



Corridor Cities Transitway

Montgomery County, Maryland

Alternatives Analysis Report

for

Mission Hills Community

May 2014

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I. INTRODUCTION

The Maryland Transit Administration (MTA) is studying the Corridor Cities Transitway (CCT) in Montgomery County, Maryland, between the Metropolitan Grove MARC Station and Shady Grove Metrorail Station. The approximately 9-mile CCT alignment is proposed to serve the growing number of residents and employers in the corridor and to provide enhanced transit service. The CCT project would improve inter-modal connections; increase transit capacity and meet transit demand; enhance mobility and provide congestion relief; support economic development and enhance livability; and improve regional air quality by increasing transit use.

The CCT alignment has been actively evaluated for more than a decade, during which time three National Environmental Policy Act (NEPA) planning documents were prepared and approved. The I-270/US 15 Multi-Modal Corridor Study Draft Environmental Impact Statement (DEIS) was approved in 2002, the I-270/US 15 Multi-Modal Corridor Study Alternatives Analysis/Environmental Assessment (AA/EA) in 2009, and the Corridor Cities Transitway Supplemental Environmental Assessment (SEA) in 2010. Both the 2002 DEIS and the 2009 AA/EA evaluated highway and transit alternatives to relieve congestion along the I-270 corridor and provide an alternate transportation option to the automobile. The 2010 SEA addressed only the transit elements of the Multi-Modal Study and focused on proposed modifications to the original CCT alignment to serve three distinct areas within the corridor: the Kentlands community/redevelopment; the Life Sciences Center biotechnology campus; and the Crown Farm development.

Following approval of the AA/EA, the Maryland State Highway Administration (SHA) and MTA, co-sponsors of both the 2002 DEIS and the 2009 AA/EA, separated the highway element from the transit element which allowed MTA to move forward with the CCT. The locally preferred alternative (LPA) was announced in May 2012 by Governor Martin O'Malley and it defined the CCT route alignment and the mode as bus rapid transit (BRT). In October 2013, the Line and Grade plans were completed and they included five percent design of the CCT and refinements to the transitway alignment. An EA based on 15 percent design is scheduled to be completed in Fall 2014, followed by a Finding of No Significant Impact (FONSI) anticipated in Fall 2015. After the publication of the EA, the issuance of a FONSI, and the completion of the 30 percent design plans, the NEPA process for this portion of the improvements would be concluded.

In the area near the Mission Hills community and the Belward Farm, the CCT alignment would travel along the south side of Great Seneca Highway to the intersection of Great Seneca Highway and Muddy Branch Road, then along the east side of Muddy Branch Road, and through the proposed Belward Campus development along an extension of Belward Campus Drive to the intersection of Belward Campus Drive and Johns Hopkins Drive. While travelling along the east side of Muddy Branch Road, the transitway would cross Mission Drive and a new traffic signal would be installed at the intersection of Muddy Branch Road and Mission Drive/Midsummer Drive.

On December 3, 2013, members of the CCT Project Team met with residents of Mission Hills to discuss their concerns about the transitway, its location relative to their homes, and vehicular access to their community. Residents expressed concern that the addition of the transitway, along with the existing congestion on Muddy Branch Road, would make it difficult to exit the community during morning and afternoon peak travel times. Mission Drive is the only access



point to the Mission Hills community of 52 homes. Consequently, the MTA agreed to study alternatives to address the community's concerns.

This Alternatives Analysis Report summarizes the studies that have been completed by the MTA for this segment of the CCT as discussed with the Mission Hills community. Some of the alternatives presented in this report are based on suggestions made by the residents, while others are based on considerations from the MTA project team. These segments are shown in **Figure 1**. In general terms, inbound travel refers to CCT buses heading from Metropolitan Grove Station south to Shady Grove Station, or from Great Seneca Highway to Johns Hopkins Drive. Outbound travel refers to CCT buses heading north from Shady Grove Station to Metropolitan Grove Station.

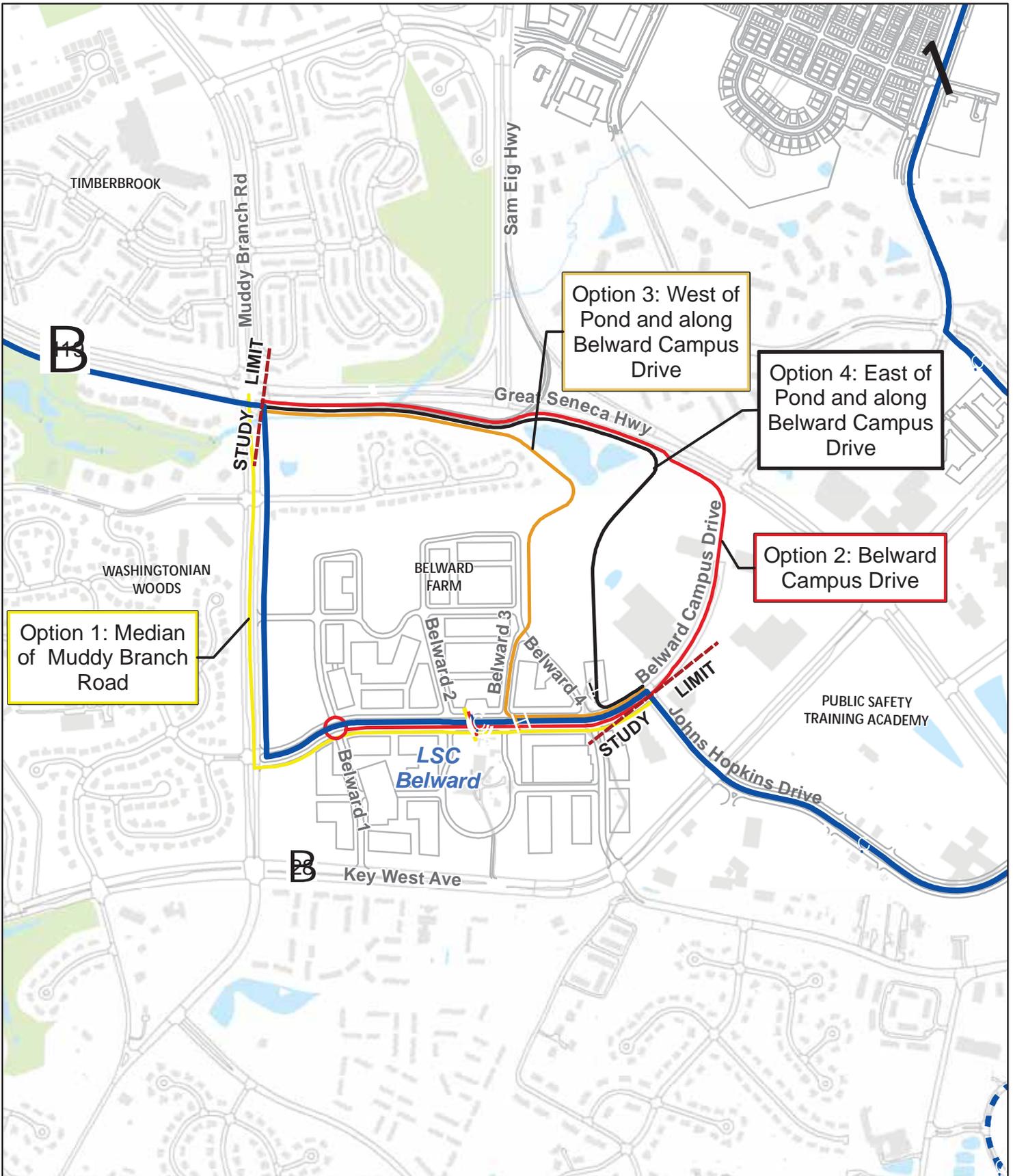


Figure 1

Corridor Cities Transitway

Legend

- Line and Grade Alignment
- B Station Locations



Mission Hills Alternatives



II. MISSION HILLS ALTERNATIVES

A. Study Area

The Mission Hills study area begins at the intersection of Muddy Branch Road and Great Seneca Highway (MD 119) and extends to the intersection of Belward Campus Drive and Johns Hopkins Drive. Muddy Branch Road is a Montgomery County roadway classified as a major highway with a posted speed limit of 45 mph and it contains two through travel lanes in each direction, separated by a grass median. The extension of Belward Campus Drive, recommended in the Great Seneca Science Corridor (GSSC) Master Plan (2010), would extend from Muddy Branch Road at the intersection of Muddy Branch Road and Midsummer Drive, bisect the Belward site, and connect to the existing Belward Campus Drive near Johns Hopkins Drive. Proposed Belward Campus Drive would be classified as an arterial road that would contain four travel lanes with a posted speed limit of 30 mph. The GSSC Plan recommends the construction of grade-separated interchanges at Great Seneca Highway and Muddy Branch Road and at Great Seneca Highway and Sam Eig Highway. The Plan also specifies widening Muddy Branch Road to six through travel lanes between Darnestown Road (MD 28) and West Diamond Avenue (MD 117).

The currently undeveloped Belward property, owned by Johns Hopkins University, is designated as part of the greater Life Sciences Center (LSC) and will be developed as a research campus. The property's historic Belward Farm includes the farmhouse, barns, and outbuildings which, due to its historic significance, will remain in place after construction of the surrounding research campus.

B. Line and Grade Alignment: East Side of Muddy Branch Road – Median of Belward Campus Drive

1. Description

The proposed Line and Grade alignment would begin at the intersection of Muddy Branch Road and Great Seneca Highway. The transitway would run parallel to Muddy Branch Road along the east side; turn east and travel within the median of extended Belward Campus Drive; and continue in the median to the intersection of Belward Campus Drive and Johns Hopkins Drive. The location of the transitway would require the displacement of one residence in the southeast quadrant of the intersection of Muddy Branch Road and Mission Drive. See **Appendix A** for detailed mapping.

The transitway would be 28 feet wide, with one 14-foot lane in each direction, including the gutter pan. Proposed stormwater management facilities would separate the transitway from the northbound lanes on Muddy Branch Road. A five-foot wide sidewalk would be constructed on the east side of the transitway parallel to Muddy Branch Road from Great Seneca Highway to Belward Campus Drive. Belward Campus Drive would accommodate the CCT transitway and stormwater management facilities in the median of the roadway. The transitway would be physically separated from the eastbound and westbound travel lanes on Belward Campus Drive by a median.

Roadway improvements would include the addition of a left turn lane on southbound Muddy Branch Road and right turn lane on northbound Muddy Branch Road at the intersection of Muddy Branch Road and Midsummer Drive/Mission Drive. Milling and overlay, full-depth reconstruction, and restriping of lane lines, crosswalks and stop bars would be required at the intersections of

Muddy Branch Road and Midsummer Drive/Mission Drive and Muddy Branch Road and Midsummer Drive/Belward Campus Drive.

2. Structures

An existing 12-foot by 10-foot triple cell box culvert carrying a tributary to Muddy Branch crosses under Muddy Branch Road, just south of Great Seneca Highway. The proposed transitway would directly impact the upstream end of the culvert and would require construction of a new headwall and extension of the culvert by approximately 45 feet.

3. Stormwater Management

The Line and Grade alignment along Mission Hills would involve construction of 3.5 acres of new impervious area, reconstruction of 0.9 acres of existing impervious area, and removal of 0.01 acres of existing impervious area. As a result, the impervious area requiring treatment would be 3.9 acres.

The proposed SWM design would involve treating runoff from the proposed CCT transitway by using a combination of Environmental Site Design (ESD) facilities and proprietary devices. ESD would be provided through bio-swales to the maximum extent practicable. Approximately 2.5 acres of impervious area would be treated in the proposed bio-swales with a footprint of approximately 14,520 square feet. The proposed bio-swales would not be able to meet the entire ESD requirements. Therefore, six Filterra inlets would be proposed to provide the remaining water quality treatment. Quantity control for channel protection volume and the 10-year storm would be provided through three underground detention structures. The proposed alignment would not impact any existing SWM facilities. The locations of the inlets and underground storage facilities have not yet been determined.

A new storm drain system would be required for the proposed transitway. It is estimated that 35 drainage structures (inlets and manholes) and 5,460 linear feet of storm drain pipes would be required for the proposed CCT roadway and retrofitting the existing storm drain system.

4. Stations

Under the Line and Grade alignment, the LSC Belward Station would be located on Belward Campus Drive. The station would contain a center platform located in the median of the proposed roadway and would be 150 feet long and 18 feet wide. Access would be provided by pedestrian ramps at both ends of the platform and corresponding crosswalks would be located at the nearest roadway intersection. The station would be located on the block adjacent to the historic farm where the campus activity center would be constructed. This station would provide a centralized location to serve the campus while remaining in close proximity to the adjacent activity center in the heart of the proposed campus. The goal of this station location would be to integrate into the fabric of the developing campus and provide strong pedestrian connections between the transitway and the campus.

5. Traffic

For the Line and Grade alignment, CCT buses would operate on an exclusive transitway along the east side of Muddy Branch Road and in the median of Belward Campus Drive. The LSC Belward Station would be located in the median of Belward Campus Drive, as described above, between two signalized intersections with proposed roadways (described herein as Belward 1



and Belward 4). The transitway would cross at-grade through the following signalized intersections:

- Great Seneca Highway and Muddy Branch Road (existing signal)
- Muddy Branch Road and Mission Drive/Midsummer Drive (new signal)
- Muddy Branch Road and Belward Campus Drive (new signal)
- Belward Campus Drive and Belward 1 (new signal)
- Belward Campus Drive and Belward 4 (new signal)
- Belward Campus Drive and Johns Hopkins Drive (new signal)

Under the Line and Grade alignment, Belward North would terminate just east of the CCT and would not provide access to Muddy Branch Road.

A VISSIM traffic simulation model was used to project traffic conditions for the year 2035 along the Line and Grade alignment. **Table 2** summarizes the Level of Service and delay results for the Line and Grade Alignment at all intersections in the Mission Hills and Belward Campus area.

Intersection	AM Peak		PM Peak	
	LOS	Overall Intersection Delay (seconds)	LOS	Overall Intersection Delay (seconds)
Great Seneca Highway and Muddy Branch Road	F	139	F	139
Muddy Branch Road and Mission Drive/Midsummer Drive	B	18	E	77
Muddy Branch Road and Belward Campus Drive	B	19	D	39
Belward Campus Drive and Belward 1	B	11	C	20
Belward Campus Drive and Belward 4	B	16	B	11
Belward Campus Drive and Johns Hopkins Drive	B	15	C	24

Table 1 summarizes the travel time results for the CCT between the Kentlands Station and the LSC West Station (including a stop at the LSC Belward Station) along the Line and Grade alignment.

Segment	AM Peak (minutes)	PM Peak (minutes)
Inbound Travel Times	9.9	11.7
Outbound Travel Times	10.1	11.0

The analysis results presented above for the build year of 2035 are based on future year 2035 traffic volumes. The future year 2035 traffic volumes were developed from 2010 traffic counts that were projected to the year 2035 using growth rates from the Metropolitan Washington Council of Governments (MWCOC) travel demand models. These rates account for population growth, employment, land use and development. To validate the volumes used in the existing conditions (No-Build) and Build-year models, additional field observations were conducted in April



2014 to obtain traffic volumes for all turning movements at the intersection of Muddy Branch Road and Mission Drive/Midsummer Drive and the intersection of Great Seneca Highway and Muddy Branch Road. In general, no issues regarding delay were observed at the intersection of Muddy Branch Road and Mission Drive/Midsummer Drive. However, during both the AM and PM peak periods, delays were observed for many movements at the intersection of Great Seneca Highway and Muddy Branch Road. Despite the observed delay, the signal functioned well in a coordinated system with the signalized intersection to the south at Sam Eig Highway. Experienced delays were predictable and consistent.

6. Operations

Under the Line and Grade alignment, buses would operate in an exclusive transitway and would generally utilize the same signal phase as adjacent through traffic. At the intersection of Muddy Branch Road and Great Seneca Highway, buses would require a transit-only signal phase in order to transition from the south side of Great Seneca Highway to the east side of Muddy Branch Road.

7. Utilities

Impacted utilities would include a 30-inch underground sanitary line near the intersection of Muddy Branch Road and Great Seneca Highway as well as crossings of a 12-inch underground water line, underground telecommunications lines, and an 8-inch underground gas line near Mission Drive. It is assumed that the existing light poles along the east side of Muddy Branch Road would remain intact. There are underground gas, sanitary and water lines at the intersection of Johns Hopkins Drive and Belward Campus Drive that may require protection, pending further utility investigation. An overhead electric line crossing the transitway alignment near Johns Hopkins Drive may also require relocation.

8. Environmental Resources

As previously mentioned, the Line and Grade alignment would require a residential displacement at Mission Hills. This option would also impact approximately 500 linear feet of streams, 0.4 acres of wetlands, 0.3 acres of 100-year floodplain, 2.5 acres of forest, and 0.3 acres of forest conservation easement.

Impacts to the forest conservation easement would require approval from M-NCPPC and justification would need to be presented demonstrating why removal of the Forest Conservation Easement would be necessary, and would require coordination with M-NCPPC to determine appropriate mitigation.

Belward Farm is a historic property, listed on the National Register of Historic Places and thus protected by Section 4(f) of the US Department of Transportation Act of 1966 and Section 106 of the National Historic Preservation Act of 1966. Under the Line and Grade alignment, approximately 14 acres of Belward Farm would be impacted. A Section 4(f) Evaluation would be completed to assess whether there is a feasible and prudent alternative to the use of Belward Farm and to identify efforts to minimize harm to the property resulting from use.

Environmental resources are shown on **Figures 2** and **3** for all alignment alternatives.



	<p>Figure 2</p>	<p>Corridor Cities Transitway</p> <p>Forest Conservation Easements and Historic Properties</p>
<p>Legend</p> <ul style="list-style-type: none"> Field Verified Forested Area Forested Area Forest Conservation Easement Historic Property - Belward Farm 		

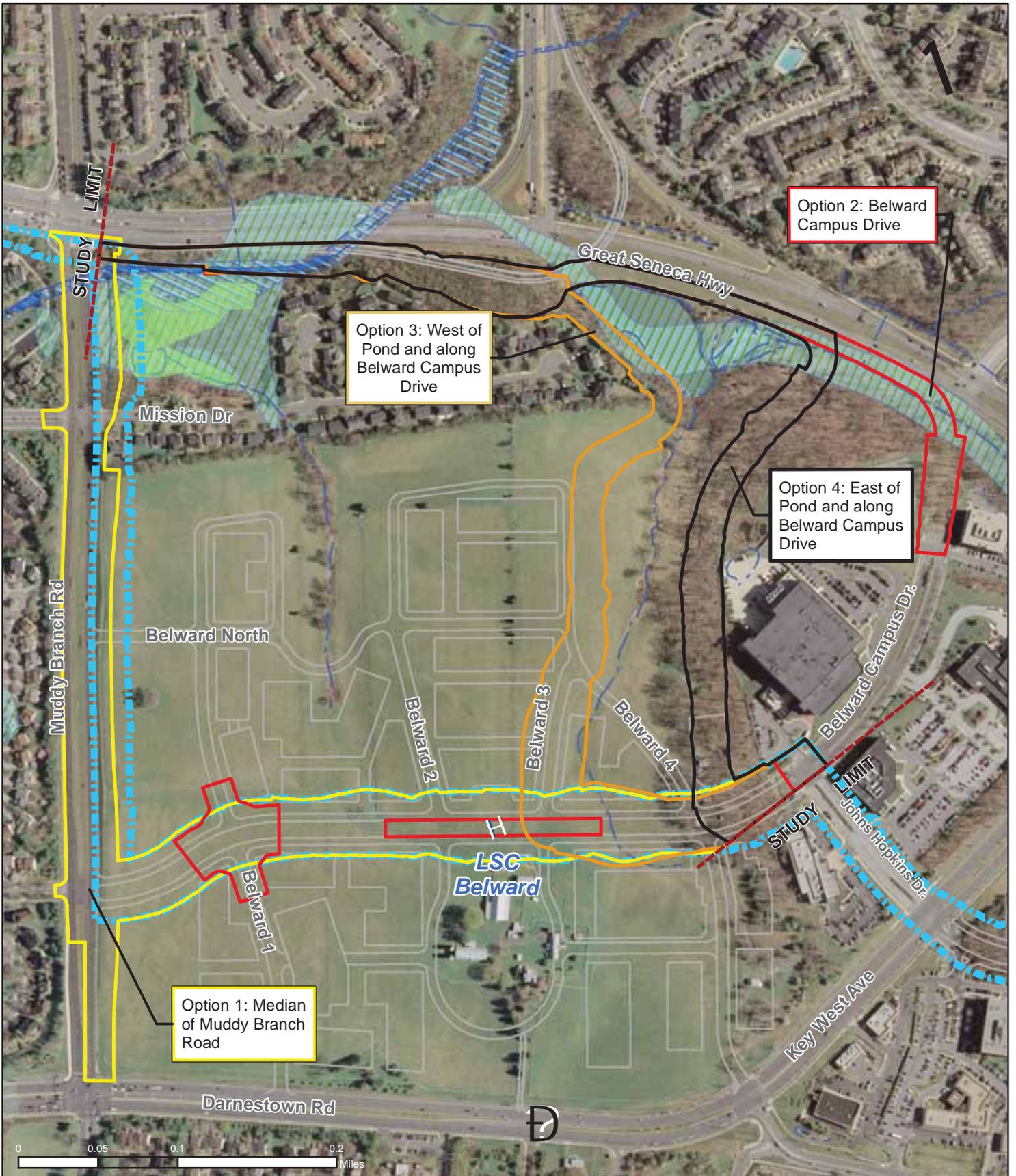


Figure 3

Corridor Cities Transitway

Waters of the U.S. and Floodplains




Legend

	Field Verified Streams		Wetlands (DNR & NWI)
	Field Verified Wetlands		Streams
	100-Year Floodplains		

C. Option 1: Median of Muddy Branch Road

1. Description

Under Option 1, the proposed alignment would begin at the intersection of Muddy Branch Road and Great Seneca Highway. The transitway would run south in the median of Muddy Branch Road, turn east into the median of Belward Campus Drive, and continue in the median to the intersection of Belward Campus Drive and Johns Hopkins Drive. See **Appendix A** for detailed mapping.

The transitway would be 28 feet wide, with one 14-foot lane in each direction, including the gutter pan. The transitway would be built within the existing Muddy Branch Road median that is planned to accommodate an additional lane in each direction on Muddy Branch Road. Medians varying in width from 6 feet to 18 feet would separate the transitway from the travel lanes on Muddy Branch Road. A five-foot wide sidewalk would be constructed on the east side of Muddy Branch Road.

Belward Campus Drive would accommodate the CCT transitway and stormwater management facilities in the median of the roadway. The transitway would be physically separated from the eastbound and westbound travel lanes on Belward Campus Drive by a median.

Roadway and sidewalk improvements would be required along Muddy Branch Road between Great Seneca Highway and Darnestown Road. Improvements would include the addition of a left turn lane on southbound Muddy Branch Road at the intersection of Muddy Branch Road and Midsummer Drive/Mission Drive. Milling and overlay, full-depth reconstruction, and restriping of lane lines, crosswalks and stop bars would be required at the intersection of Muddy Branch Road and Midsummer Drive/Mission Drive and the intersection of Muddy Branch Road and Midsummer Drive/Belward Campus Drive. Roadway widening would occur along the northbound lanes of Muddy Branch Road to accommodate the transitway, travel lanes, and turn lanes. Widening would extend south of Belward Campus Drive to the intersection of Muddy Branch Road and Darnestown Road.

2. Structures

The proposed location of the transitway in Option 1 would directly impact the upstream end of the triple box culvert described in the Line and Grade alignment. Construction of a new headwall would be required in addition to an extension of the culvert by approximately 33 feet. A retaining wall would be needed along the east side of Muddy Branch Road in the southeast quadrant of the intersection with Mission Drive to avoid a displacement of the adjacent residential property. The wall would be approximately 120 feet long and five feet high.

3. Stormwater Management

Under Option 1, proposed new impervious area would be 3.5 acres, reconstruction of existing impervious would be 1.4 acres, and removal of existing impervious would be 0.4 acres. As a result, the impervious area requiring treatment would be 4.0 acres.

The proposed SWM design would involve treating runoff from reconstructed Muddy Branch Road and the proposed CCT transitway by using a combination of ESD facilities, a surface pond and proprietary BMP facilities. ESD would be provided through micro-scale practices such as bio-swales and micro-bioretenion facilities to the maximum extent practicable. Approximately 2.6 acres of impervious would be treated in the proposed bio-swales with a proposed footprint of 21,800 square feet. The proposed bio-swales would not be able to meet the full ESD

requirements. Therefore, six Filterra inlets would be proposed to provide the remaining water quality treatment. Quantity control would be provided using one surface pond and one underground detention structure. The total footprint of the surface pond would be approximately 27,200 square feet. The proposed alignment would not impact any existing SWM facilities. The locations of the inlets, ponds and underground storage facilities have not yet been determined.

Option 1 would impact the existing storm drain system along Muddy Branch Road. A new storm drain system would be required for the proposed transitway. It is estimated that a total of 55 drainage structures (inlets and manholes) and 8,640 linear feet of storm drain pipe would be required for the proposed CCT and existing Muddy Branch Road.

4. Stations

Under Option 1, the proposed LSC Belward Station design and location would be the same as the Line and Grade alignment.

5. Traffic

Under Option 1, CCT buses would operate on an exclusive transitway in the median of Muddy Branch Road and in the median of Belward Campus Drive. A new signal phase dedicated to the CCT movements would be needed at the intersection of Muddy Branch Road and Midsummer Drive/Belward Campus Drive where the buses would cross from the median of Muddy Branch Road to the median of Belward Campus Drive. This would create a conflict with the northbound through movement on Muddy Branch Road, prohibiting this movement during each crossing of a CCT vehicle. Thus, only the southbound traffic on Muddy Branch Road would be able to operate at the same time as the CCT buses. Under the Line and Grade alignment, both the northbound and southbound traffic on Muddy Branch Road would operate at the same time as the CCT phase at this intersection. However, under Option 1, there would not be conflicts between the CCT buses and the northbound right turn movement from Muddy Branch Road to Great Seneca Highway, the westbound right turn movement from Mission Drive to Muddy Branch Road, and the westbound right turn movement from Belward Campus Drive to Muddy Branch Road, thus allowing motorists more opportunities to complete the free right turn. Under the Line and Grade alignment, these movements would be impeded and unable to turn during each CCT crossing. The transitway would cross at-grade through the following signalized intersections:

- Great Seneca Highway and Muddy Branch Road (existing signal)
- Muddy Branch Road and Mission Drive/Midsummer Drive (new signal)
- Muddy Branch Road and Belward Campus Drive (new signal)
- Belward Campus Drive and Belward 1 (new signal)
- Belward Campus Drive and Belward 4
- Belward Campus Drive and Johns Hopkins Drive

Under Option 1, Belward North would be a proposed right-in, right-out access with Muddy Branch Road.

Table 3 summarizes the Level of Service and delay results for Option 1 at all intersections in the Mission Hills and Belward Campus area. The results are based on an average of four runs of the



simulation model for this particular option and account for the variability of vehicular traffic movements, motorist behavior and interaction with the traffic signal system.

Table 3. Option 1 LOS and Intersection Delay (2035)

Intersection	AM Peak		PM Peak	
	LOS	Overall Intersection Delay (seconds)	LOS	Overall Intersection Delay (seconds)
Great Seneca Highway and Muddy Branch Road	F	120	F	142
Muddy Branch Road and Mission Drive/Midsummer Drive	B	15	E	68
Muddy Branch Road and Belward Campus Drive	C	23	C	28
Belward Campus Drive and Belward 1	B	11	B	17
Belward Campus Drive and Belward 4	B	17	B	12
Belward Campus Drive and Johns Hopkins Drive	B	15	C	24

Table 4 summarizes the change in CCT travel times between the Line and Grade alignment and Option 1 based on the segment travel times between the Kentlands and LSC West Stations.

Table 4. Travel Time Comparison Between Line and Grade and Option 1 (2035)

Direction/Time Period	Line and Grade Forecasted Future Travel Time (minutes)	Option 1 Forecasted Future Travel Time (minutes)	Change in Forecasted Future Travel Time (minutes)	Percentage Increase of Corridor-Wide Travel Time
Inbound AM Peak	9.9	10.6	+0.7	+1.8%
Inbound PM Peak	11.7	12.4	+0.7	+1.8%
Outbound AM Peak	10.1	10.5	+0.4	+1.1%
Outbound PM Peak	11.0	11.6	+0.6	+1.6%

Under Option 1, the travel time increases would range from 0.4 minutes to 0.7 minutes. The percentage increase in travel time, relative to the forecasted end-to-end travel time of 38 minutes, would range between 1.1 percent and 1.8 percent.

6. Operations

Under Option 1, buses would run on the south side of Great Seneca Highway in a dedicated transitway, similar to the Line and Grade alignment. At Muddy Branch Road, the CCT would transition from the south side of Great Seneca Highway to the median of Muddy Branch Road. This transition would be made utilizing the Great Seneca Highway through-movement signal phase and would not require changes to the phasing of the signal at this intersection. The transition of the movement from the median of Muddy Branch Road to the median of Belward Campus Drive would require a transit-only signal phase that would impact northbound general traffic movements on Muddy Branch Road. Southbound movements on Muddy Branch would not be impacted.

Operational impacts associated with Option 1 are anticipated to be minimal, with the only change relative to the Line and Grade alignment being a marginal increase in travel time (see **Table 4**). This change should have a minimal impact on passenger convenience or ridership.

7. Utilities

Option 1 would have the same utility impacts as discussed in the Line and Grade alignment as well as impacts to a 24-inch underground water line running parallel to Muddy Branch Road in the existing median. Additionally, an 8-inch underground gas line and underground telecommunications lines running perpendicular to Muddy Branch Road through the existing median would also be impacted.

8. Environmental Resources

Because Option 1 would run in the existing median of Muddy Branch Road, there would be no residential displacement at Mission Hills. However, this option would impact approximately 435 linear feet of streams, less than 0.1 acres of wetlands, 0.3 acres of 100-year floodplain, 1.5 acres of forest, and 0.2 acres of forest conservation easement.

Impacts to the forest conservation easement would require approval from M-NCPPC and justification would need to be presented demonstrating why removal of the Forest Conservation Easement would be necessary, and would require coordination with M-NCPPC to determine appropriate mitigation.

Under Option 1 approximately 13 acres of Belward Farm would be impacted. A Section 4(f) Evaluation would be completed to assess whether there is a feasible and prudent alternative to the use of Belward Farm and to identify efforts to minimize harm to the property resulting from use (see **Figures 2 and 3**).

D. Option 2: Belward Campus Drive

1. Description

Under Option 2, the proposed alignment would begin at the intersection of Muddy Branch Road and Great Seneca Highway and run east along the south side of Great Seneca Highway. The transitway would separate from Great Seneca Highway to allow for the future flyover ramp to Sam Eig Highway and would turn southwest near the intersection of Great Seneca Highway and Decoverly Drive to connect to existing Belward Campus Drive. The CCT buses would then operate in mixed traffic along the existing and extended Belward Campus Drive serving the LSC Belward Station and continue west to a proposed roundabout just east of Muddy Branch Road at Belward 1. Using the roundabout, buses would turn around and travel east to the intersection of Belward Campus Drive and Johns Hopkins Drive. See **Appendix A** for detailed mapping.

The exclusive transitway section would be 28 feet wide, with one 14-foot lane in each direction, including the gutter pan. A two-foot wide concrete median barrier would separate the transitway from the southbound lanes on Great Seneca Highway.

2. Structures

An existing 12-foot by 10-foot triple cell box culvert carrying a tributary to Muddy Branch crosses under Great Seneca Highway, east of Muddy Branch Road. The proposed transitway location in Option 2 would impact the downstream end of the culvert and would require construction of a new headwall and extension of the culvert by approximately 30 feet. Construction of a new culvert would also be required under Option 2 to carry a tributary beneath the transitway, northwest of the intersection of Great Seneca Highway and Decoverly Drive.

Two retaining walls would be needed along the south side of the transitway to avoid impacts to the tributary and existing regional SWM pond. The retaining wall extending from Muddy Branch Road to the culvert extension would be approximately 710 feet long and 12 feet high. The retaining wall adjacent to the pond, east of the Mission Hills community, would be approximately 1,300 feet long and 4 feet high. Further geotechnical investigation would be required to determine the feasibility of constructing the retaining wall on the embankment of the pond.

3. Stormwater Management

Under Option 2, proposed new impervious area would be approximately 2.7 acres, reconstruction of existing impervious area would be 0.8 acres, and removal of existing impervious area would be 0.1 acres. As a result, the impervious area requiring treatment would be approximately 3.1 acres.

Due to site constraints, no space would be available for ESD facilities. Therefore, 13 Filterra inlets would be proposed to provide the water quality treatment. Quantity control for channel protection volume and the 10-year storm would be provided using three underground detention structures. The location of the inlets and underground storage facilities have not yet been determined.

This option would impact the existing regional SWM pond owned by Montgomery County, located southeast of the intersection of Great Seneca Highway and Sam Eig Highway. The CCT would run along the northeast embankment of the pond and would impact the embankment for the 100-year pool elevation. As a result, re-grading in other portions of the pond would be required to accommodate the lost 100-year storage. Furthermore, the alignment would block the existing maintenance access road to the pond and a new access road would need to be constructed. Additional analysis would be required to determine if impacts to the pond would be significant enough that the pond would have to be upgraded to meet current standards.

The Option 2 alignment would impact the existing storm drain system along Great Seneca Highway. A new storm drain system would need to be installed for the proposed transitway. The proposed storm drain system would consist of a total of 35 drainage structures (inlets and manholes) and 5,510 linear feet of storm drain pipes for the CCT alignment and retrofitting existing storm drain system.

4. Stations

Under Option 2, the LSC Belward Station design and location would be similar to the Line and Grade alignment. The primary difference is that this option would locate the station in mixed traffic rather than within a dedicated transitway. The center platform station would be located in the median of Belward Campus Drive and would be 150 feet long and 18 feet wide. Access to the platform would be provided by pedestrian ramps at both ends and corresponding crosswalks would be located at the nearest roadway intersection. This station location would maintain the same centralized, prominent location as described in the Line and Grade alignment. Dedicated drop-off lanes would be included at the station to provide direct access for CCT buses and limit the potential for intermingling of vehicular traffic with station patrons. The goal of this station location would be to integrate into the fabric of the developing campus and provide strong pedestrian connections between the transitway and the campus.

5. Traffic

Under Option 2, CCT buses would travel in an exclusive transitway proposed along the south side of Great Seneca Highway and would operate in mixed traffic along Belward Campus Drive.



This option would require the addition of a roundabout at the intersection of Belward Campus Drive and Belward 1. The CCT buses would be in mixed traffic through the following intersections:

- Belward Campus Drive and Belward 1 (new roundabout)
- Belward Campus Drive and Belward 2
- Belward Campus Drive and Belward 3
- Belward Campus Drive and Belward 4 (new signal)
- Belward Campus Drive and Johns Hopkins Drive (new signal)

In this option, CCT vehicles would not cross the following intersections:

- Muddy Branch Road and Mission Drive/Midsummer Drive
- Muddy Branch Road and Belward North
- Muddy Branch Road and Belward Campus Drive

Table 5 below summarizes the Level of Service and delay results for Option 2 at all intersections in the Mission Hills and Belward Campus area. The results are based on an average of four runs of the simulation model for this particular option and account for the variability of vehicular traffic movements, motorist behavior and interaction with the traffic signal system.

Table 5. Option 2 LOS and Intersection Delay (2035)				
Intersection	AM Peak		PM Peak	
	LOS	Overall Intersection Delay (seconds)	LOS	Overall Intersection Delay (seconds)
Great Seneca Highway and Muddy Branch Road	F	151	F	125
Belward Campus Drive and Belward 1	B	11	B	17
Belward Campus Drive and Belward 4	B	17	B	15
Belward Campus Drive and Johns Hopkins Drive	C	21	C	23

Table 6 summarizes the change in CCT travel times between the Line and Grade alignment and Option 2 based on the segment travel times between the Kentlands and LSC West Stations.



Direction/Time Period	Line and Grade Forecasted Future Travel Time (minutes)	Option 2 Forecasted Future Time (minutes)	Change in Forecasted Future Travel Time (minutes)	Percentage Increase of Corridor-Wide Travel Time
Inbound AM Peak	9.9	12.0	+2.1	+5.5%
Inbound PM Peak	11.7	12.8	+1.1	+2.9%
Outbound AM Peak	10.1	12.3	+2.2	+5.8%
Outbound PM Peak	11.0	13.2	+2.2	+5.8%

Under Option 2, the travel time increases would range from 1.1 minutes to 2.2 minutes. The percentage increase in travel time relative to the forecasted end-to-end travel time of 38 minutes would range between 2.9 percent and 5.8 percent.

6. Operations

There are two key operational issues that would result from the implementation of Option 2.

Indirect Routing: Under Option 2, through trips from the intersection of Belward Campus Drive and Johns Hopkins Drive would be routed west on Belward Campus Drive to access the LSC Belward Station near the center of the Belward Campus. Buses would then proceed around the roundabout to head back east to the intersection of Belward Campus Drive and Johns Hopkins Drive. This U-turn effect would likely be perceived by riders as a greater burden than the actual time penalty resulting from this option. The negative impacts associated with this type of indirect route would be especially prominent on a premium transit service such as the CCT.

Ridership Impacts and Additional Run Time: As noted in **Table 6**, this option would result in an increase in peak hour end-to-end run time of up to 2.2 minutes. The increase in run time would make the CCT less attractive compared to other mode options and, therefore, could result in decreased ridership.

7. Utilities

Option 2 would avoid the crossings of a 12-inch underground water line, underground telecommunications lines, and an 8-inch underground gas line near Mission Drive as discussed in the Line and Grade alignment. Impacts would also be avoided for an overhead electric line near Johns Hopkins Drive and underground gas, sanitary and water lines at the intersection of Belward Campus Drive and Johns Hopkins Drive because the CCT buses would be running on existing pavement on Belward Campus Drive. However, this option would cross a 30-inch underground sanitary sewer line near the intersection of Muddy Branch Road and Great Seneca Highway, and there would be additional impacts to approximately 15 light poles and associated power conduit (approximately 2,000 linear feet) along the south side of Great Seneca Highway. Under Option 2, there would be an additional underground sanitary sewer conflict behind the Mission Hills community near the intersection of Great Seneca Highway and Sam Eig Highway.

8. Environmental Resources

Because Option 2 does not travel along Muddy Branch Road, there would be no residential displacement at Mission Hills. However, there would be minor impacts to three residential properties in the Mission Hills community that back to Great Seneca Highway. This option would



also impact approximately 800 linear feet of streams, 1.7 acres of wetlands, 3.2 acres of forest, 0.6 acres of 100-year floodplain, and less than 0.1 acres of forest conservation easement.

Impacts to the forest conservation easement would require approval from M-NCPPC and justification would have to be presented demonstrating why removal of the Forest Conservation Easement would be necessary, and would require coordination with M-NCPPC to determine appropriate mitigation.

Under Option 2 approximately 3 acres of Belward Farm would be impacted. A Section 4(f) Evaluation would be completed to assess whether there is a feasible and prudent alternative to the use of Belward Farm and to identify efforts to minimize harm to the property resulting from use (see **Figures 2 and 3**).

E. Option 3: West of Pond and Along Belward Campus Drive

1. Description

Under Option 3, the proposed alignment would begin at the intersection of Muddy Branch Road and Great Seneca Highway and run east along the south side of Great Seneca Highway. The transitway would turn southeast near the intersection of Great Seneca Highway and Sam Eig Highway to run on retained fill between the existing regional SWM pond and Mission Hills community, and would then turn west toward the Belward campus. The alignment would continue south parallel to the campus along the east side and would enter into the median of Belward 3 just west of Belward 4. The transitway would then turn east into the median of Belward Campus Drive and would run in the median to the intersection of Belward Campus Drive and Johns Hopkins Drive. See **Appendix A** for detailed mapping.

The transitway would be 28 feet wide, with one 14-foot lane in each direction, including the gutter pan. A two-foot wide concrete median barrier would separate the transitway from the southbound lanes on Great Seneca Highway. Belward Campus Drive would accommodate the transitway and stormwater management facilities in the median of the roadway. The transitway would be physically separated from the eastbound and westbound travel lanes on Belward Campus Drive by a median.

2. Structures

The proposed transitway location in Option 3 would directly impact the downstream end of the culvert described in Option 2. Construction of a new headwall would be required in addition to extension of the culvert by approximately 30 feet. Two retaining walls would be needed along the transitway to avoid impacts to the tributary and existing regional SWM pond. The retaining wall on the south side of the transitway, extending from Muddy Branch Road to the proposed culvert extension, would be approximately 710 feet long and 12 feet high. The retaining wall along the east side of the transitway, between the pond and the Mission Hills community, would be approximately 620 feet long and 11.5 feet high. Further geotechnical investigation would be required to determine the feasibility of constructing the retaining wall on the embankment of the pond.

3. Stormwater Management

Under Option 3, proposed new impervious area would be approximately 3.0 acres, reconstruction of existing impervious area would be approximately 0.5 acres, and removal of existing impervious

area would be approximately 0.1 acres. As a result, the impervious area requiring treatment would be approximately 3.2 acres.

The proposed SWM design would involve treating runoff from the proposed transitway by using a combination of ESD facilities and proprietary BMP facilities. ESD would be provided through micro-scale practices such as bio-swailes and micro-bioretenion facilities to the maximum extent practicable. Approximately 0.3 acres of impervious would be treated in the proposed bio-swailes with a footprint of approximately 1,600 square feet. The proposed bio-swailes would not be able to meet the full ESD requirement. Therefore, 12 Filterra Inlets would be proposed to provide the remaining water quality treatment. Quantity control channel protection volume and the 10-year storm would be provided using three underground detention structures. The locations of the inlets and underground storage facilities have not yet been determined.

This option would impact the existing regional SWM pond southeast of the intersection of Great Seneca Highway and Sam Eig Highway. The CCT would run along the southwest embankment of the pond and would impact the embankment for the 100-year pool elevation. As a result, re-grading in other portions of the pond would be required to accommodate the lost 100-year storage. Furthermore, the alignment would block the existing access road to the pond, and a new access road would need to be constructed. Additional analysis would be required to determine if impacts to the pond would be significant enough that the pond would have to be upgraded to meet current standards.

A new storm drain system would need to be installed for the proposed transitway. The proposed storm drain system would consist of a total of 38 drainage structures (inlets and manholes) and 5,960 linear feet of storm drain pipes for the CCT and retrofitting existing storm drain system.

4. Stations

Under Option 3, the location of the LSC Belward Station would be shifted one block east of the location provided in the Line and Grade alignment. This shift to the end of the block would maintain the connection to the central activity area of the campus. This block is longer, which would create an extended walkway from the eastern intersection to the platform. This station would contain a center platform that would be 150 feet long and 18 feet wide. Access to the platform would be provided by pedestrian ramps at both ends and corresponding crosswalks would be located at the nearest roadway intersection.

5. Traffic

Under Option 3, CCT buses would operate on an exclusive transitway along the south side of Great Seneca Highway and in the median of Belward Campus Drive. Option 3 would require a new signal at the intersection where the proposed transitway would meet the intersection of Belward 3 and Belward 4. The CCT buses would cross at-grade through the following intersections:

- Belward 3 and Belward 4 (new signal)
- Belward Campus Drive and Belward 3 (new signal)
- Belward Campus Drive and Belward 4 (new signal)
- Belward Campus Drive and Johns Hopkins Drive (new signal)



In this option, CCT vehicles would not cross the following intersections:

- Muddy Branch Road and Mission Drive/Midsummer Drive
- Muddy Branch Road and Belward North
- Muddy Branch Road and Belward Campus Drive
- Belward Campus Drive and Belward 1
- Belward Campus Drive and Belward 2

Table 7 summarizes the Level of Service and delay results for Option 3 at all intersections in the Mission Hills and Belward Campus area. The results are based on an average of four runs of the simulation model for this particular option and account for the variability of vehicular traffic movements, motorist behavior and interaction with the traffic signal system.

Intersection	AM Peak		PM Peak	
	LOS	Overall Intersection Delay (seconds)	LOS	Overall Intersection Delay (seconds)
Great Seneca Highway at Muddy Branch Road	F	121	F	121
Belward Campus Drive at Belward 4	B	16	B	11
Belward Campus Drive at Johns Hopkins Drive	C	23	C	24

Table 8 summarizes the change in CCT travel times between the Line and Grade alignment and Option 3 based on the segment travel times between the Kentlands and LSC West Stations. The change in travel time would range from a decrease of 1.5 minutes to an increase of 0.3 minutes. The percentage change in travel time relative to the forecasted end-to-end travel time of 38 minutes ranges between a decrease of 3.9 percent and an increase of 0.8 percent.

Direction/Time Period	Line and Grade Forecasted Future Travel Time (minutes)	Option 3 Forecasted Future Time (minutes)	Change in Forecasted Future Travel Time (minutes)	Percentage Change of Corridor-Wide Travel Time
Inbound AM Peak	9.9	10.2	+0.3	+0.8%
Inbound PM Peak	11.7	10.2	-1.5	-3.9%
Outbound AM Peak	10.1	9.7	-0.4	-1.1%
Outbound PM Peak	11.0	11.1	+0.1	+0.3%

6. Operations

Operational impacts associated with Option 3 are anticipated to be minimal, as indicated in **Table 8**. The station would be located further east than the location proposed under the Line and Grade. The location would have marginal impacts because the ¼-mile catchment area around the station would still encompass the majority of the Belward campus.



7. Utilities

Option 3 would avoid the crossings of a 12-inch underground water line, underground telecommunications lines, and an 8-inch underground gas line near Mission Drive as discussed in the Line and Grade alignment. Option 3 would impact the 30-inch underground sanitary sewer line near Muddy Branch Road described in Option 2, and there would be additional impacts to approximately seven light poles and associated power conduit (approximately 900 linear feet) along the south side of Great Seneca Highway. Under Option 3, there would be an additional underground sanitary sewer conflict behind the Mission Hills community near the intersection of Great Seneca Highway and Sam Eig Highway. Utility impacts resulting from the transitway in the median of Belward Campus Drive would include overhead electric and underground gas, water, and sewer lines near the intersection of Belward Campus Drive and Johns Hopkins Drive.

8. Environmental Resources

Because Option 3 does not travel along Muddy Branch Road, there would be no residential displacement at Mission Hills. However, there would be minor impacts to six residential properties in the Mission Hills community that back to Great Seneca Highway and on the eastern end of the community. This option would also impact approximately 1,150 linear feet of streams, 1.0 acres of wetlands, 0.6 acres of 100-year floodplain, 4.4 acres of forest, and 0.6 acres of forest conservation easement.

Impacts to the forest conservation easement would require approval from M-NCPPC and justification would have to be presented demonstrating why removal of the Forest Conservation Easement would be necessary, and would require coordination with M-NCPPC to determine appropriate mitigation.

Under Option 3 approximately 8.3 acres of Belward Farm would be impacted. A Section 4(f) Evaluation will be completed to assess whether there is a feasible and prudent alternative to the use of Belward Farm and to identify efforts to minimize harm to the property resulting from use (see **Figures 2 and 3**).

F. Option 4: East of Pond and Along Belward Campus Drive

1. Description

Under Option 4, the proposed alignment would begin at the intersection of Muddy Branch Road and Great Seneca Highway and would run east along the south side of Great Seneca Highway. East of the existing regional SWM pond, the transitway would turn southwest and run parallel along the east side of an existing stream toward the Belward Campus. The alignment would turn east at the proposed 5-legged intersection of Belward 4 and Belward Campus Drive and would travel within the median of Belward Campus Drive to the intersection of Belward Campus Drive and Johns Hopkins Drive. See **Appendix A** for detailed mapping.

The transitway would be 28 feet wide, with one 14-foot lane in each direction, including the gutter pan. A two-foot wide concrete median barrier would separate the transitway from the southbound lanes on Great Seneca Highway. Belward Campus Drive would accommodate the transitway and stormwater management facilities in the median of the roadway. The transitway would be physically separated from the eastbound and westbound travel lanes on Belward Campus Drive with a median.

2. Structures

The proposed transitway location in Option 4 would directly impact the downstream end of the culvert, as described in Option 2. A new headwall would be needed in addition to extension of the culvert by approximately 30 feet. Construction of one new culvert would be required to carry a stream beneath the transitway just east of the existing regional SWM pond behind the Mission Hills community.

Two retaining walls would be needed along the south side of the transitway to avoid impacts to the tributary and pond. The retaining wall extending from Muddy Branch Road to the proposed culvert extension would be approximately 710 feet long and 12 feet high. The retaining wall adjacent to the pond, on the south side of Great Seneca Highway, would be approximately 880 feet long and 5 feet high.

3. Stormwater Management

Under Option 4, proposed new impervious area would be approximately 3.4 acres, reconstruction of existing impervious area would be 1.4 acres, and removal of existing impervious area would be 0.2 acres. As a result, the impervious area requiring treatment would be 4.0 acres.

The proposed SWM design would involve treating runoff from the proposed transitway by using a combination of ESD facilities and proprietary BMP facilities. ESD would be provided through micro-scale practices such as bio-swales and micro-bioretenion facilities to the maximum extent practicable. Approximately 0.6 acres of impervious area would be treated in the proposed bio-swales with a proposed footprint of approximately 3,800 square feet. The proposed bio-swales would not be able to meet the full ESD requirement. Therefore, 14 Filterra Inlets would be proposed to provide the remaining water quality treatment. Quantity control channel protection volume and the 10-year storm would be provided using three underground detention structures. The locations of the inlets and underground storage facilities have not yet been determined.

This option would impact the existing regional SWM pond located southeast of the intersection of Great Seneca Highway and Sam Eig Highway. The CCT would run along the northeast embankment of the pond and would impact the embankment for the 100-year pool elevation. As a result, re-grading in other portions of the pond would be required to accommodate the lost 100-year storage. Furthermore, the alignment would block the existing access road to the pond, and a new access road would need to be constructed. Additional analysis would be required to determine if impacts to the pond would be significant enough that the pond would have to be retrofitted to meet current standards.

The Option 4 alignment would impact the existing storm drain system along Great Seneca Highway. A new storm drain system would need to be installed for the proposed transitway. The proposed storm drain system would consist of a total of 50 drainage structures (inlets and manholes) and 7,760 linear feet of storm drain pipes for the CCT and retrofitting existing storm drain system.

4. Stations

Under Option 4, the LSC Belward Station would be shifted northeast, removing it from the prominent location on Belward Campus Drive and placing it on proposed dedicated alignment perpendicular to Belward Campus Drive. The connection with the historic farm and central activity area of the campus would not be as strong. This station would contain a center platform



that would be 150 feet long and 18 feet wide. Access to the platform would be provided by pedestrian ramps at both ends and corresponding crosswalks would be located at the nearest roadway intersection. Because of the isolated location of the platform, the walkways to the north would be approximately 150 feet longer to reach the crosswalks. This isolated location would also reduce the visibility of the station, therefore, reducing safety because it would not be visible from the immediate surroundings.

5. Traffic

Under Option 4, CCT buses would operate on a dedicated transitway along the south side of Great Seneca Highway and in the median of Belward Campus Drive. The CCT buses would cross at-grade through the following intersections:

- Belward Campus Drive and Belward 4 (new signal)
- Belward Campus Drive and Johns Hopkins Drive (new signal)

The CCT vehicles would no longer cross the following intersections:

- Muddy Branch Road and Mission Drive/Midsummer Drive
- Muddy Branch Road and Belward North
- Muddy Branch Road and Belward Campus Drive
- Belward Campus Drive and Belward 1
- Belward Campus Drive and Belward 2
- Belward Campus Drive and Belward 3

Table 9 summarizes the Level of Service and delay results for Option 4 at all intersections in the Mission Hills area. The results are based on an average of four runs of the simulation model for this particular option and account for the variability of vehicular traffic movements, motorist behavior and interaction with the traffic signal system.

Table 9. Option 4 LOS and Intersection Delay (2035)				
Intersection	AM Peak		PM Peak	
	LOS	Overall Intersection Delay (seconds)	LOS	Overall Intersection Delay (seconds)
Great Seneca Highway and Muddy Branch Road	F	140	F	133
Belward Campus Drive and Belward 4	B	16	B	13
Belward Campus Drive and Johns Hopkins Drive	C	21	C	26

Table 10 summarizes the change in CCT travel times between the Line and Grade alignment and Option 4 based on the segment travel times between the Kentlands Station and LSC West Station.



Table 10. Travel Time Comparison Between Line and Grade and Option 4 (2035)

Direction/Time Period	Line and Grade Forecasted Future Travel Time (minutes)	Option 4 Forecasted Future Time (minutes)	Change in Forecasted Future Travel Time (minutes)	Percentage Decrease of Corridor-Wide Travel Time
Inbound AM Peak	9.9	8.9	-1.0	-2.6%
Inbound PM Peak	11.7	9.9	-1.8	-4.7%
Outbound AM Peak	10.1	9.0	-1.1	-2.9%
Outbound PM Peak	11.0	10.0	-1.0	-2.6%

Under Option 4, the travel time decreases would range from 1.0 minute to 1.8 minutes. The percentage decrease in travel time relative to the forecasted end-to-end travel time of 38 minutes would range between 2.6 percent and 4.7 percent.

6. Operations

Operational impacts associated with Option 4 are anticipated to be minimal, as indicated in **Table 10**. Under Option 4, the station would be located further east than the location proposed under the Line and Grade. The location would result in shorter travel times and may result in an increase in ridership. The ¼-mile catchment area around the station would still encompass the majority of the Belward campus.

7. Utilities

Option 4 would avoid the crossings of a 12-inch underground water line, underground telecommunications lines, and an 8-inch underground gas line near Mission Drive as discussed in the Line and Grade alignment. Option 4 would impact the 30-inch underground sanitary sewer line near Muddy Branch Road described in Option 2, and there would be additional impacts to approximately 12 light poles and associated power conduit (approximately 1,500 linear feet) along the south side of Great Seneca Highway. Under Option 4, there would be an additional underground sanitary sewer conflict behind the Mission Hills community near the intersection of Great Seneca Highway and Sam Eig Highway. Utility impacts resulting from the transitway in the median of Belward Campus Drive would include overhead electric and underground gas, water, and sewer lines near the intersection of Belward Campus Drive and Johns Hopkins Drive.

8. Environmental Resources

Because Option 4 does not travel along Muddy Branch Road, there would be no residential displacement at Mission Hills. However, there would be minor impacts to three residential properties in the Mission Hills community that back to Great Seneca Highway. This option would also impact approximately 700 linear feet of streams, 1.2 acres of wetlands, 0.6 acres of 100-year floodplain, 7 acres of forest, and 2.5 acres of forest conservation easement.

Impacts to the forest conservation easement would require approval from M-NCPPC and justification would have to be presented demonstrating why removal of the Forest Conservation Easement would be necessary, and would require coordination with M-NCPPC to determine appropriate mitigation.

Under Option 4 approximately 2.7 acres of Belward Farm would be impacted. A Section 4(f) Evaluation will be completed to assess whether there is a feasible and prudent alternative to the



use of Belward Farm and to identify efforts to minimize harm to the property resulting from use (see **Figures 2 and 3**).

III. SUMMARY/CONCLUSIONS

This Alternatives Analysis Report evaluated two segments of the CCT to address concerns expressed by the Mission Hills community. The segments include Muddy Branch Road and Belward Campus Drive. The recommended option is described below and **Table 11** includes a comparison of the options.

The Line and Grade alignment and four options were evaluated. One option would place the transitway in the median of Muddy Branch Road and allow free right turn movements from northbound Muddy Branch Road to Great Seneca Highway, from westbound Mission Drive to Muddy Branch Road, and from westbound Belward Campus Drive to Muddy Branch Road. The other three options would continue the transitway along Great Seneca Highway past the Muddy Branch Road intersection and then into Belward Farm, allowing free movements from westbound Mission Drive to Muddy Branch Road, and from westbound Belward Campus Drive to Muddy Branch Road, but not from northbound Muddy Branch Road to Great Seneca Highway.

Option 1 would provide four travel lanes on Muddy Branch Road with the transitway in the median and would increase the project cost by approximately \$2.0 million as compared to the Line and Grade, due to roadway resurfacing and reconstruction. Because future widening would not be accommodated, the residential displacement included in the Line and Grade alignment would be eliminated. Option 1 would increase the travel time by an average of 0.5 minutes, would have the least wetland and stream impacts, and would have the second smallest impact to the Forest Conservation Easement on the Belward Farm.

Option 2 would continue the transitway along Great Seneca Highway to the extension of Belward Campus Drive, run in the existing travel lanes to the LSC Belward station, and then turn around to head back to Johns Hopkins Drive. It would have the smallest impact to the Forest Conservation Easement on the Belward Farm, the greatest impact to wetlands, and the second highest impact to streams. Option 2 would also eliminate the residential displacement and decrease the project cost by approximately \$0.5 million as compared to the Line and Grade. However, due to the mixed traffic operations, it would increase the travel time by an average of 2.0 minutes. Due to the travel time increase and environmental impacts, Option 2 is not preferred.

Option 3 would continue the transitway along Great Seneca Highway then turn south between the regional SWM pond and the community and run along the east side of the Belward Campus. It would also eliminate the residential displacement, but would increase the project cost by approximately \$1.0 million as compared to the Line and Grade due to retaining wall structures and existing regional SWM pond impacts. Option 3 would include the largest number of steam impacts and the second highest impact to the Forest Conservation Easement on the Belward Farm. It would decrease the travel time by an average of 0.5 minutes. However, it would include minor right-of-way impacts to six homes in the Mission Hills Community. Because of the SWM pond impacts, and additional property impacts, Option 3 is not preferred.

Option 4 would continue the transitway along Great Seneca Highway, around the SWM pond and along the east side of the Belward Campus. It would also eliminate the residential displacement, but it would increase the project cost by approximately \$1.0 million as compared to the Line and Grade due to retaining wall structures and existing regional SWM pond impacts. It would decrease the travel time by an average of 1.0 minute. Option 4 would include minor right-of-way impacts to three homes in the Mission Hills Community and have the largest impact to the Forest



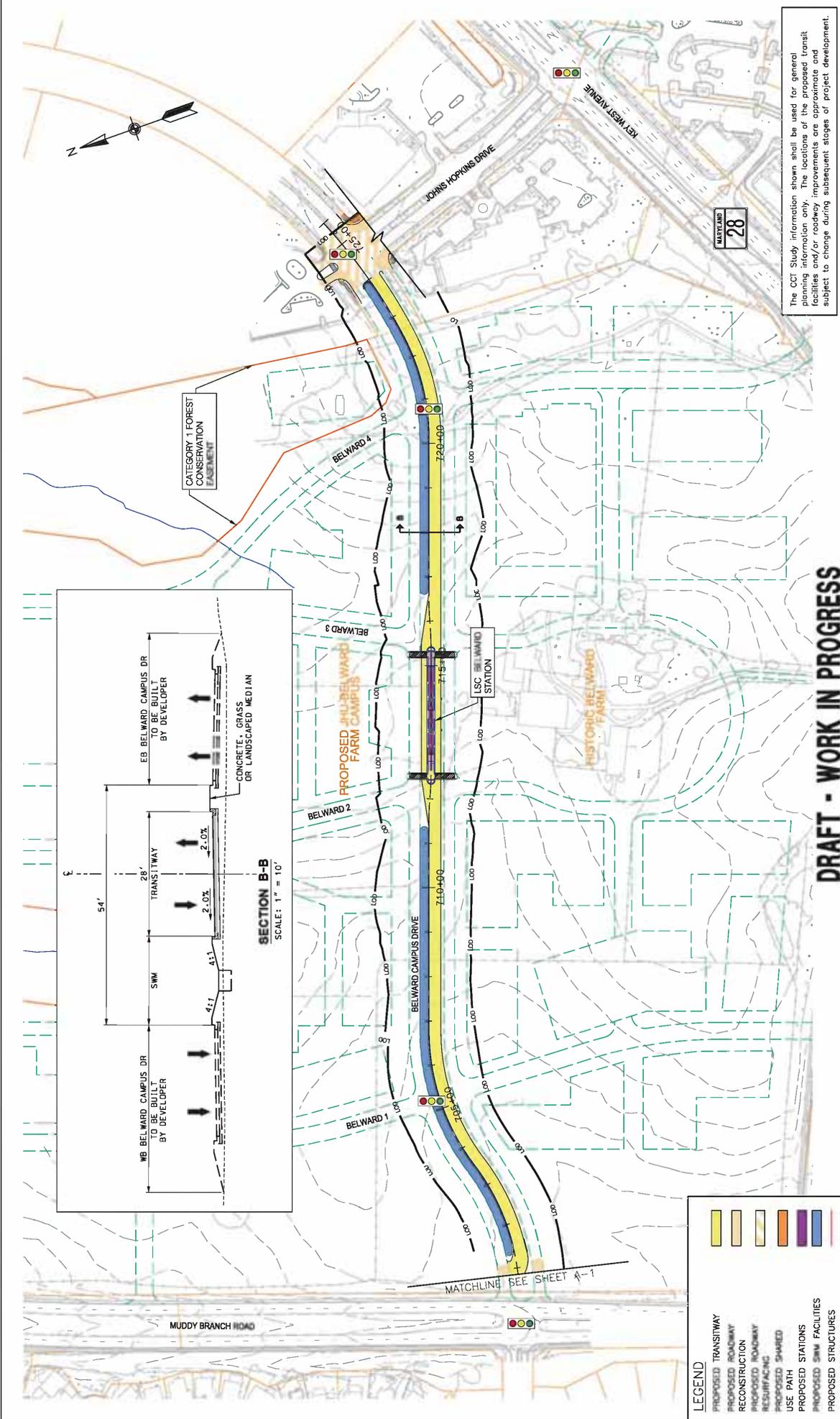
Conservation Easement. Because of the SWM pond impacts, Forest Conservation Easement impacts, and additional property impacts, Option 4 is not preferred.

Option 1 is the preferred alignment for this segment of the transitway because it would have the least environmental impacts, eliminate the residential displacement and allow for free right turn movements in three locations: from Muddy Branch Road to Great Seneca Highway, from Mission Drive to Muddy Branch Road, and from Belward Campus Drive to Muddy Branch Road.



Table 11. Comparison of Options for Mission Hills

Option	Transitway/Roadway	Structures	Stormwater / Drainage	Stations	Traffic for CCT	Operations	Utilities	Environmental Resources	Cost (in 2013 \$)
Option 1	<ul style="list-style-type: none"> Median alignment on Muddy Branch Road and Belward Campus Drive Assume four lanes for Muddy Branch Road Would eliminate residential displacement 	<ul style="list-style-type: none"> Culvert extension would be 12 feet shorter than Line and Grade alignment Would need 120 foot long retaining wall 	<ul style="list-style-type: none"> Two fewer underground detention facilities Would require one surface pond Would impact existing storm drain system along Muddy Branch Road Would require 20 additional drainage structures Would require an additional 3,200 LF of pipe 	<p>LSC Belward:</p> <ul style="list-style-type: none"> Station location same as Line and Grade alignment 	<ul style="list-style-type: none"> Would allow free right turn from NB Muddy Highway to Great Seneca Highway Would allow free right turn from WB Mission Drive to NB Muddy Branch Road Would allow free right turn from WB Belward Campus Drive to NB Muddy Branch Road No significant change in overall intersection delay Average travel time changes: +0.5 Min 	<ul style="list-style-type: none"> No significant operational impacts relative to Line and Grade alignment 	<ul style="list-style-type: none"> Encasement of 30" sanitary line Encasement of 24" water and 8" gas line in median Relocation of overhead electric line and utility poles Relocation of underground telecommunication lines 	<ul style="list-style-type: none"> Minor impacts to Category 1 Forest Conservation Easement Fewest impacts to streams and wetlands Greatest impact to Belward Farm 	<ul style="list-style-type: none"> \$2 M more than Line and Grade
Option 2	<ul style="list-style-type: none"> South side of Great Seneca Highway and mixed traffic on Belward Campus Drive Would eliminate residential displacement Would include ROW impacts to three homes in Mission Hills Community 	<ul style="list-style-type: none"> Culvert extension would be 15 feet shorter than Line and Grade alignment Would require construction of a new culvert Would need two additional retaining walls: 710 feet and 1,300 feet long 	<ul style="list-style-type: none"> Would require approximately seven additional Filterra inlets Would impact existing regional SWM pond Would require reconstruction or relocation of the pond access road 	<p>LSC Belward:</p> <ul style="list-style-type: none"> Station location same as Line and Grade alignment In mixed traffic with dedicated drop off lanes 	<ul style="list-style-type: none"> No free right turn from NB Muddy Branch Road to Great Seneca Highway Would allow free right turn from WB Mission Drive to Muddy Branch Road Would allow free right turn from WB Belward Campus Drive to Muddy Branch Road Would require CCT buses to run in mixed traffic along Belward Campus Drive Average travel time changes: +2.0 min 	<ul style="list-style-type: none"> Indirect operating configuration would negatively impact travel times and passenger perception & convenience Increased run time would make CCT less desirable mode choice and ridership could be negatively impacted 	<ul style="list-style-type: none"> Encasement of 30" sanitary line Relocation of 15 light poles and associated power conduit 	<ul style="list-style-type: none"> Least impact to Category 1 Forest Conservation Easement Second highest impact to streams and highest wetland impacts, including temporary impacts for construction of retaining walls and culvert extension Least impact to Belward Farm 	<ul style="list-style-type: none"> \$0.5 M less than Line and Grade
Option 3	<ul style="list-style-type: none"> South side of Great Seneca Highway, between pond/Mission Hills, and median of Belward Campus Drive Would eliminate residential displacement Would include minor ROW impacts to six homes in Mission Hills Community 	<ul style="list-style-type: none"> Culvert extension would be 15 feet shorter than Line and Grade alignment Would need two additional retaining walls: 710 feet and 620 feet long 	<ul style="list-style-type: none"> Would require approximately six additional Filterra inlets Would impact existing regional SWM pond Would require reconstruction or relocation of the pond access road Would require three additional drainage structures Would require an additional 500 LF of pipe 	<p>LSC Belward:</p> <ul style="list-style-type: none"> Station location shifts one block east away from center of campus Maintains connection to developing campus while strengthening connection to existing campus 	<ul style="list-style-type: none"> No free right turn from NB Muddy Branch Road to Great Seneca Highway Would allow free right turn from WB Mission Drive to Muddy Branch Road Would allow free right turn from WB Belward Campus Drive to Muddy Branch Road Would require a new signal where the proposed transitway meets Belward Road 1. Average travel time changes: -0.5 Min 	<ul style="list-style-type: none"> No significant operational impacts relative to Line and Grade alignment 	<ul style="list-style-type: none"> Encasement of 30" sanitary line Relocation of 7 light poles and associated power conduit 	<ul style="list-style-type: none"> Second highest impact to Category 1 Forest Conservation Easement Most impact to streams; second fewest wetland impacts, including temporary impacts for construction of retaining walls and culvert extension Second highest impact to Belward Farm 	<ul style="list-style-type: none"> \$1 M more than Line and Grade
Option 4	<ul style="list-style-type: none"> South side of Great Seneca Highway, east side of pond, and median of Belward Campus Drive Would eliminate residential displacement Would include minor ROW impacts to three homes in Mission Hills Community 	<ul style="list-style-type: none"> Culvert extension would be 15 feet shorter than Line and Grade alignment Would require construction of a new culvert Would need two additional retaining walls: 710 feet and 880 feet long 	<ul style="list-style-type: none"> Would require approximately eight additional Filterra inlets Would impact existing regional SWM pond Would require reconstruction or relocation of the pond access road Would require 15 additional drainage structures Would require an additional 2,300 LF of pipe 	<p>LSC Belward:</p> <ul style="list-style-type: none"> Station location shifted to the northeast to new campus road perpendicular to Belward Campus Drive North end of platform somewhat isolated (150 ft walkway to connect to Belward Campus Drive); Reduces safety due to low visibility from surroundings Less desirable station location 	<ul style="list-style-type: none"> No free right turn from Muddy Branch Road to Great Seneca Highway Would allow free right turn from WB Mission Drive to Muddy Branch Road Average travel time changes: -1.0 Min 	<ul style="list-style-type: none"> No significant operational impacts relative to Line and Grade alignment 	<ul style="list-style-type: none"> Encasement of 30" sanitary line Relocation of 12 light poles and associated power conduit 	<ul style="list-style-type: none"> Highest impacts to Category 1 Forest Conservation Easement along the east side of Belward Campus Second smallest impact to streams; second highest impact to wetlands, including temporary impacts for construction of retaining walls and culvert extension Second smallest impact to Belward Farm 	<ul style="list-style-type: none"> \$1 M more than Line and Grade



The CCT Study information shown shall be used for general planning information only. The locations of the proposed transit facilities and/or roadway improvements are approximate and subject to change during subsequent stages of project development.

LEGEND	
[Yellow line]	PROPOSED TRANSITWAY
[Orange line]	PROPOSED SIDEWALK
[Light blue line]	RECONSTRUCTION
[Dark blue line]	PROPOSED ROADWAY RESURFACING
[Light green line]	PROPOSED SHARED USE PATH
[Red line]	PROPOSED STATIONS
[Purple line]	PROPOSED SWM FACILITIES
[Blue line]	PROPOSED STRUCTURES
[Grey line]	PROPOSED SIDEWALK
[Red hatched area]	EXISTING PAVEMENT TO BE REMOVED
[Green dashed line]	LIMIT OF DISTURBANCE
[Green dashed line]	PROPOSED DEVELOPMENT
[Green dashed line]	EXISTING PROPERTY LINES

DRAFT - WORK IN PROGRESS

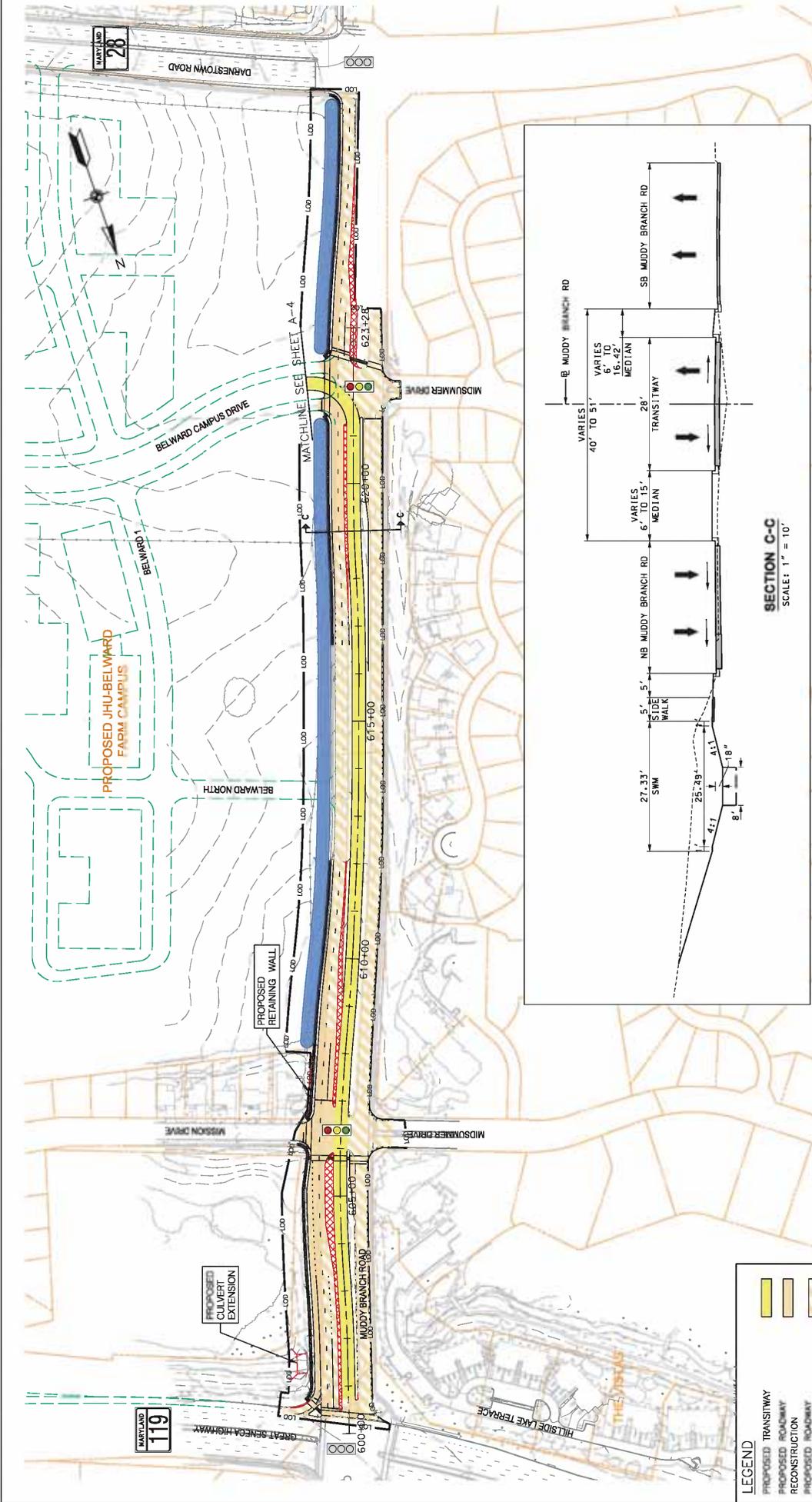


CORRIDOR CITIES TRANSITWAY
MISSION HILLS ALTERNATIVES

LINE AND GRADE ALIGNMENT

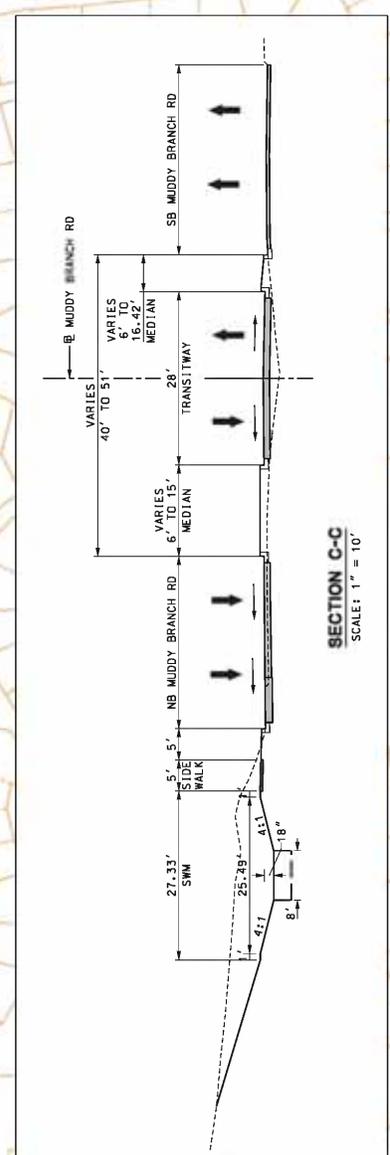
SHEET NO.
A-2

DATE: MAY 2014
SCALE: 1" = 200'



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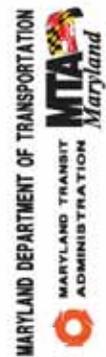
SECTION C-C
SCALE: 1" = 10'



LEGEND

[Yellow Box]	PROPOSED TRANSITWAY
[Light Yellow Box]	PROPOSED SIDEWALK
[Light Green Box]	RECONSTRUCTION
[Light Blue Box]	PROPOSED ROADWAY
[Light Purple Box]	RESURFACING
[Light Orange Box]	PROPOSED SHARED
[Light Red Box]	USE PATH
[Light Blue Box]	PROPOSED STATIONS
[Light Blue Box]	PROPOSED SWM FACILITIES
[Light Blue Box]	PROPOSED STRUCTURES
[Light Blue Box]	PROPOSED SIDEWALK
[Light Blue Box]	EXISTING PAVEMENT TO BE REMOVED
[Light Blue Box]	LIMIT OF DISTURBANCE
[Light Blue Box]	PROPOSED DEVELOPMENT
[Light Blue Box]	EXISTING PROPERTY LINES

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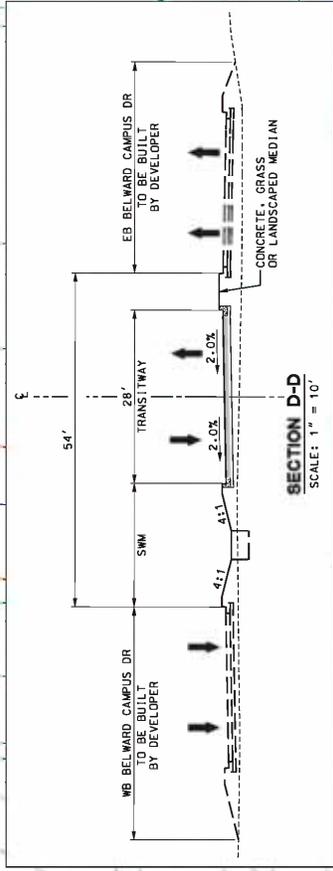
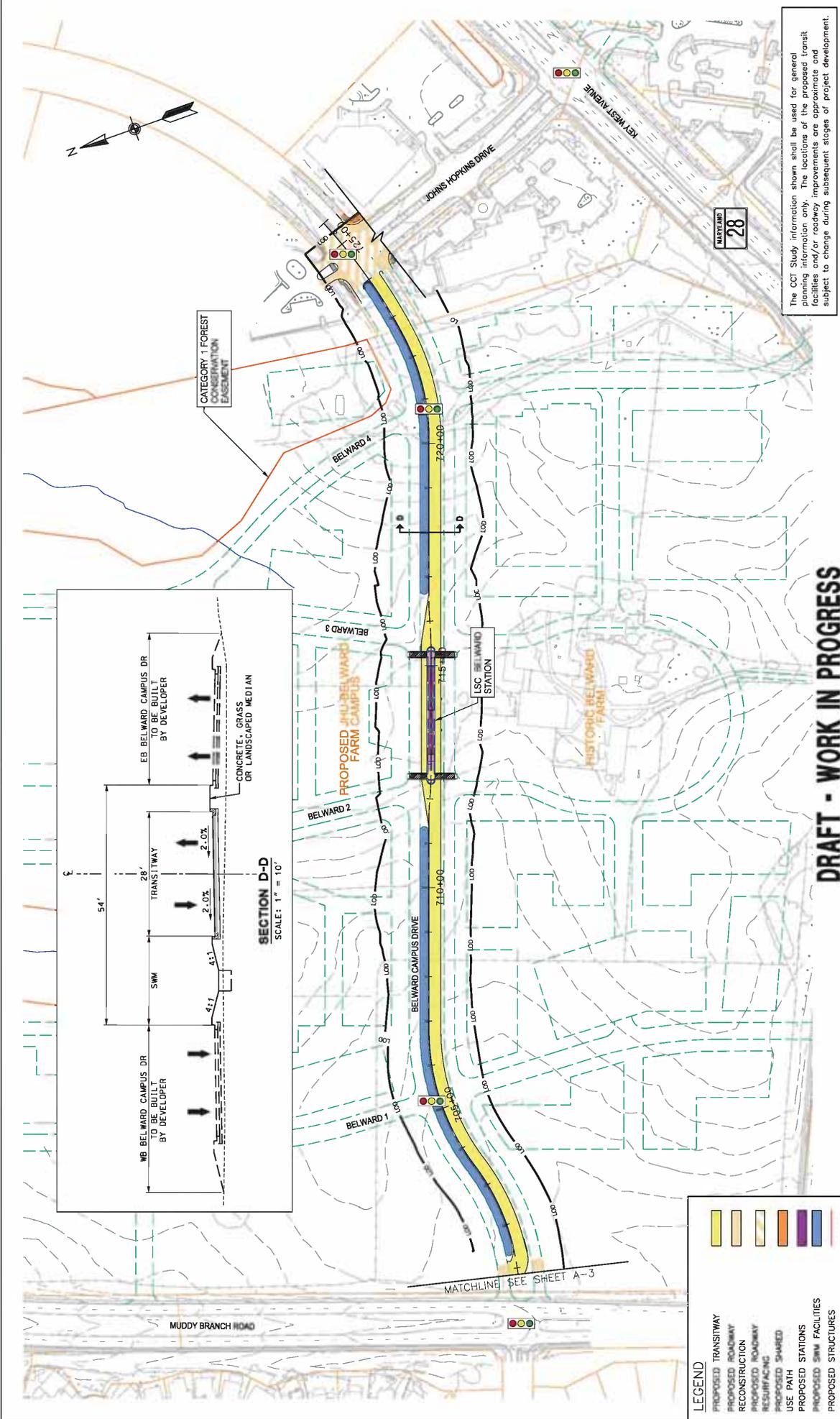
CORRIDOR CITIES TRANSITWAY
MISSION HILLS ALTERNATIVES

OPTION 1: MEDIAN OF MUDDY BRANCH ROAD
DATE: MAY 2014
SCALE: 1"=200'

SHEET NO.
A-3

MARYLAND
28

MARYLAND
119



LEGEND	
[Yellow line]	PROPOSED TRANSITWAY
[Orange line]	PROPOSED SIDEWALK
[Red line]	RECONSTRUCTION
[Green line]	PROPOSED ROADWAY RESURFACING
[Blue line]	PROPOSED SHARED USE PATH
[Purple line]	PROPOSED STATIONS
[Light blue line]	PROPOSED SWM FACILITIES
[Dark blue line]	PROPOSED STRUCTURES
[Grey line]	PROPOSED SIDEWALK
[Red hatched area]	EXISTING PAVEMENT TO BE REMOVED
[Green dashed line]	LIMIT OF DISTURBANCE
[Red dashed line]	PROPOSED DEVELOPMENT
[Black dashed line]	EXISTING PROPERTY LINES

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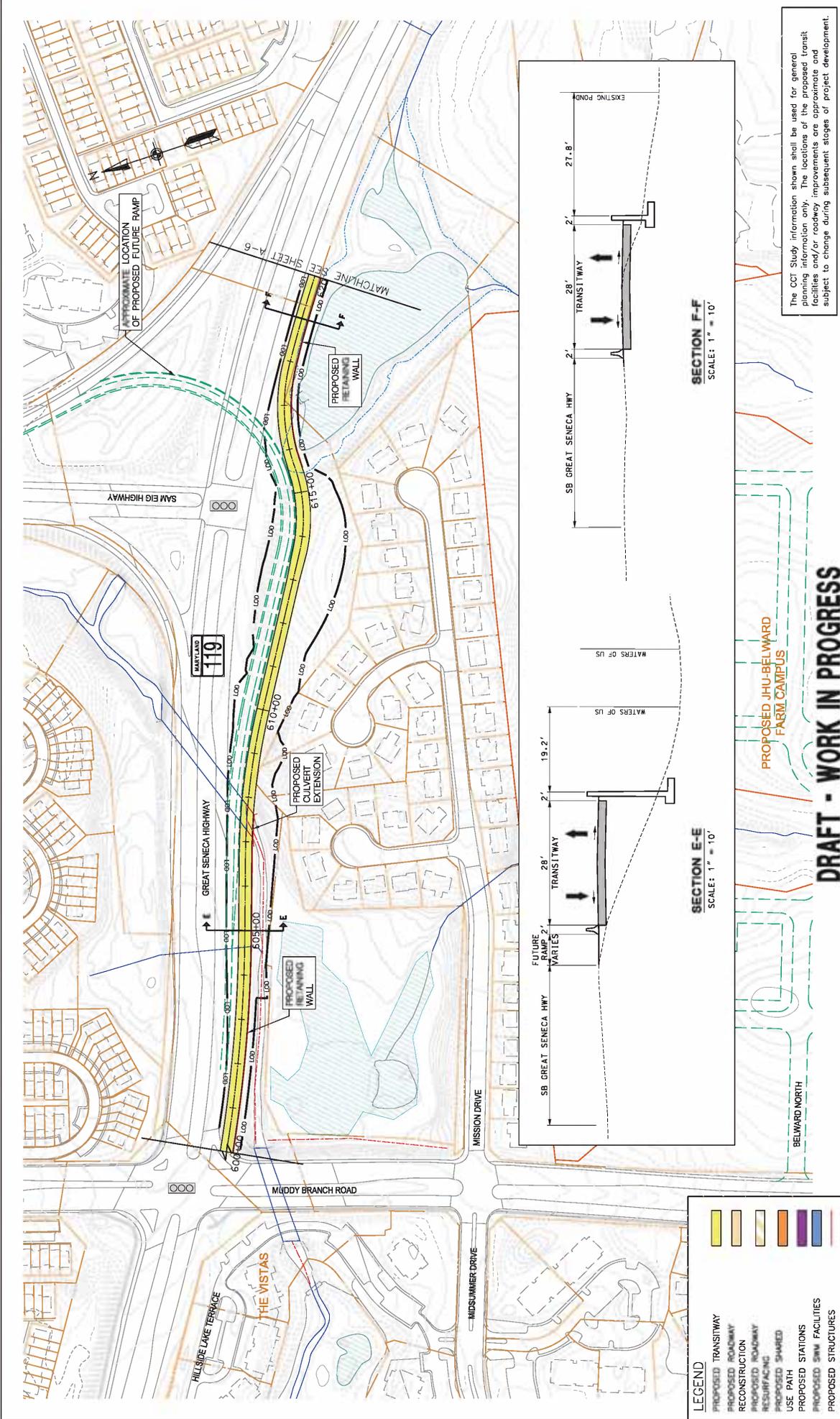
DRAFT - WORK IN PROGRESS

MARYLAND DEPARTMENT OF TRANSPORTATION
 MTA ADMINISTRATION
 MARYLAND TRANSIT ADMINISTRATION

Corridor Cities Transitway

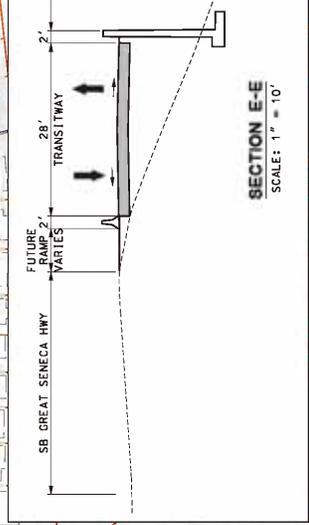
CORRIDOR CITIES TRANSITWAY
 MISSION HILLS ALTERNATIVES
 OPTION 1: MEDIAN OF MUDDY BRANCH ROAD
 DATE: MAY 2014
 SCALE: 1"=200'

SHEET NO.
 A-4



LEGEND

[Yellow line]	PROPOSED TRANSITWAY
[Orange line]	PROPOSED ROADWAY
[Light blue line]	RECONSTRUCTION
[Dark blue line]	PROPOSED ROADWAY RESURFACING
[Green line]	PROPOSED SHARED USE PATH
[Red line]	PROPOSED STATIONS
[Blue line]	PROPOSED SWM FACILITIES
[Purple line]	PROPOSED STRUCTURES
[Dashed line]	PROPOSED SIDEWALK
[Red hatched area]	EXISTING PAVEMENT TO BE REMOVED
[Red dashed line]	LIMIT OF DISTURBANCE
[Green dashed line]	PROPOSED DEVELOPMENT
[Black dashed line]	EXISTING PROPERTY LINES



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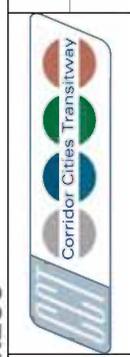
PROPOSED JHU-BELWARD FARM CAMPUS

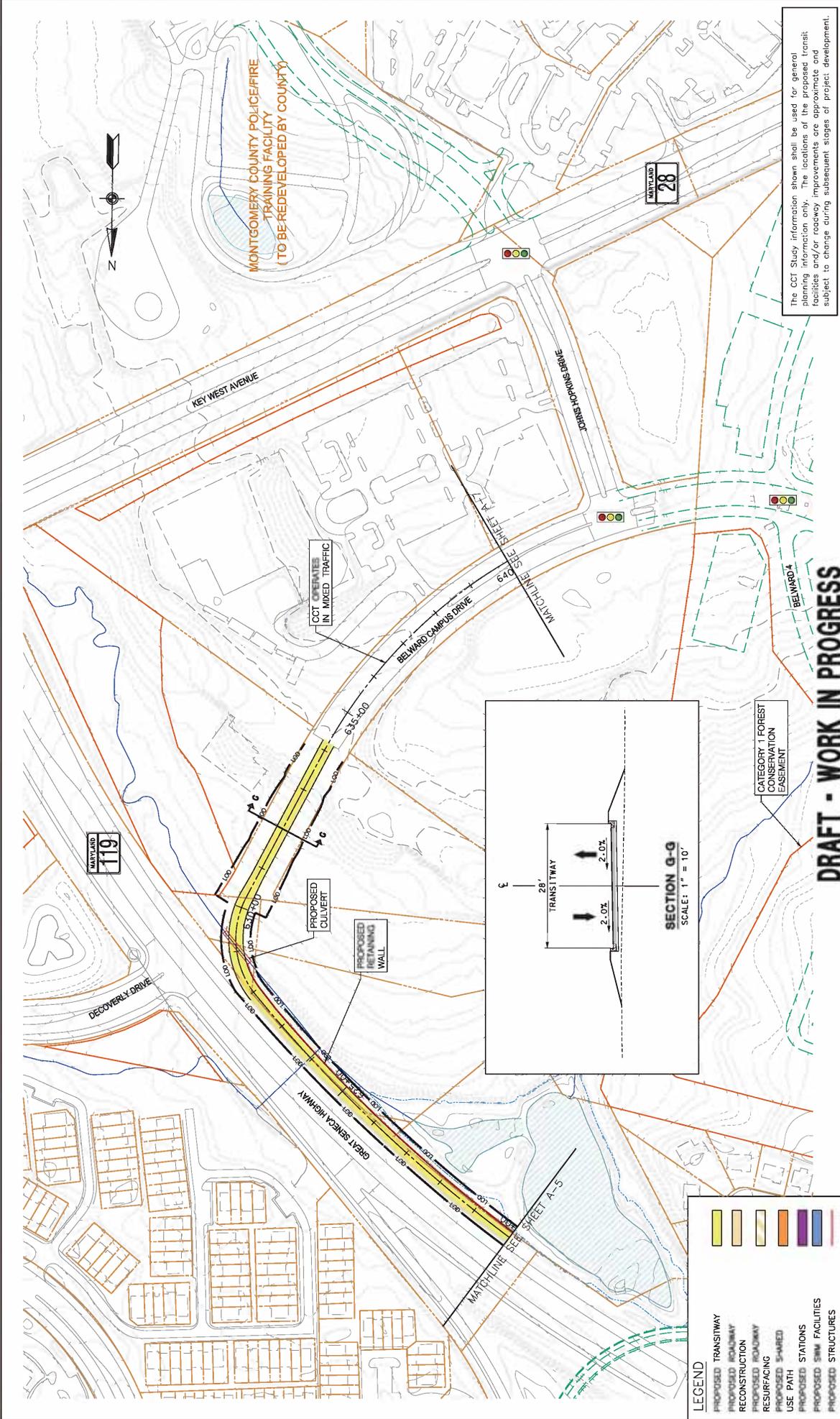
CORRIDOR CITIES TRANSITWAY
MISSION HILLS ALTERNATIVES

OPTION 2: BELWARD CAMPUS DRIVE

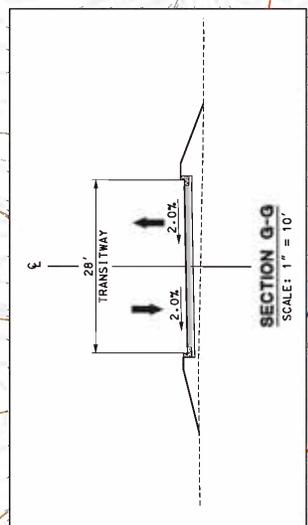
DATE: MAY 2014

SHEET NO.
A-5





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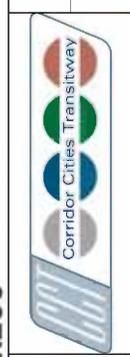


CATEGORY 1 FOREST CONSERVATION EASEMENT

LEGEND

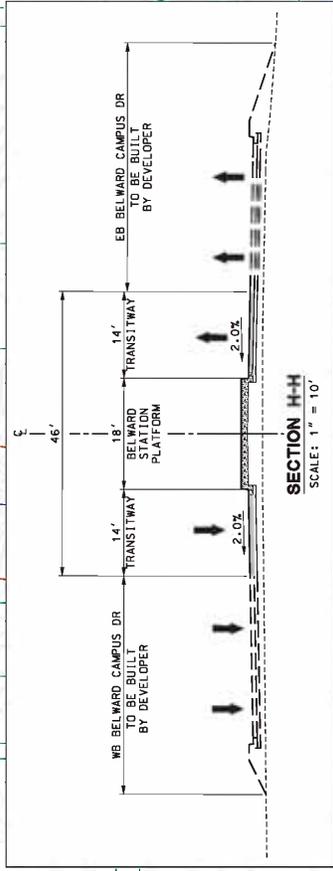
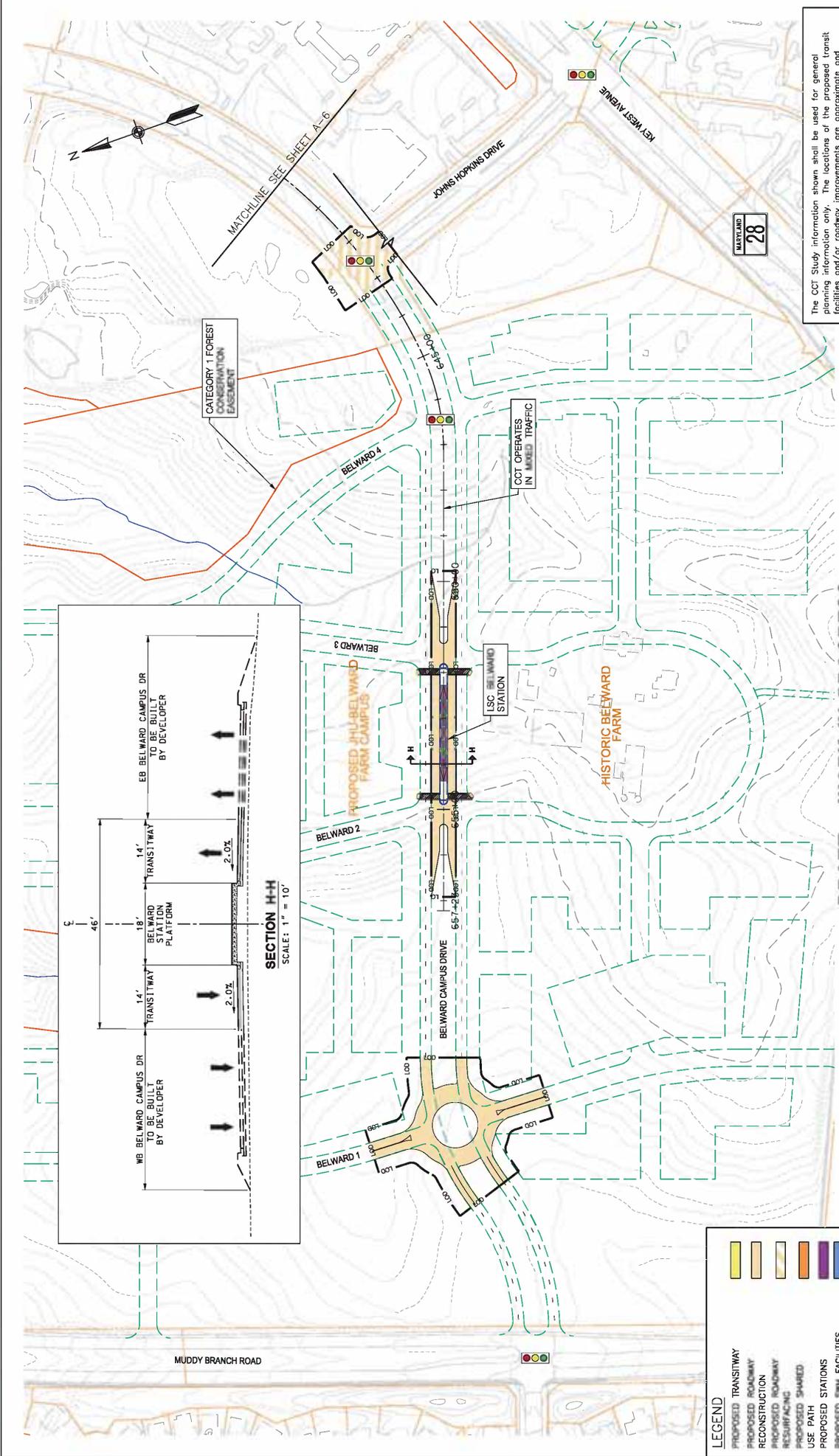
- PROPOSED TRANSITWAY
- PROPOSED ROADWAY RECONSTRUCTION
- PROPOSED ROADWAY RESURFACING
- PROPOSED SHARED USE PATH
- PROPOSED STATIONS
- PROPOSED SRM FACILITIES
- PROPOSED STRUCTURES
- PROPOSED SIDEWALK
- EXISTING PAVEMENT TO BE REMOVED
- LIMIT OF DISTURBANCE
- PROPOSED DEVELOPMENT
- EXISTING PROPERTY LINES

CORRIDOR CITIES TRANSITWAY MISSION HILLS ALTERNATIVES
 OPTION 2: BELWARD CAMPUS DRIVE
 SCALE: 1"=200'
 DATE: MAY 2014



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SHEET NO. A-6



LEGEND

[Yellow line]	PROPOSED TRANSITWAY
[Orange line]	PROPOSED SIDEWALK
[Purple line]	RECONSTRUCTION
[Light blue line]	PROPOSED ROADWAY
[Dark blue line]	PROPOSED ROADWAY RESURFACING
[Green line]	PROPOSED SHARED USE PATH
[Blue rectangle]	PROPOSED STATIONS
[Light blue rectangle]	PROPOSED SWM FACILITIES
[Dark blue rectangle]	PROPOSED STRUCTURES
[Dashed line]	PROPOSED SIDEWALK
[Red hatched area]	EXISTING PAVEMENT TO BE REMOVED
[Red dashed line]	LIMIT OF DISTURBANCE
[Green dashed line]	PROPOSED DEVELOPMENT
[Black dashed line]	EXISTING PROPERTY LINES

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**CORRIDOR CITIES TRANSITWAY
MISSION HILLS ALTERNATIVES**

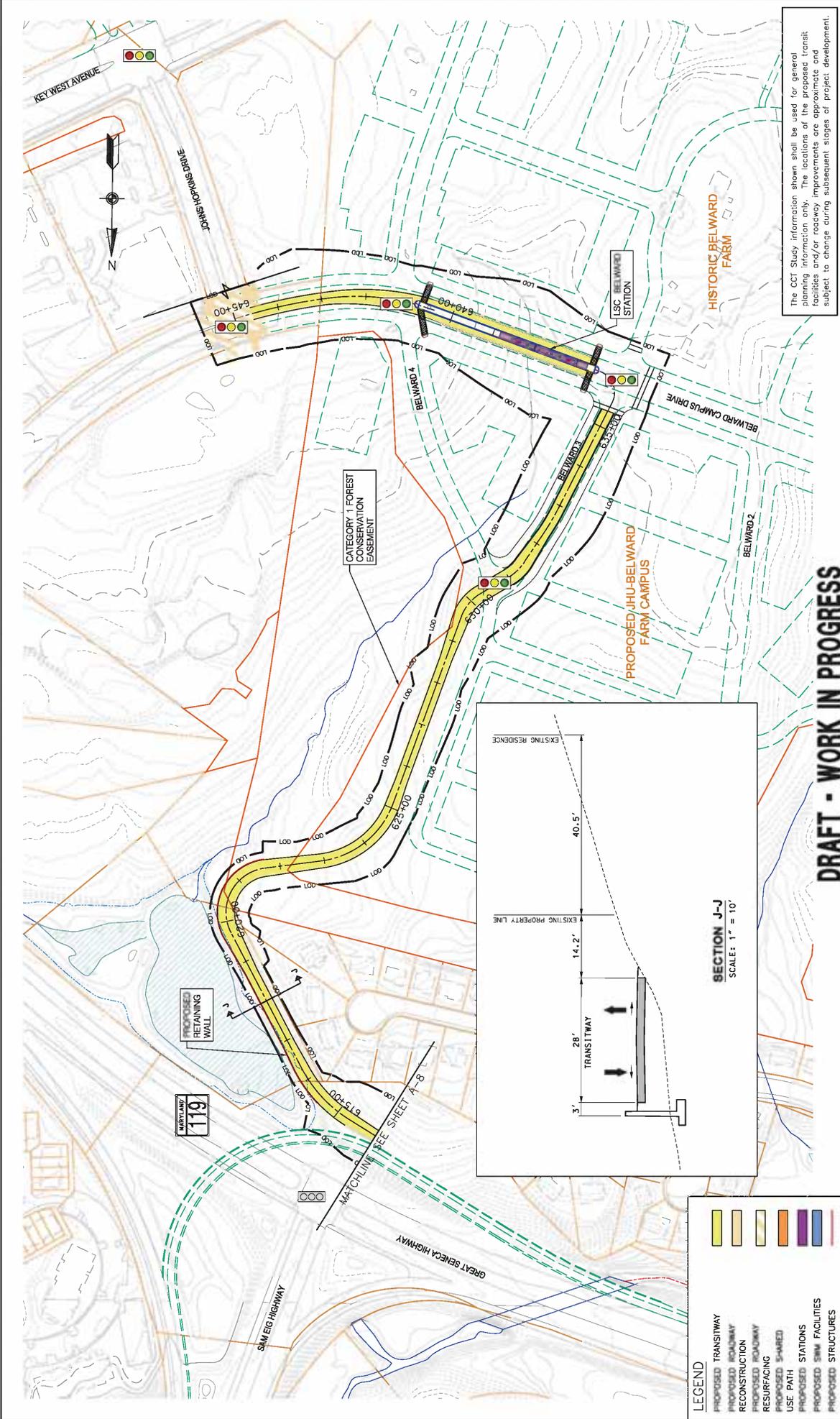
OPTION 2: BELWARD CAMPUS DRIVE

DATE: MAY 2014

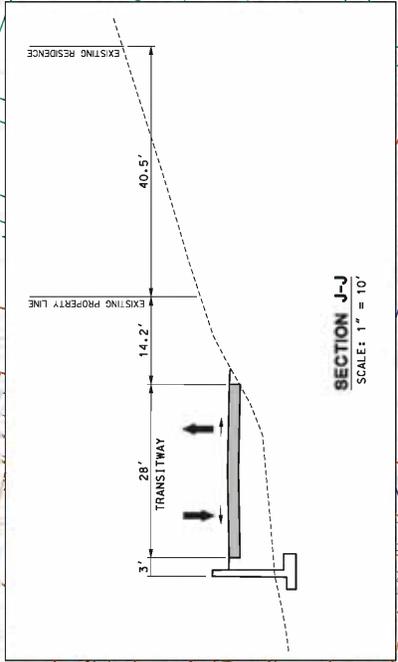
SCALE: 1"=200'



SHEET NO.
A-7



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LEGEND

[Yellow line]	PROPOSED TRANSITWAY
[Orange line]	PROPOSED SIDEWALK
[Light blue line]	RECONSTRUCTION
[Light green line]	PROPOSED ROADWAY
[Dark green line]	RESURFACING
[Blue line]	PROPOSED SHARED
[Purple line]	USE PATH
[Red line]	PROPOSED STATIONS
[Dark red line]	PROPOSED SHM FACILITIES
[Light purple line]	PROPOSED STRUCTURES
[Light blue line]	PROPOSED SIDEWALK
[Light green line]	EXISTING PAVEMENT TO BE REMOVED
[Light blue line]	LIMIT OF DISTURBANCE
[Light green line]	PROPOSED DEVELOPMENT
[Dashed line]	EXISTING PROPERTY LINES



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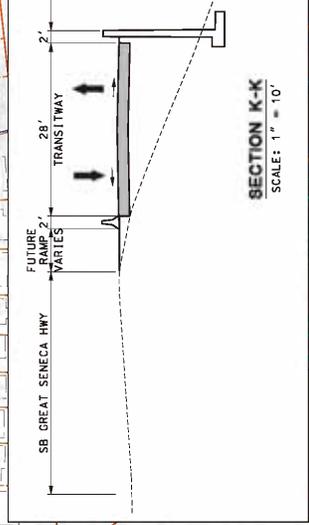
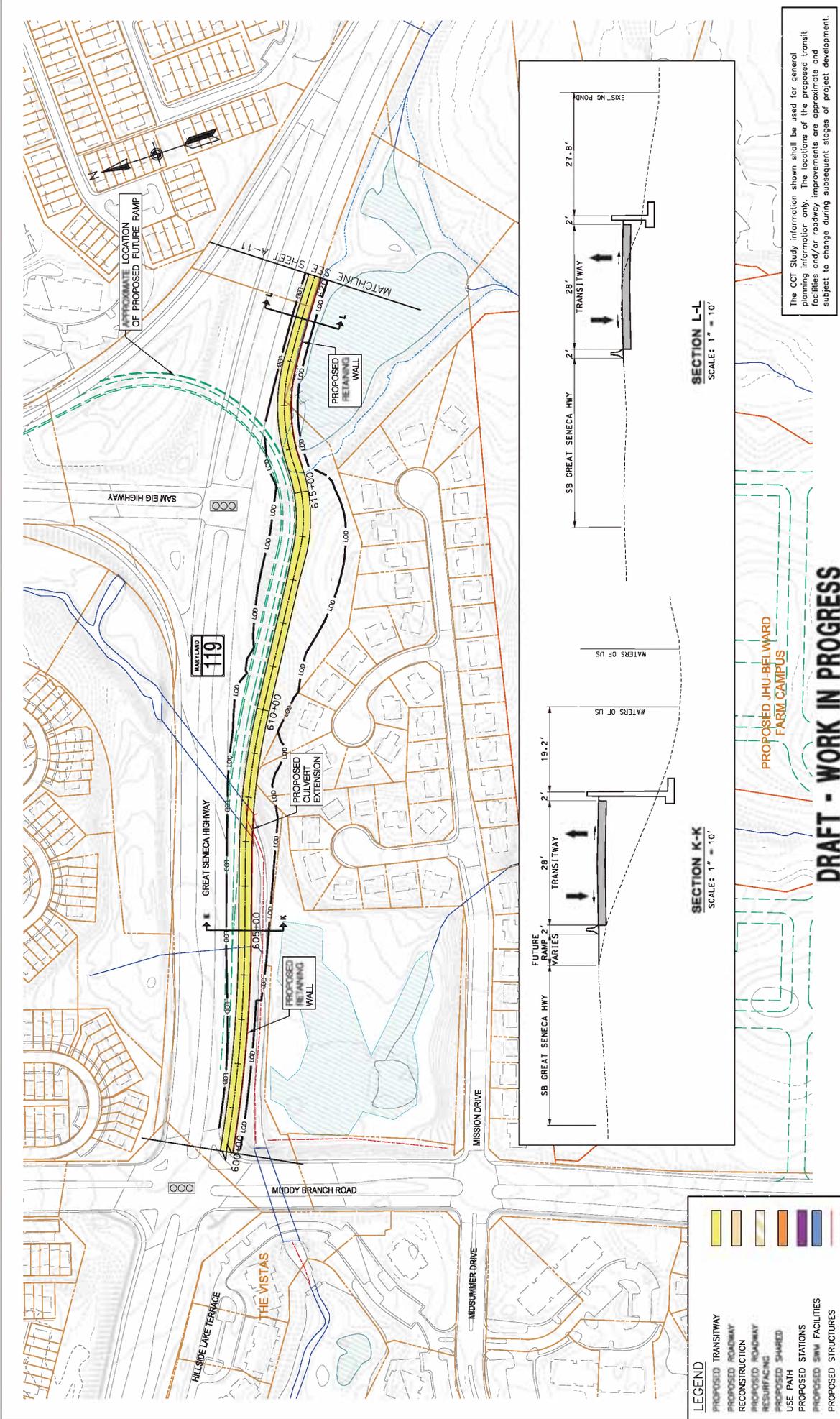
MARYLAND DEPARTMENT OF TRANSPORTATION
 MARYLAND TRANSIT ADMINISTRATION
MTA
 Maryland

**CORRIDOR CITIES TRANSITWAY
 MISSION HILLS ALTERNATIVES**

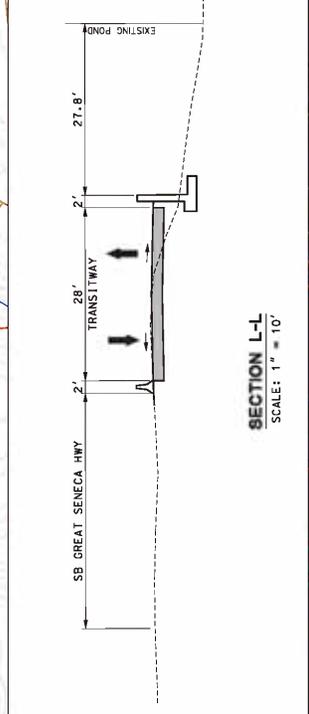
OPTION 3: WEST OF POND AND ALONG
 BELWARD CAMPUS DRIVE

DATE: MAY 2014
 SCALE: 1"=200'

SHEET NO.
 A-9



SECTION K-K
SCALE: 1" = 10'



SECTION L-L
SCALE: 1" = 10'

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LEGEND

	PROPOSED TRANSITWAY
	PROPOSED SIDEWALK
	RECONSTRUCTION
	PROPOSED ROADWAY
	PROPOSED SHARED
	USE PATH
	PROPOSED STATIONS
	PROPOSED SWM FACILITIES
	PROPOSED STRUCTURES
	PROPOSED SIDEWALK
	EXISTING PAVEMENT TO BE REMOVED
	LIMIT OF DISTURBANCE
	PROPOSED DEVELOPMENT
	EXISTING PROPERTY LINES

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PROPOSED JHU-BELWARD FARM CAMPUS

CORRIDOR CITIES TRANSITWAY
MISSION HILLS ALTERNATIVES

OPTION 4: EAST OF POND AND ALONG BELWARD CAMPUS DRIVE

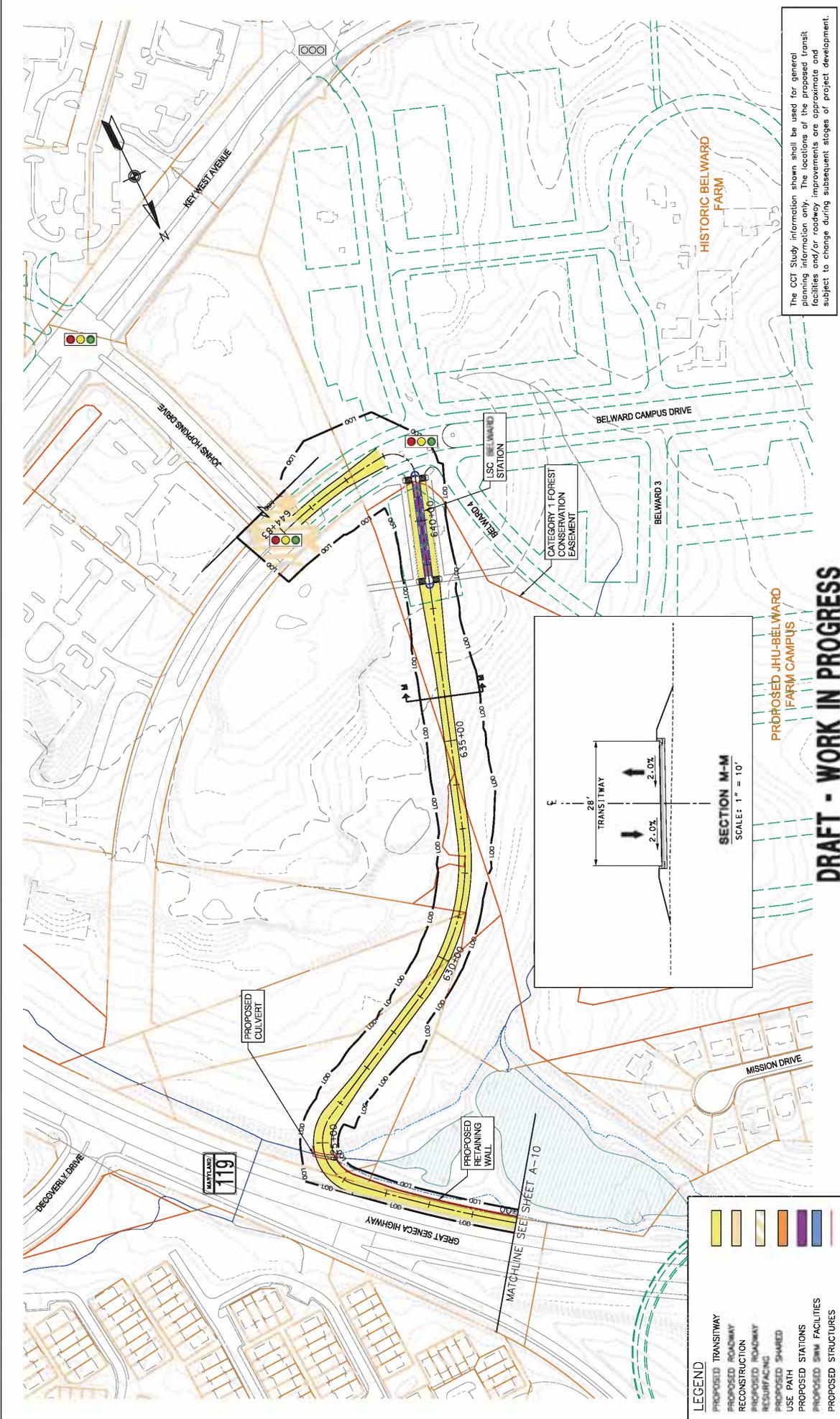
DATE: MAY 2014

SHEET NO.
A-10

SCALE: 1" = 200'

MARYLAND DEPARTMENT OF TRANSPORTATION

5/7/2014 - Current Project\1108 - Corridor Cities Transitway (CCT) - Corridor Cities Transitway (CCT) - D&E\01 Project Planning\Alternatives-Engineering\CAD\Displays\Civil\Alignment Studies\Mission Hills\1108\CV0004-Option 4.dgn

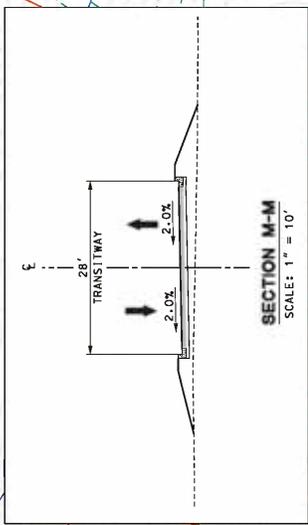


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**CORRIDOR CITIES TRANSITWAY
MISSION HILLS ALTERNATIVES**
OPTION 4: EAST OF POND AND ALONG
BELWARD CAMPUS DRIVE
DATE: MAY 2014
SCALE: 1"=200'



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LEGEND

[Yellow line]	PROPOSED TRANSITWAY
[Orange line]	PROPOSED SIDEWALK
[Light blue line]	RECONSTRUCTION
[Dark blue line]	PROPOSED ROADWAY
[Green line]	PROPOSED SHOULDER
[Purple line]	USE PATH
[Red line]	PROPOSED STATIONS
[Blue line]	PROPOSED SWM FACILITIES
[Grey line]	PROPOSED STRUCTURES
[Dashed line]	PROPOSED SIDEWALK
[Red hatched area]	EXISTING PAVEMENT TO BE REMOVED
[Green hatched area]	LIMIT OF DISTURBANCE
[Red dashed line]	PROPOSED DEVELOPMENT
[Black dashed line]	EXISTING PROPERTY LINES