

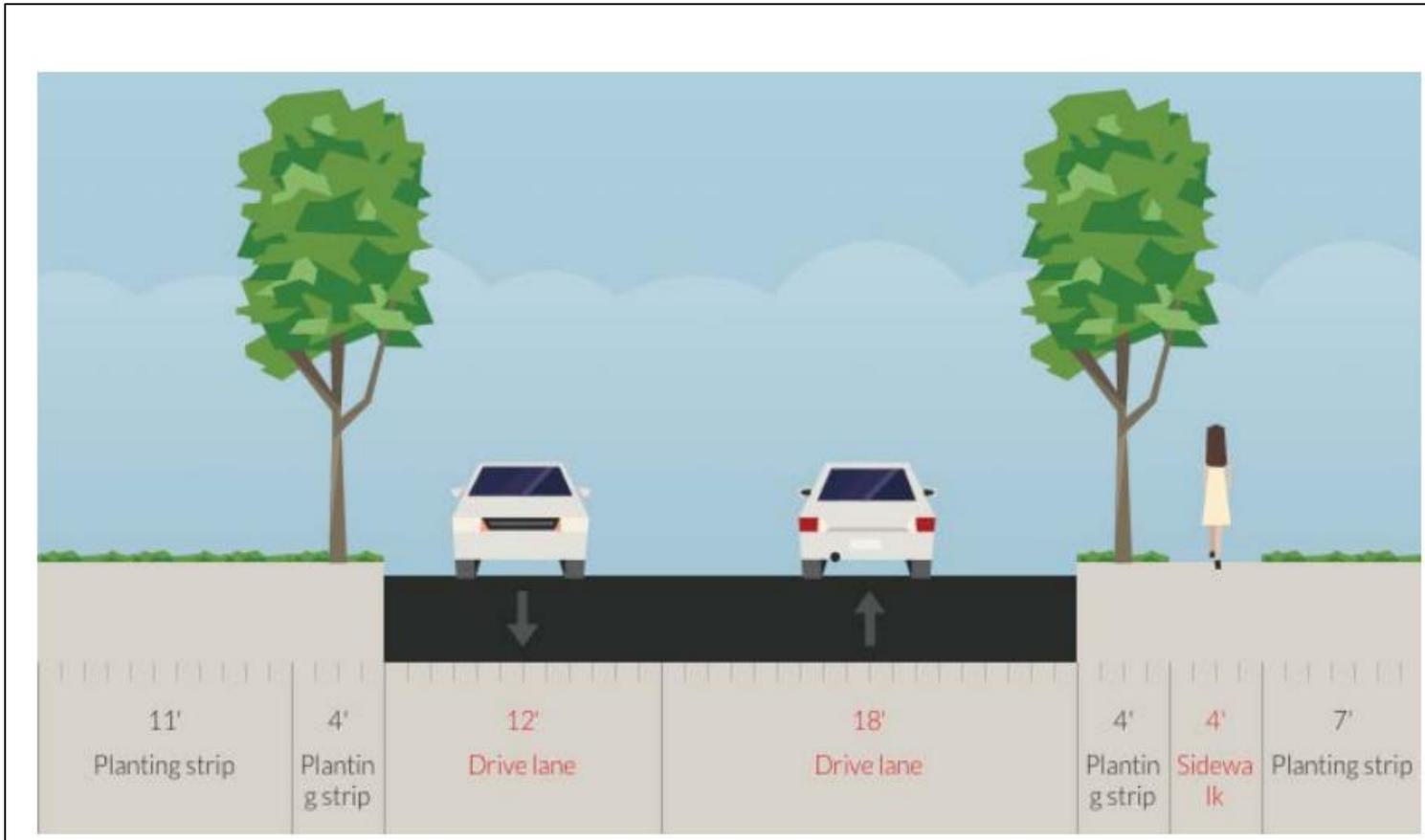


**Princeton Engineering Department
Municipal Evaluation of the Various Valley Road Design Options Presented by Sam Bunting
at the 6/15/15 Neighborhood Meeting
September 2015**

Options to consider for a safer
Valley Road

Note: These designs are for discussion purposes only and are not endorsed by any municipal entity. For further information, please refer to municipal engineering department
Sam Bunting 99 Dempsey Avenue
Citizen member, Traffic and Transportation Committee
samuel.bunting@outlook.com

Option 1 – 9 Roadway Cross Sections and Titles courtesy of Sam Bunting,
as posted at http://www.princetonnj.gov/engineering/S-Bunting-061515_valley_road_options_v2.pdf

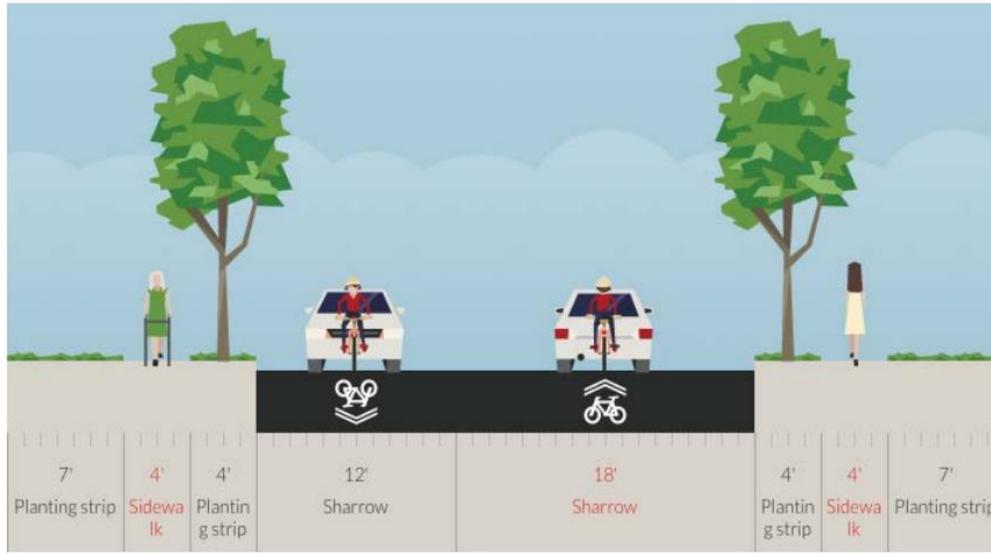


Existing Conditions, Generally, on Valley Road Facing Eastbound
Municipally owned right of way is 65', except between Ewing and Harrison where it narrows to 50'.

- Please note, the narrowest distance between existing tree trunks on opposite sides of Valley Road is 30 ½'.
- Current pavement widths vary from 29' – 30', except where it widens at the Valley Road athletic fields (32') and from Ewing to Harrison Street (up to 38').
- The westbound lane is currently 12' – 16' wide.
- The eastbound lane is currently 15 ½' – 20' wide where on-street parking is allowed; at Harrison Street, the two eastbound lanes are 11' wide each.

Sidewalks + 'sharrows'

'Option 1'



Municipal Evaluation of Option 1:

- The proposed pavement width of 30' fits generally within the existing paved area of Valley Road. Some areas may need to be narrowed by one foot to accommodate existing trees.
- The slide to the left is not clear whether the 18' sharrow provides for 7' parking lane and 11' travel lane. For this analysis, we will propose that parking is retained and included.

Although the 11' lane (18' total lane width less 7' parking) currently exists, it does not meet the currently adopted roadway design standard of a 12' wide lane for a minor collector as shown at:

<http://www.princetonnj.gov/masterplan/appendix-B-classification%20roadwaydesign.pdf>.

However, NACTO permits a lane widths of 10 feet.

<http://nacto.org/publication/urban-street-design-guide/street-design-elements/lane-width/>

- Sharrows provide extra recognition on the roadway for bicyclists.
- Per AASHTO Bicycle Design Guidelines, there is no minimum lane width for use of sharrows. Sharrows on roadways with a speed of 35 mph or faster and a volume higher than 3,000 vehicles per day is not a preferred treatment per NACTO. As only one of these parameters is exceeded, sharrows can be an acceptable option on this roadway.
- Existing intersection layouts at Harrison and Witherspoon can accommodate sharrows without modification. We note that Harrison Street at this location is currently marked with sharrows.
- If desired, the above layout can accommodate curb extensions / bumpouts to reduce pedestrian crossing distances.
- Placement of leaf and brush piles for pick up could continue where permitted in the roadway, as currently takes place.
- The above slide does not show a double yellow centerline roadway stripe. Valley Road currently has this type of centerline striping, and it will be retained in the final design.

Municipal Evaluation of Option 2:

- The proposed pavement width of 30' fits generally within the existing paved area of Valley Road. Some areas may need to be narrowed by one foot to accommodate existing trees.
- The slide to the right is not clear whether the 18' lane provides for 7' parking lane and 11' travel lane. For this analysis, we will propose that parking is retained and included.

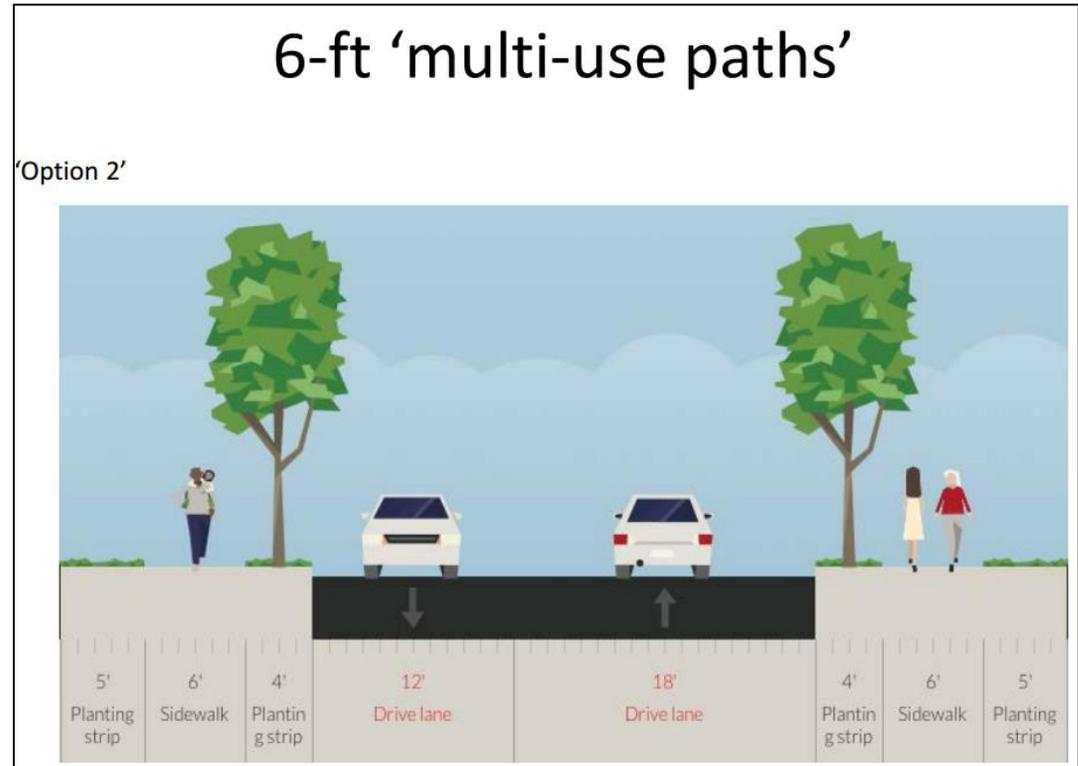
Although the 11' lane (18' total lane width less 7' parking) currently exists, it does not meet the currently adopted roadway design standard of a 12' wide lane for a minor collector as shown at:

<http://www.princetonnj.gov/masterplan/appendix-B-classification%20roadwaydesign.pdf>.

However, NACTO permits a lane widths of 10 feet.

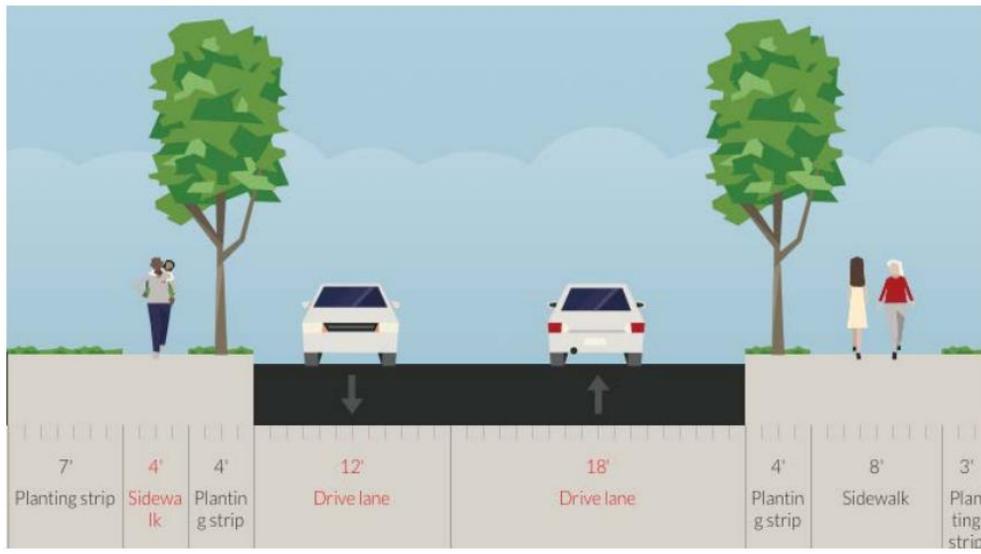
<http://nacto.org/publication/urban-street-design-guide/street-design-elements/lane-width/>

- 6' sidewalks are non-compliant with current standards for multi-use pathways. However, it does provide 2 extra feet for accommodating users.
- No recognition is provided on the roadway for bicyclists.
- If desired, this layout can accommodate curb extensions / bumpouts to reduce pedestrian crossing distances.
- Placement of leaf and brush piles for pick up could continue where permitted in the roadway, as currently takes place.
- The above slide does not show a double yellow centerline roadway stripe. Valley Road currently has this type of centerline striping, and it will be retained in the final design.



Sidewalk + 8-ft 'multi-use path'

'Option 3'



Municipal Evaluation of Option 3:

- The proposed pavement width of 30' fits generally within the existing paved area of Valley Road. Some areas may need to be narrowed by one foot to accommodate existing trees.
- The slide to the left is not clear whether the 18' lane provides for 7' parking lane and 11' travel lane. For this analysis, we will propose that parking is retained and included.

Although the 11' lane (18' total lane width less 7' parking) currently exists, it does not meet the currently adopted roadway design standard of a 12' wide lane for a minor collector as shown at:

<http://www.princetonnj.gov/masterplan/appendix-B-classification%20roadwaydesign.pdf>.

However, NACTO permits a lane widths of 10 feet.

<http://nacto.org/publication/urban-street-design-guide/street-design-elements/lane-width/>

- 4' sidewalk is compliant with current standards for sidewalks.
- 8' sidewalk is the narrowest compliant width of a multi-use path.
- 20+ driveways on the side of the road and intersecting roadways provide potential conflict points for a multi-use side pathway.
- No recognition is provided on the roadway for bicyclists.
- Due to the existing 50' right of way width between Ewing and Harrison, the installation of an 8' wide multi-use path would require the narrowing of the westbound travel lane and moving of the existing curbs to keep the improvements within municipal property.
- The above slide does not show a double yellow centerline roadway stripe. Valley Road currently has this type of centerline striping, and it will be retained in the final design.

Municipal Evaluation of Option 4:

- The proposed width of 30' fits generally within the existing paved area of Valley Road. Some areas may need to be narrowed by one foot to accommodate existing trees.
- 9' drive lanes are not an accepted design standard.
- Per the currently adopted roadway design standards, 12' wide lanes shall be provided for a minor collector as shown at:
<http://www.princetonnj.gov/masterplan/appendix-B-classification%20roadwaydesign.pdf>.

However, NACTO permits a lane widths of 10 feet.

<http://nacto.org/publication/urban-street-design-guide/street-design-elements/lane-width/>

- If the drive lanes are increased to 10', then the proposed width does not fit within the confines of the existing trees.



- The slide does not show a double yellow centerline roadway stripe. Valley Road currently has this type of centerline striping, and it will be retained in the final design.
- On-street parking is prohibited in this option. Removal of parking between Witherspoon Street and Harrison Street is not desired by the municipality and the school district, as it accommodates school, municipal and community pool overflow parking and playing field parking.
- If service vehicles (FedEx, UPS, USPS, landscapers, garbage trucks, etc.) stop in the roadway briefly, traffic may not be able to pass.
- The image shows green bike lanes. There are two ways to create green bike lanes: paint or colored asphalt. Both treatments are more costly for construction and maintenance. It will be more costly for the Public Works Department to repair and questionable if the municipality can require the utility companies to repair colored pavement patches in colored bike lane areas in the future, if the municipality institutes a colored bike lane policy.
- Per NACTO (<http://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/buffered-bike-lanes/>), buffered bicycle lanes are typically used at the following locations:

- Anywhere a standard bike lane is being considered.
- On streets with high travel speeds, high travel volumes, and/or high amounts of truck traffic.
- On streets with extra lanes or extra lane width.

It is our opinion that Valley Road does not meet the definition of “high travel speeds, high travel volumes, and / or high amounts of truck traffic.” The posted speed limit is 25 mph; the vehicle volumes are in the range of 5,000 – 6,000 vehicles per day, and the road currently has a 5-ton weight limit. The NACTO design guide provides the following image for buffered bike lanes:

Design Guidance

Buffered Bike Lanes

Required Features

- 1 Bicycle lane word and/or symbol and arrow markings (MUTCD Figure 9C-3) shall be used to define the bike lane and designate that portion of the street for preferential use by bicyclists.⁸
- 2 The buffer shall be marked with 2 solid white lines, with diagonal hatching if 3 feet in width or wider. White lines on both edges of the buffer space indicate lanes where crossing is discouraged, though not prohibited. For clarity, consider dashing the buffer boundary where cars are expected to cross at driveways.¹⁰
- 3 The buffer area shall have interior diagonal cross hatching or chevron markings if 3 feet in width or wider.¹¹

Recommended Features

- 4 If used, interior diagonal cross hatching should consist of 4 inch lines angled at 30 to 45 degrees and striped at intervals of 10 to 40 feet. Increased striping frequency may increase motorist compliance.¹²

2 The buffer shall be marked with 2 solid white lines. Minimum buffer width: 18 inches
5 The combined width of the buffer(s) and bike lane should be considered "bike lane width" with respect to guidance given in other documents that don't recognize the existence of buffers. Where buffers are used, bike lanes can be narrower because the shy distance function is assumed by the buffer. For example, a 3 foot buffer and 4 foot bike lane next to a curb can be considered a 7 foot bike lane. For travel side buffered lanes next to on street parking, a 5 foot minimum width is recommended to encourage bicyclists to ride outside of the door zone.

7 Buffers should be at least 18 inches wide because it is impractical to mark a zone narrower than that.
11 Separation may also be provided between bike lane striping and the parking boundary to reduce door zone conflicts.

8 On intersection approaches with right turn only lanes, the bike lane should be transitioned to a through bike lane to the left of the right turn only lane, or a combined bike lane/turn lane should be used if available road space does not permit a dedicated bike lane.
12 On wide one-way streets with buffered bike lanes, consider adding a buffer to the opposite side

9 On intersection approaches with no dedicated right turn only lane the buffer markings should transition to a conventional dashed line. Consider the use of a bike box at these locations.

10 Like a conventional bike lane, a wide (6 to 8 inch) solid white line may be used to mark the edge adjacent to a motor vehicle travel lane. For a parking side buffer, parking T's or a solid line are acceptable to mark between a parking lane and the buffer.
13 The interior of the buffer area may use different paving materials to separate it from the bike lane. Textured surface materials may cause difficulties for bicyclists as surfaces may be rough. Increased maintenance requirements are likely.

11 For travel lane buffer configurations, separation may also be provided between bike lane striping and the parking boundary to reduce door zone conflicts. This creates a type of parking-side buffer.
14 Color may be used at the beginning of each block to discourage motorists from entering the buffered lane. For other uses of color in buffered bike lanes see colored bike facilities.

12 On wide one-way streets with buffered bike lanes, consider adding a buffer to the opposite side

6 to 8 Inches
4 Inches

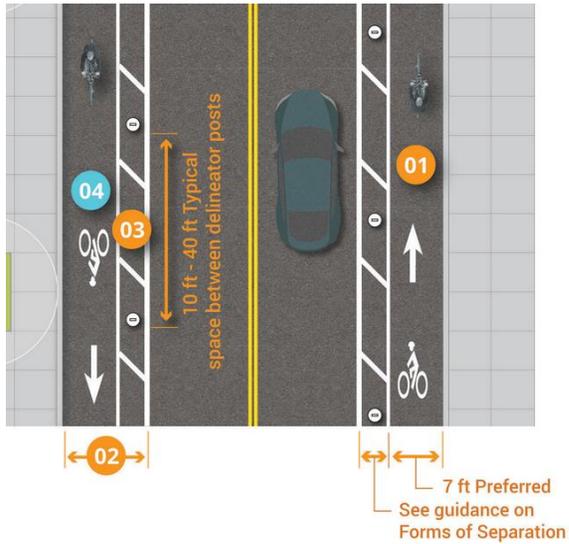
MUTCD FIGURE 18-24
MUTCD FIGURE 18-24

MUTCD FIGURE 3D-2

Optional Features

- 10 Like a conventional bike lane, a wide (6 to 8 inch) solid white line may be used to mark the edge adjacent to a motor vehicle travel lane. For a parking side buffer, parking T's or a solid line are acceptable to mark between a parking lane and the buffer.
- 11 For travel lane buffer configurations, separation may also be provided between bike lane striping and the parking boundary to reduce door zone conflicts. This creates a type of parking-side buffer.
- 12 On wide one-way streets with buffered bike lanes, consider adding a buffer to the opposite side
- 13 The interior of the buffer area may use different paving materials to separate it from the bike lane. Textured surface materials may cause difficulties for bicyclists as surfaces may be rough. Increased maintenance requirements are likely.
- 14 Color may be used at the beginning of each block to discourage motorists from entering the buffered lane. For other uses of color in buffered bike lanes see colored bike facilities.

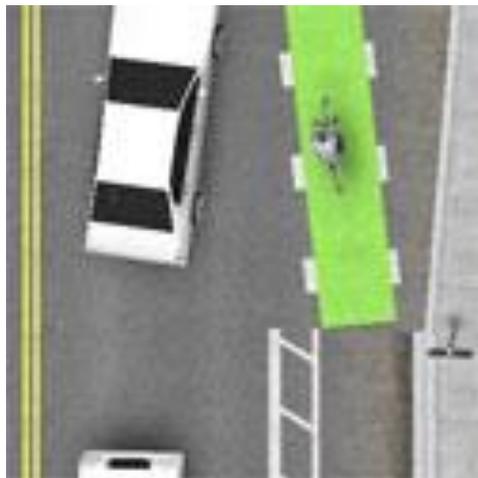
- The 1' wide curb / buffer shown in the Option 4 slide cannot be vegetated due to the width of concrete curbing need to create the raised buffer.
 - A 16" raised buffer width is preferred according to FHWA at the following link: http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/page08.cfm
 - If a non-raised / flush buffer is provided, 3' is the preferred minimum width per FHWA or 18" per NACTO (<http://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/buffered-bike-lanes/>). Flexible delineator posts on a 10' – 40' spacing are desired by FHWA (see below). http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/page07.cfm#figure8



(Courtesy of <http://www.idealshield.com/products/other-products/delineator-posts/>)

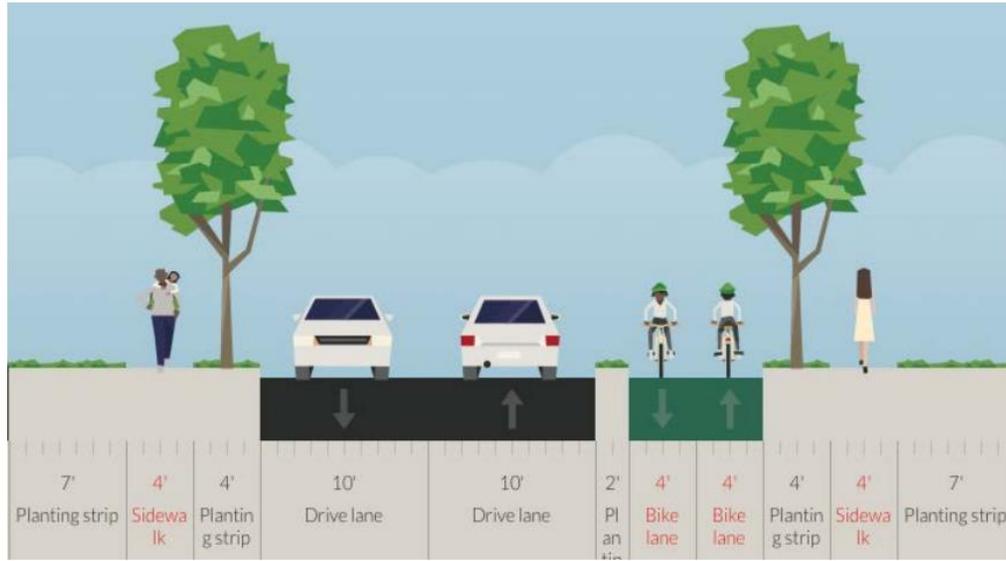
- Per FHWA, 5' is the minimum width of a buffered bike lane; the preferred width is 7'.
- A buffer strip will make leaf and brush pick up difficult with the claw and backhoe currently utilized by Public Works.
- Municipal ordinances for leaf and brush pick up would require modification to have materials placed on the planting strip not in the bike lane or the roadway.
- 5' buffered bike lanes cannot be plowed with any equipment currently owned by Public Works.
- 20+ driveways on each side of the road and intersecting roadways provide cross traffic from the road edges. A raised bike lane buffer will have to accommodate openings at each driveway and intersecting roadway.
- If bike lanes are to carry through to the Valley / Harrison and Valley / Witherspoon intersections (rather than transitioning to sharrows), widening will be required.
- This option requires the purchase of additional right of way and relocation of utility poles between Ewing Street and Harrison Street if the bike lanes are to continue through this section of the roadway. The existing right of way is 50 feet wide and contains 38 feet of roadway and 8 feet of sidewalks currently.

- Special treatment, similar to that shown below, is needed to carry the bike lane past the dedicated right turn only lane from EB Valley to SB Harrison.



Sidewalks + Protected Cycletrack

'Option 5'



Municipal Evaluation of Option 5:

- The proposed width of 30' fits generally within the existing paved area of Valley Road. Some areas may need to be narrowed by one foot to accommodate existing trees.

- Per the currently adopted roadway design standards, 12' wide lanes shall be provided for a minor collector as shown at: <http://www.princetonnj.gov/masterplan/appendix-B-classification%20roadwaydesign.pdf>.

However, NACTO permits a lane widths of 10 feet.

<http://nacto.org/publication/urban-street-design-guide/street-design-elements/lane-width/>

- The slide does not show a double yellow centerline roadway stripe. Valley Road currently has this type of centerline striping, and it will be retained in the final design.
- On-street parking is prohibited in this option. Removal of parking between Witherspoon Street and Harrison Street is not

desired by the municipality and the school district, as it accommodates municipal and community pool overflow parking and playing field parking.

- If service vehicles (FedEx, UPS, USPS, landscapers, garbage trucks, etc.) stop in the roadway briefly, only one lane of traffic may be able to pass.
- The image shows green bike lanes. There are two ways to create green bike lanes: paint or colored asphalt. Both treatments are more costly for construction and maintenance. It will be more costly for the Public Works Department to repair and questionable if the municipality can require the utility companies to repair colored pavement patches in colored bike lane areas in the future, if the municipality institutes a colored bike lane policy.
- Per NACTO (<http://nacto.org/publication/urban-bikeway-design-guide/cycle-tracks/two-way-cycle-tracks/>), two way cycle tracks are typically used in the following locations:
 - On streets with few conflicts such as driveways or cross-streets on one side of the street.
 - On streets where there is not enough room for a one-way cycle track on both sides of the street.
 - On one-way streets where contra-flow bicycle travel is desired.
 - On streets where more destinations are on one side thereby reducing the need to cross the street.
 - On streets with extra right-of-way on one side.

- To connect with another bicycle facility, such as a second cycle track on one side of the street.
- Along streets on which bike lanes would cause many bicyclists to feel stress because of factors such as multiple lanes, high traffic volumes, high speed traffic, high incidence of double parking, and high parking turnover.
- On streets for which conflicts at intersections can be effectively mitigated using parking lane setbacks, bicycle markings through the intersection, and other signalized intersection treatments.
- Along streets with high bicycle volumes.
- Along streets with high motor vehicle volumes and/or speeds.

It is our opinion that the street typology described above does not match Valley Road.

Design Guidance

Two-Way Cycle Track

Recommended Features

- 5** The desirable two-way cycle track width is 12 feet. Minimum width in constrained locations is 8 feet.⁴²
- 6** When protected by a parking lane, 3 feet is the desired width for a parking buffer to allow for passenger loading and to prevent dooring collisions.⁴³
- 7** A dashed yellow centerline should be used to separate two-way bicycle traffic and to help distinguish the cycle track from any adjacent pedestrian area.
- 8** Driveways and minor street crossings are a unique challenge to cycle track design. A review of existing facilities and design practice has shown that the following guidance may improve safety at crossings of driveways and minor intersections:
 - If the cycle track is parking protected, parking should be prohibited near the intersection to improve visibility. The desirable no-parking area is 30 feet from each side of the crossing.⁴⁴
 - For motor vehicles attempting to cross the cycle track from the side street or driveway, street and sidewalk furnishings and/or other features should accommodate a sight triangle of 20 feet to the cycle track from minor street crossings, and 10 feet from driveway crossing.
 - Color, yield lines, and "Yield to Bikes" signage should be used to identify the conflict area and make it clear that the cycle track has priority over entering and exiting traffic.⁴⁵

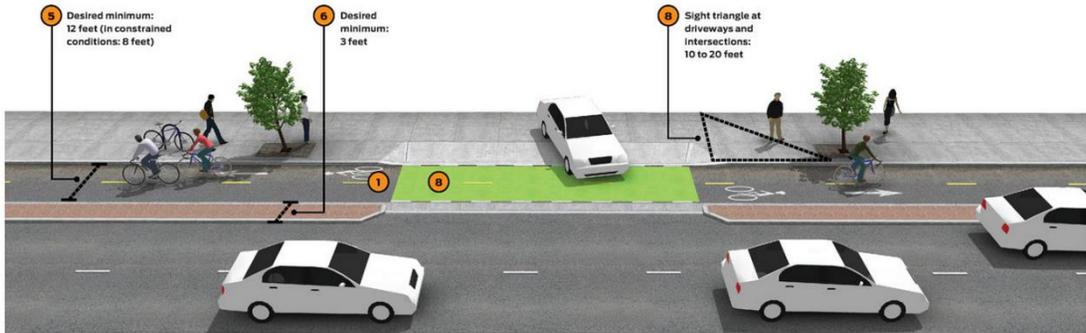
Required Features

- 1** Bicycle lane word, symbol, and/or arrow markings (MUTCD Figure 9C-3) shall be placed at the beginning of a cycle track and at periodic intervals along the facility to define the bike lane direction and designate that portion of the street for preferential use by bicyclists.
- 2** If configured on a one-way street, a "ONE WAY" sign (MUTCD R6-1, R6-2) with "EXCEPT BIKES" plaque shall be posted along the facility and at intersecting streets, alleys, and driveways informing motorists to expect two-way traffic.
- 3** A "DO NOT ENTER" sign (MUTCD R5-1) with "EXCEPT BIKES" plaque shall be posted along the facility to only permit use by bicycles.
- 4** Intersection traffic controls along the street (e.g., stop signs and traffic signals) shall also be installed and oriented toward bicyclists traveling in the contra-flow direction.

5 Desired minimum: 12 feet (in constrained conditions: 8 feet)

6 Desired minimum: 3 feet

8 Sight triangle at driveways and intersections: 10 to 20 feet



5 Desired minimum: 12 feet (in constrained conditions: 8 feet)

6 Desired minimum: 3 feet

9 Parking should be prohibited near the intersection to improve visibility.



Optional Features

- 9** Two-stage turn queue boxes should be provided to assist in making turns from the cycle track facility.
- 10** Tubular markers may be used to protect the cycle track from the adjacent travel lane. The color of the tubular markers shall be the same color as the pavement marking they supplement.⁴⁷
- 11** Cycle tracks may be shifted more closely to the travel lanes on minor intersection approaches to put bicyclists clearly in the field of view of motorists.⁴⁸
- 12** A raised median, bus bulb or curb extension may be configured in the cycle track buffer area to accommodate transit stops. Cyclists should yield to pedestrians crossing the roadway at these points to reach the bus stop. A two-way cycle track may be configured on the left side of a one-way street to avoid conflicts at transit stops.
- 13** May be configured as a raised cycle track.

Intersection Configuration Alternatives

See the Cycle Track Intersection Approach and Bicycle Signals sections for details on design strategies at intersections.



Bicycle Signal Phase
A dedicated bicycle signal phase can eliminate conflict between turning automobiles and bicyclists.



"Bend In" Crossing
Using a curb extension or painted buffer, the cycle track may be bent-in to promote visibility of bicyclists in advance of the intersection.

- The 8' width is less than the NACTO-desired 12' minimum width for a protected two way cycle track.
- The 2' raised buffer exceeds minimum FHWA 16" wide standards.

http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pg/page08.cfm

If a non-raised / flush buffer is provided, 3' is the preferred minimum width per FHWA and NACTO. Flexible delineator posts on a 10' – 40' spacing are desired.

- A 2' wide planting strip would be able to accommodate 1' width of vegetation, as curbing would take the other 1'. Public Works does not have the staff to maintain a 1' wide planted buffer between drive and bike lanes. Additionally, the chosen vegetation material would have to be immune to road salt as this is an exposed area subject to snow piles. The vegetation will not be permitted to be taller than 24" tall and cannot extend past the curbs.
- 20+ driveways and intersecting roadways provide cross traffic from the road edges. A raised bike lane buffer will have to accommodate openings at each driveway and intersecting roadway. The two direction bike lanes will provide more visual conflict for drivers exiting the driveways and intersecting roadways to process. NACTO has preferred treatments for these locations in the image above.
- A buffer strip will make leaf and brush pick up difficult with the claw and backhoe currently utilized by Public Works.
- Municipal ordinances for leaf and brush pick up would require modification to have materials placed on the planting strip not in the bike lane and the roadway.
- If bike lanes are to carry through to the Valley / Harrison and Valley / Witherspoon intersections, widening will be required.
- This option requires the purchase of additional right of way and relocation of utility poles between Ewing Street and Harrison Street if the bike lanes are to continue through this section of the roadway. The existing right of way is 50 feet wide and contains 38 feet of roadway and 8 feet of sidewalks currently.
- This option does not provide much flexibility in modifying the intersections at Jefferson, Walnut and Ewing to calm traffic and increase intersection sight distance.
- Special treatment is needed for the following design challenges:
 - Providing dedicated bike lane(s) for the left, straight and right movements at the Harrison Street intersection where the driving lanes become dedicated left turn / straight and right turn only lanes.
 - Getting westbound bike traffic into the buffered lane on the opposite side of the roadway without having conflicts with vehicle traffic entering and exiting the Princeton Shopping Center. This might be accomplished by separating the traffic signal cycles for eastbound and westbound traffic at Harrison Street.
 - Discouraging motorists from entering the separated bike lanes from each of the intersecting roadways.

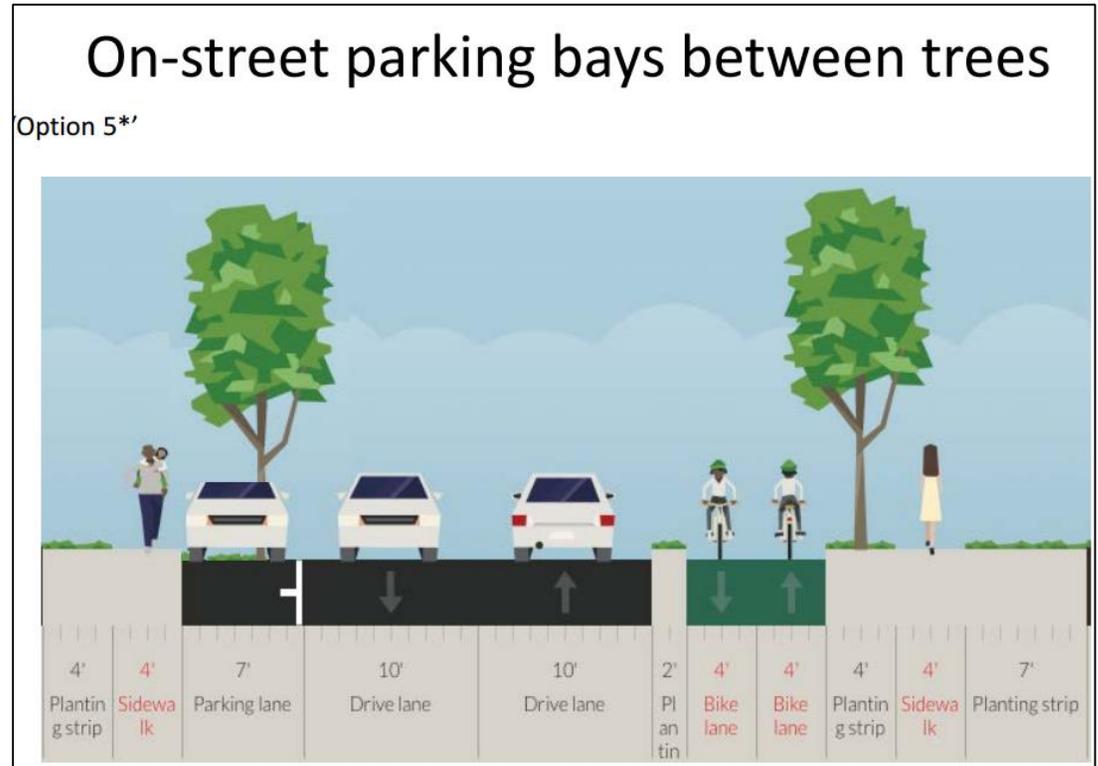
Municipal Evaluation of Option 5*:

- The proposed main pavement width of 30', exclusive of the parking lane, fits generally within the existing paved area of Valley Road. Some areas may need to be narrowed by one foot to accommodate existing trees.
- The slide does not show a double yellow centerline roadway stripe. Valley Road currently has this type of centerline striping, and it will be retained in the final design.
- Per the currently adopted roadway design standards, 12' wide lanes shall be provided for a minor collector as shown at:

<http://www.princetonnj.gov/masterplan/appendix-B-classification%20roadwaydesign.pdf>.

However, NACTO permits a lane widths of 10 feet.

<http://nacto.org/publication/urban-street-design-guide/street-design-elements/lane-width/>



- The 7' wide parking lane will push the sidewalk back into what is perceived as "front lawns", although it is within the municipal right of way.
- The image shows green bike lanes. There are two ways to create green bike lanes: paint or colored asphalt. Both treatments are more costly for construction and maintenance. It will be more costly for the Public Works Department to repair and questionable if the municipality can require the utility companies to repair colored pavement patches in colored bike lane areas in the future, if the municipality institutes a colored bike lane policy.
- A 2' wide planting strip would be able to accommodate 1' width of vegetation, as curbing would take the other 1'. Public Works does not have the staff to maintain a 1' wide planted buffer between drive and bike lanes. Additionally, the chosen vegetation material would have to be immune to road salt as this is an exposed area subject to snow piles.
- 20+ driveways and intersecting roadways provide cross traffic from the road edges. A raised bike lane buffer will have to accommodate openings at each driveway and intersecting roadway.

- Existing tree spacing ranges from 30' to 45'. Parking spaces must be at least 35' to accommodate tree trunks and the parking. In general, two parking spaces per block can be accommodated within the tree spacing; however, this does not take into consideration the tree root system. Existing tree roots can sustain damage due to the installation of the parking bays, which may lead to the decline and death of the tree.
- Per NACTO (<http://nacto.org/publication/urban-bikeway-design-guide/cycle-tracks/two-way-cycle-tracks/>), two way cycle tracks are typically used in the following locations:
 - On streets with few conflicts such as driveways or cross-streets on one side of the street.
 - On streets where there is not enough room for a one-way cycle track on both sides of the street.
 - On one-way streets where contra-flow bicycle travel is desired.
 - On streets where more destinations are on one side thereby reducing the need to cross the street.
 - On streets with extra right-of-way on one side.
 - To connect with another bicycle facility, such as a second cycle track on one side of the street.
 - Along streets on which bike lanes would cause many bicyclists to feel stress because of factors such as multiple lanes, high traffic volumes, high speed traffic, high incidence of double parking, and high parking turnover.
 - On streets for which conflicts at intersections can be effectively mitigated using parking lane setbacks, bicycle markings through the intersection, and other signalized intersection treatments.
 - Along streets with high bicycle volumes.
 - Along streets with high motor vehicle volumes and/or speeds.

It is our opinion that the street typology described above does not match Valley Road.

Design Guidance

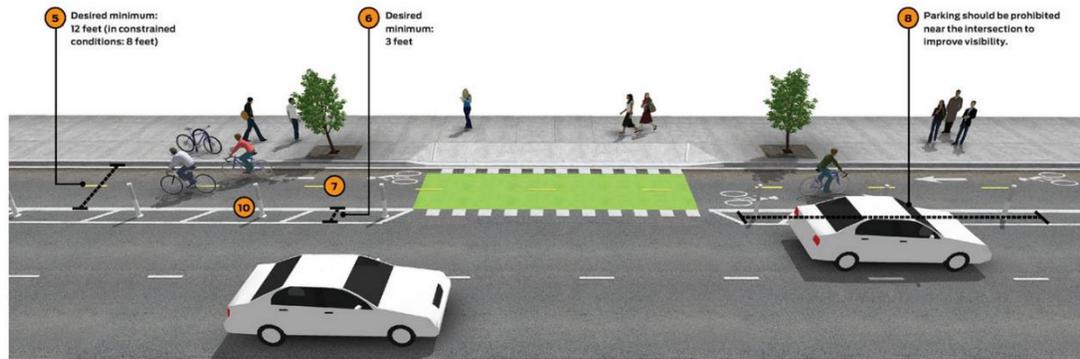
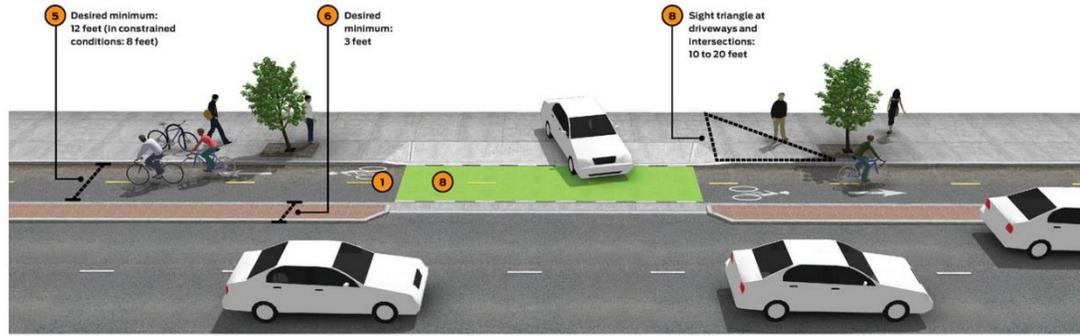
Two-Way Cycle Track

Required Features

- 1 Bicycle lane word, symbol, and/or arrow markings (MUTCD Figure 9C-3) shall be placed at the beginning of a cycle track and at periodic intervals along the facility to define the bike lane direction and designate that portion of the street for preferential use by bicyclists.
- 2 If configured on a one-way street, a "ONE WAY" sign (MUTCD R6-1, R6-2) with "EXCEPT BIKES" plaque shall be posted along the facility and at intersecting streets, alleys, and driveways informing motorists to expect two-way traffic.
- 3 A "DO NOT ENTER" sign (MUTCD R5-1) with "EXCEPT BIKES" plaque shall be posted along the facility to only permit use by bicycles.
- 4 Intersection traffic controls along the street (e.g., stop signs and traffic signals) shall also be installed and oriented toward bicyclists traveling in the contra-flow direction.

Recommended Features

- 5 The desirable two-way cycle track width is 12 feet. Minimum width in constrained locations is 8 feet.⁴²
- 6 When protected by a parking lane, 3 feet is the desired width for a parking buffer to allow for passenger loading and to prevent dooring collisions.⁴³
- 7 A dashed yellow centerline should be used to separate two-way bicycle traffic and to help distinguish the cycle track from any adjacent pedestrian area.
- 8 Driveways and minor street crossings are a unique challenge to cycle track design. A review of existing facilities and design practice has shown that the following guidance may improve safety at crossings of driveways and minor intersections:
 - If the cycle track is parking protected, parking should be prohibited near the intersection to improve visibility. The desirable no-parking area is 30 feet from each side of the crossing.⁴⁴
 - For motor vehicles attempting to cross the cycle track from the side street or driveway, street and sidewalk furnishings and/or other features should accommodate a sight triangle of 20 feet to the cycle track from minor street crossings, and 10 feet from driveway crossing.
- 9 Color, yield lines, and "Yield to Bikes" signage should be used to identify the conflict area and make it clear that the cycle track has priority over entering and exiting traffic.⁴⁵



- Motor vehicle traffic crossing the cycle track should be constrained or channelized to make turns at sharp angles to reduce travel speed prior to the crossing.
- If configured as a raised cycle track, the crossing should be raised, in which the sidewalk and cycle track maintain their elevation through the crossing. Sharp inclines on either side from road to sidewalk level serve as a speed hump for motor vehicles.⁴⁶

- 9 Two-stage turn queue boxes should be provided to assist in making turns from the cycle track facility.

Optional Features

- 10 Tubular markers may be used to protect the cycle track from the adjacent travel lane. The

- color of the tubular markers shall be the same color as the pavement marking they supplement.⁴⁷
- 11 Cycle tracks may be shifted more closely to the travel lanes on minor intersection approaches to put bicyclists clearly in the field of view of motorists.⁴⁸
- 12 A raised median, bus bulb or curb extension may be configured in the cycle track buffer area to accommodate transit stops. Cyclists should yield to pedestrians crossing the roadway at these points to reach the bus stop. A two-way cycle tracks may be configured on the left side of a one-way street to avoid conflicts at transit stops.

- 13 May be configured as a raised cycle track.

Intersection Configuration Alternatives

See the Cycle Track Intersection Approach and Bicycle Signals sections for details on design strategies at intersections.



Bicycle Signal Phase
A dedicated bicycle signal phase can eliminate conflict between turning automobiles and bicyclists.



"Bend In" Crossing
Using a curb extension or painted buffer, the cycle track may be bent-in to promote visibility of bicyclists in advance of the intersection.

- The 8' width is below the NACTO desired 12' minimum width for a protected two way cycle track.
- If bike lanes are to carry through to the Valley / Harrison and Valley / Witherspoon intersections, widening will be required.
- This option requires the purchase of additional right of way and relocation of utility poles between Ewing Street and Harrison Street if the bike lanes are to continue through this section of the roadway. The existing right of way is 50 feet wide and contains 38 feet of roadway and 8 feet of sidewalks currently.
- This option does not provide much flexibility in modifying the intersections at Jefferson, Walnut and Ewing to calm traffic and increase intersection sight distance. In fact, parked cars between the existing trees may further reduce sight distance at the intersections of these roadways; this may result in the loss of on-street parking.
- Special treatment is needed for the following design challenges:
 - Providing dedicated bike lane(s) for the left, straight and right movements at the Harrison Street intersection where the driving lanes become dedicated left turn / straight and right turn only lanes.

- Getting westbound bike traffic into the buffered lane on the opposite side of the roadway without having conflicts with vehicle traffic entering and exiting the Princeton Shopping Center. This might be accomplished by separating the traffic signal cycles for eastbound and westbound traffic at Harrison Street.
- Discouraging motorists from entering the separated bike lanes from each of the intersecting roadways.

Regular painted bike lanes

'Option 6'



Municipal Evaluation of Option 6:

- The proposed pavement width of 30' fits generally within the existing paved area of Valley Road. Some areas may need to be narrowed by one foot to accommodate existing trees.
- The slide does not show a double yellow centerline roadway stripe. Valley Road currently has this type of centerline striping, and it will be retained in the final design.
- Per the currently adopted roadway design standards, 12' wide lanes shall be provided for a minor collector as shown at:
<http://www.princetonnj.gov/masterplan/appendix-B-classification%20roadwaydesign.pdf>.

However, NACTO permits a lane widths of 10 feet.

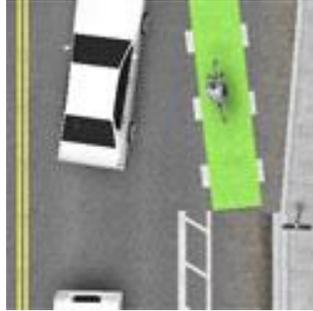
<http://nacto.org/publication/urban-street-design-guide/street-design-elements/lane-width/>

- On-street parking is prohibited. Removal of parking

between Witherspoon Street and Harrison Street is not desired by the municipality and the school district, as it accommodates school, municipal and community pool overflow parking and playing field parking.

- This design provides extra recognition and accommodation for bicyclists within the roadway.
- The image shows green bike lanes. There are two ways to create green bike lanes: paint or colored asphalt. Both treatments are more costly for construction and maintenance. It will be more costly for the Public Works Department to repair and questionable if the municipality can require the utility companies to repair colored pavement patches in colored bike lane areas in the future, if the municipality institutes a colored bike lane policy.
- If bike lanes are to carry through to the Valley / Harrison and Valley / Witherspoon intersections, widening will be required.
- This option requires the purchase of additional right of way and relocation of utility poles between Ewing Street and Harrison Street if the bike lanes are to continue through this section of the roadway. The existing right of way is 50 feet wide and contains 38 feet of roadway and 8 feet of sidewalks currently.

- This option does not provide much flexibility in modifying the intersections at Jefferson, Walnut and Ewing to calm traffic and increase intersection sight distance.
- Special treatment, similar to that shown below, is needed to carry the bike lane past the dedicated right turn only lane from eastbound Valley to southbound Harrison.



Municipal Evaluation of Option 7:

- The proposed pavement width of 30' fits generally within the existing paved area of Valley Road. Some areas may need to be narrowed by one foot to accommodate existing trees.
- The slide does not show a double yellow centerline roadway stripe. Valley Road currently has this type of centerline striping, and it will be retained in the final design.
- 9' drive lanes are not an accepted standard in any reference design manual.
- Per the currently adopted roadway design standards, 12' wide lanes shall be provided for a minor collector as shown at: <http://www.princetonnj.gov/masterplan/appendix-B-classification%20roadwaydesign.pdf>

However, NACTO permits a lane widths of 10 feet.

<http://nacto.org/publication/urban-street-design-guide/street-design-elements/lane-width/>

- Only one direction of bicycle travel is provided in this option.
- The image shows green bike lanes. There are two ways to create green bike lanes: paint or colored asphalt. Both treatments are more costly for construction and maintenance. It will be more costly for the Public Works Department to repair and questionable if the municipality can require the utility companies to repair colored pavement patches in colored bike lane areas in the future, if the municipality institutes a colored bike lane policy.
- If this option presumes that the bike lane is in the westbound direction, what is the proposed cycle accommodation from Witherspoon Street to destinations to the east (i.e., Princeton Shopping Center)?



Sidewalk, one bike lane, one 'sharrow' lane

Option 8'



However, NACTO permits a lane widths of 10 feet.

<http://nacto.org/publication/urban-street-design-guide/street-design-elements/lane-width/>

Municipal Evaluation of Option 8:

- The proposed pavement width of 30' fits generally within the existing paved area of Valley Road. Some areas may need to be narrowed by one foot to accommodate existing trees.
- The slide does not show a double yellow centerline roadway stripe. Valley Road currently has this type of centerline striping, and it will be retained in the final design.
- The 15' sharrow lane does not provide enough space for a vehicle to maintain its lane when cars are parked on the side. 7' is the minimum parking lane size which would leave only 8' for a vehicle.
- Per the currently adopted roadway design standards, 12' wide lanes shall be provided for a minor collector as shown at: <http://www.princetonnj.gov/masterplan/appendix-B-classification%20roadwaydesign.pdf>.

- This design does provide for bicycle accommodation in both directions.
- The image shows green bike lanes. There are two ways to create green bike lanes: paint or colored asphalt. Both treatments are more costly for construction and maintenance. It will be more costly for the Public Works Department to repair and questionable if the municipality can require the utility companies to repair colored pavement patches in colored bike lane areas in the future, if the municipality institutes a colored bike lane policy.
- Sharrows on roadways with a speed of 35 mph or faster and a volume higher than 3,000 vehicles per day is not a preferred treatment per NACTO. As only one of these parameters is exceeded, sharrows is an acceptable option on this roadway.
- This drive lane / sharrow layout provides the flexibility in adjusting intersections at Jefferson and Walnut to achieve safer crossings for all users. It may require the narrowing of the sharrow lane at intersections to accommodate a modification.

- Municipal ordinances for leaf and brush pick up would require modification to have materials placed on the planting strip not in the bike lane or the roadway.

Municipal Evaluation of Option 9:

- Per NACTO, bike boulevards should be designed for motor vehicle volumes under 1,500 vehicles per day with up to 3,000 vpd allowed in limited sections. Valley Road currently has more than 5,000 vehicles per day; thus this is not a viable design option.

