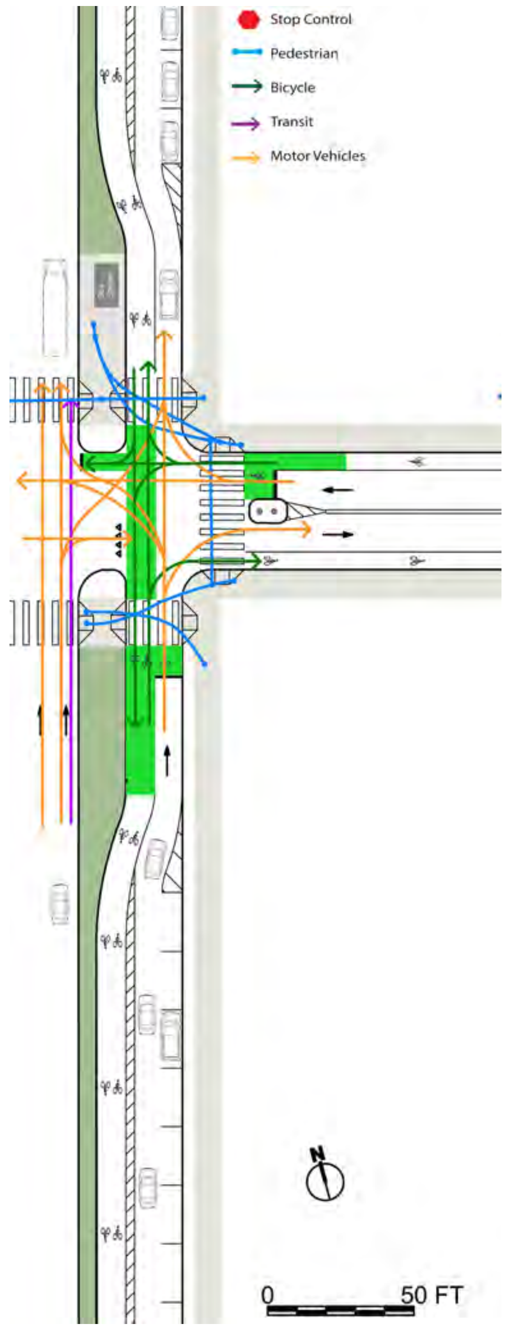


Figure 22 Option D Plan View Vehicle Movements at Signalized Intersection



In Option D at signalized intersections, the bike lane and bike box must stop behind the near-side crosswalk to allow safe pedestrian crossings. Bike boxes on the cross street allow left turns into the cycletrack. The paths of left-turning cars and through/left turning cyclists create a point of potential conflict which can be addressed through signalization techniques.

COMPARISON OF OPTIONS

Common Elements

All options have a bioswale median of varying width. All options use green pavement marking paint to identify potential conflict areas. All options use bike boxes to differing extents to give additional queuing and turning space to cyclists. All options have automobile parking, though the quantity of spaces varies depending on choices related to curb cuts, bus stop locations, and intersection designs.

Facility Comparison Matrix

Figure 23

	Lane in Main Road*	Option A**	Option B	Option C	Option D
Separation from Automobiles	None	None	Buffer + Flexposts	Buffer + Flexposts	Buffer + Flexposts
BLOS Rating (BCI Value)	D- (4.05)	D (3.86)	A (1.09)	A (1.09)	A+ (.72)
Bike/Motor Vehicle Uphill Speed Differential	27 - 31 MPH	17 - 21 MPH	n/a	n/a	n/a
Accommodates Contraflow Riding	No	No	No	No	Yes
Forced right turn for autos at intersections	n/a	No	Yes	No	No
Auto Parking	Curbside in side rd	Curbside	Median Side	Curbside	Curbside
Compatible w/ Slip Lanes	No	Yes	Yes	No	No
Compatible w/ Driveways	Yes	Yes	No	Yes	Yes
Bioswale Width, ft.	16	16	7	7	6
Sidewalk Width, ft.	15	15	15	15	13
Pervious Pavement Option Width, ft.	None	None	10	10	13
May Differ by Block	No	Yes	Yes	Yes	No

* Bike Lane concept from Takoma Langley Crossroads Sector Plan
** Bike facility concept from New Hampshire Avenue Corridor Concept Plan

Hybrid Options

As noted in the facility comparison matrix, options A, B, and C may differ from one block to the next, while option D must be a consistent design throughout its course due to the two-way bicycle traffic movements. For options A, B, and C, each block must be consistent to one design, but the design could shift from option A for one block, to option B the next, followed by option C on the following block in nearly any order or combination. For purposes of discussion, any of these combinations may be termed "hybrid" options.

For hybrid options, the challenge is in shifting cyclists from one configuration to the next at various intersections. Since each intersection is unique, they will all present their own design challenges to facilitate bicycle movements. Further, the more frequent the shift from one option to another, the more complex the route becomes for cyclists. While cyclists are adept at shifting from one type of facility to another, one goal of a good bicycle facility is to create a vernacular design that doesn't require additional instruction, signage, or planning to use it.

The main benefit of hybrid options is to maintain the dedicated bicycle infrastructure through a block where an insurmountable hurdle would not allow the preferred option to be built.

We recommend minimal shifts between two options, with the long term goal of creating a unified bicycle design vernacular for the entire New Hampshire Avenue corridor.

CONSTRUCTION PHASING

Phasing Challenges

In an ideal scenario, the bicycle facility could be constructed as one continuous project. However, the realities of redevelopment introduce various uncertainties: a freshly reconfigured street may need to be torn up again to provide sub-surface utilities to new buildings; one landowner may hold-out on redeveloping or selling their property; unknown or hidden structures or geology may delay or derail planned construction projects.

Value Engineering

Taking a value engineering approach, the preferred bicycle facility could be built in phases as the adjacent lands are upgraded over time to conform to the sector plan. The question is, how could the facility be built to function well in this interim time? The best approach would be to choose a preferred option for the long-term vision, and to implement temporary solutions on blocks that don't yet conform to that long-term vision.

For instance, if Takoma Park and Montgomery County select option B as the preferred option, but one block has a hold-out landowner who would prefer to keep his lot set up as-is with many curb-cuts, the city could build that block with bicycle option A or option C until such a time as the adjacent parcel is redeveloped. At the time of the redevelopment, the city could require the developer to reconfigure the block to their preferred, option B, as part of their permitting approvals package. If the city and county were to choose Option D as the preferred configuration, they might reserve the needed 12 feet of right-of-way, but keep the facility operating as one-way until all the blocks in the corridor conform to the plan, and two-way operation can be established.[9]

In this way, cyclists will have a reasonably well-planned facility to use during the interim period while construction and redevelopment activity are ongoing.

Stormwater Management[10]

One of the priorities from both the sector plan and the concept plan is enhanced on-site stormwater management for the corridor. To accomplish this, New Hampshire Avenue will have wide tree strips along the sidewalk, a planted median separating the side road from the main road, and a wide planted median running down the center of the main road. All of these planted areas will be designed with improved stormwater management characteristics as compared to how the road functions today.

With regard to the bicycle facility, options B, C, and D require narrowing the side road planted median by different amounts (see figure 18). However, options B, C, and D allow for high-performance subterranean stormwater measures and the use of high-performance pervious pavement which allows stormwater to drain directly through the roadbed into below-grade structured soils, silva cells, cisterns, or other stormwater management features.

Pervious pavement performs best for surfaces that don't bear heavy loads that compact the void space between the aggregate, the underlying soils, or damage underground structures. For this reason, bicycle facilities are ideally suited for pervious treatments since the combined weight of bicycle and rider rarely exceed 300 pounds. Parking lanes are also a candidate for pervious pavement, but with curbside weights of passenger vehicles often exceeding 6,000 pounds, and commercial vehicles reaching well above that threshold, stormwater features in parking areas are harder to plan and manage. Option A is not a candidate for pervious pavers since the road must be shared between bicycles and heavy vehicles.

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[9] The 15th Street cycletrack in the District of Columbia was started as a one-way facility under a pilot project, and was later retrofit into a two-way facility after review of the pilot's performance.

[10] See Stormwater Memo for additional information.

BICYCLE FACILITY IMAGES

Figure 24 Shared Lane Markings

Provide additional reinforcement for existing laws that bicycles may use roadway lanes. Aids in positioning cyclist in the center of the right-hand lane, and can help direct cyclists through tricky spots on the road.
Location: Alexandria, VA

Figure 25 Cycling in Side Road of Multi-way Boulevard

Note that side road does not continue through intersection.
Location: Berlin, Germany

Figure 26 Bike box

Provides space for cyclists to move to the front of the echelon of vehicles stopped at a light, facilitates cyclist turning movements at intersections.
Location: Portland, OR

Figure 27 "Shark's Teeth" Advanced Yield Markings

Placed within a driver's field of vision, this marking indicates a likely conflict point, and cues the driver to approach with full attention.
Location: Hageland, Holland
Image-from ryanfarncomb

Figure 28 Green striping through intersection

Provides high visibility for bicycles through intersections. Especially helpful to avoid "Right Hook" crashes.

Location: Portland, OR

Figure 29 Cycletrack that swerves at intersection

Provides cyclists a clear route through an intersection especially at transitions between off-street and on-street, or divided and undivided facilities.

Location: Berlin, Germany

Figure 30 Traffic Diverter / Forced Right Turn

Allows cyclists & pedestrians to proceed through an intersection, while diverting motor vehicle traffic, in this case with a mandatory right turn.

Location: Portland, OR

Figure 31 Bell Bollard

May be placed without constructed anchoring system due to the weight and relative low-profile. Provides hard barrier against auto incursion into pedestrian or bicycle space.

Location: New York City, NY

Figure 32 Median Bioswale

Absorbs and filters stormwater on-site prior to entering the storm sewer system, also can be an appealing landscaped green area.

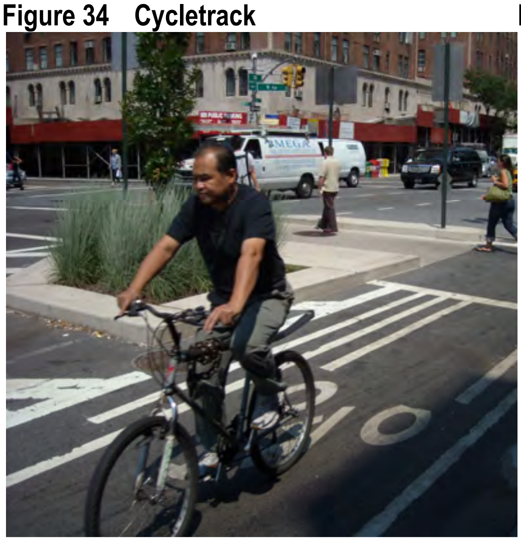
Location: Portland, OR

Figure 33 Cycletrack

Provides a separated bicycle facility with a physical division between cyclists and motor vehicles. May be one-way or two-way.

Location: Vancouver, BC

Figure 34 Cycletrack



Location: Manhattan, NY

Figure 35 Cycletrack

Location: Rio de Janeiro, Brazil

Figure 36 Cycletrack

Location: Montreal, Canada

Figure 37 Cycletrack

Location: Guadalajara, Mexico

Figure 38 Cycletrack as part of Sidewalk

Location: Berlin, Germany

Figure 39 Sidepath as Cycletrack

Intersection treatments are integral in making this facility safe and effective.

Location: Davis, CA

Figure 40 Entire Outside Lane of Multi-way Boulevard as Cycletrack

Upwards of 5000 cyclists per direction in the peak hour.

Location: Changzhou, China

BICYCLE COMPATIBILITY INDEX DATA SHEETS

Table 2 Bicycle Compatibility Index Calculations for Concept from Takoma Langley Crossroads Sector Plan and Options A, B, C, & D

Bike Lane bicycle compatibility index (BCI) Calculator

Location: Bike Lane in Main Road Concept From Takoma Sector Plan - New Hampshire Ave	
BCI Calculation Value:	**4.05**
BCI Grade	**D-**
Bicycle Compatibility Level	**Moderately Low**

factor	*Input*	*unit*	*note*
Is there a Bike Lane? (BL)	yes		(enter "yes" or "no")
Bike Lane Width (BLW)	5	Feet	enter width in feet
Curb Lane Width (CLW)	12	Feet	enter width in feet
Curb Lane Volume (CLV)	583	vph	enter the peak hour volume for the curb lane
Other Lane Volume (OLV)	583	vph	enter the peak hour vol. for the other lanes, same direction
Speed (SPD)	45	mph	Use 85th percentile speed
Is there adjacent parking lane with more than 30% occupancy? (PKG)	no		(enter "yes" or "no")
Is the adjacent area residential? (AREA)	no		(enter "yes" or "no")
Other Factors (AF)			
What is the hourly curb lane large truck volume? (ft)	29	trucks/hr	
What is the parking time limit in minutes? (fp)	0		
What is the hourly right turn volume? (frt)	269	right turns/hr	

Bike Lane bicycle compatibility index (BCI) Calculator

BCI Calculation Formula and Values From FHWA: http://safety.fhwa.dot.gov/tools/docs/bci.pdf

Location: OPTION A - New Hampshire Ave., Takoma Park, MD	
BCI Calculation Value:	**3.86**
BCI Grade	**D**
Bicycle Compatibility Level	**Moderately Low**

factor	*Input*	*unit*	*note*
Is there a Bike Lane? (BL)	no		(enter "yes" or "no")
Bike Lane Width (BLW)	0	Feet	enter width in feet
Curb Lane Width (CLW)	10	Feet	enter width in feet
Curb Lane Volume (CLV)	58	vph	enter the peak hour volume for the curb lane
Other Lane Volume (OLV)	0	vph	enter the peak hour vol. for the other lanes, same direction
Speed (SPD)	25	mph	Use 85th percentile speed
Is there adjacent parking lane with more than 30% occupancy? (PKG)	yes		(enter "yes" or "no")
Is the adjacent area residential? (AREA)	no		(enter "yes" or "no")
Other Factors (AF)			
What is the hourly curb lane large truck volume? (ft)	4	trucks/hr	
What is the parking time limit in minutes? (fp)	160		
What is the hourly right turn volume? (frt)	54	right turns/hr	

Bike Lane bicycle compatibility index (BCI) Calculator

Location: OPTION B - New Hampshire Ave., Takoma Park, MD	
BCI Calculation Value:	**1.09**
BCI Grade	**A**
Bicycle Compatibility Level	**Extremely High**

factor	*Input*	*unit*	*note*
Is there a Bike Lane? (BL)	Yes		(enter "yes" or "no")
Bike Lane Width (BLW)	7	Feet	enter width in feet
Curb Lane Width (CLW)	10	Feet	enter width in feet
Curb Lane Volume (CLV)	58	vph	enter the peak hour volume for the curb lane
Other Lane Volume (OLV)	0	vph	enter the peak hour vol. for the other lanes, same direction
Speed (SPD)	25	mph	Use 85th percentile speed
Is there adjacent parking lane with more than 30% occupancy? (PKG)	yes		(enter "yes" or "no")
Is the adjacent area residential? (AREA)	no		(enter "yes" or "no")
Other Factors (AF)			
What is the hourly curb lane large truck volume? (ft)	4	trucks/hr	
What is the parking time limit in minutes? (fp)	160		
What is the hourly right turn volume? (frt)	54	right turns/hr	

Bike Lane bicycle compatibility index (BCI) Calculator

Location: OPTION C - New Hampshire Ave., Takoma Park, MD	
BCI Calculation Value:	**1.09**
BCI Grade	**A**
Bicycle Compatibility Level	**Extremely High**

factor	*Input*	*unit*	*note*
Is there a Bike Lane? (BL)	Yes		(enter "yes" or "no")
Bike Lane Width (BLW)	10	Feet	enter width in feet
Curb Lane Width (CLW)	9	Feet	enter width in feet
Curb Lane Volume (CLV)	58	vph	enter the peak hour volume for the curb lane
Other Lane Volume (OLV)	0	vph	enter the peak hour vol. for the other lanes, same direction
Speed (SPD)	25	mph	Use 85th percentile speed
Is there adjacent parking lane with more than 30% occupancy? (PKG)	yes		(enter "yes" or "no")
Is the adjacent area residential? (AREA)	no		(enter "yes" or "no")
Other Factors (AF)			
What is the hourly curb lane large truck volume? (ft)	4	trucks/hr	
What is the parking time limit in minutes? (fp)	160		
What is the hourly right turn volume? (frt)	54	right turns/hr	

Bike Lane bicycle compatibility index (BCI) Calculator

Location: OPTION D - New Hampshire Ave., Takoma Park, MD	
BCI Calculation Value:	**0.72**
BCI Grade	**A**
Bicycle Compatibility Level	**Extremely High**

factor	*Input*	*unit*	*note*
Is there a Bike Lane? (BL)	Yes		(enter "yes" or "no")
Bike Lane Width (BLW)	12	Feet	enter width in feet
Curb Lane Width (CLW)	9	Feet	enter width in feet
Curb Lane Volume (CLV)	58	vph	enter the peak hour volume for the curb lane
Other Lane Volume (OLV)	0	vph	enter the peak hour vol. for the other lanes, same direction
Speed (SPD)	25	mph	Use 85th percentile speed
Is there adjacent parking lane with more than 30% occupancy? (PKG)	yes		(enter "yes" or "no")
Is the adjacent area residential? (AREA)	no		(enter "yes" or "no")
Other Factors (AF)			
What is the hourly curb lane large truck volume? (ft)	4	trucks/hr	
What is the parking time limit in minutes? (fp)	160		
What is the hourly right turn volume? (frt)	54	right turns/hr	