

MEMORANDUM

Date: January 11, 2017
To: City of Salem Project Management Team
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SUBJECT: Winter-Maple Family Friendly Bikeway -- Needs, Opportunities, and Constraints; Possible Treatments; Family Friendly Bikeway Toolkit

Introduction

The purpose of this memo is to further identify the existing conditions factors that will influence design recommendations for the Family Friendly Bikeway proposed on Winter Street and Maple Avenue. The memo consists of three sections:

- 1. Identification of needs, opportunities and constraints;
- 2. Enumeration of possible design treatments for segments and intersections; and
- 3. A design toolkit for this and future family friendly bikeway projects in Salem.

The alignment discussed here is the same as that presented in the Existing Conditions and Transportation Analysis memo that has already been completed. For the purposes of this memo, the proposed alignment has been broken into three segments which are identified on the following page.



Needs, Opportunities and Constraints

Existing conditions for the Winter-Maple Family Friendly Bikeway alignment were presented in the previous memo. Generally, conditions for walking along the corridor are already good: nearly all streets included have sidewalks on both sides of the street, buffers with trees are present on most streets, and larger crossings are signalized. There are some locations, however, where higher traffic volumes or wider streets make crossings difficult, uncomfortable, or challenging for vulnerable users.

Likewise, bicycling conditions are generally good, with some exceptions. Notably, conditions are quite different from segment to segment for the three areas of the corridor discussed below. Additionally, less pedestrianfriendly crossings are also difficult for bicyclists.

For the purposes of this memo, the corridor has been broken at the following locations:

- D Street
- Bliler Avenue

These locations were chosen based on major changes in the cross section of the street and land use context. Segment 1, Winter Street south of D Street, has angled parking on both sides, is approximately 60' wide, and has mostly office uses adjacent. Segment 2, from D Street to Bliler Avenue, un-striped parallel parking on both sides, is approximately 30' wide, and is adjacent mostly residential uses with two school campuses. Segment 3, north of Bliler Avenue, includes a lowervolume street in Auto Group Avenue, as well as a high volume street in Cherry Avenue, adjacent to commercial land uses.

The three segments are shown at left. Needs, opportunities and constraints for each segment of the corridor are explored in the following pages. Many of these issues are consistent for the length of a segment. Some are site specific to a particular intersection or other location. These are annotated on the map.



Segment 1: Court Street to D Street

Needs

- Separated space for bicyclists: Higher traffic volumes in this area contribute to lower comfort for less experienced bicyclists. Any type of designated bicycle space would create more continuity for bicyclists traveling the length of the corridor.
 - Current configuration with head-in angled parking presents sight-line issues for drivers backing out into bicyclists' path of travel.
- 1 Shorter pedestrian crossing distances where cross street is ~60' wide.
 - At Union Street the northeast corner recedes, creating a longer crossing distance on the east leg than the west.

Opportunities

- Adequate space within the existing street cross-section to implement separated bike lanes if the parking configuration is changed.
- Parking impacts may be mitigated by the fact that there is abundant of off-street parking available in adjacent lots and garages.

Constraints

- Parking needs for adjacent offices may be greater than that available from off-street sources.
- The weekly Saturday Market may have greater parking needs than can be accommodated when parking lot is used for the market.
- Bus routes are located along this segment.



Segment 2: D Street to Bliler Avenue

Needs

Safe crossings of major streets for bicyclists and pedestrians.

- Especially pertinent at Pine Street and Fairgrounds Road.
- Safe railroad crossing for bicyclists and pedestrians.
- 2 Pedestrian accommodation on Maple from Hickory Street to Bliler Avenue.
 - On Maple Avenue there is currently sidewalk on only the east side from Hickory to Locust, and no sidewalk from Locust to Bliler.
 - Periodic higher traffic volumes exist in this northern portion of the segment due to pick-up/drop-off at JGEMS and Oregon School for the Deaf.

Opportunities

- Traffic volumes and speeds are low along the alignment, with only two major unsignalized crossings.
- Sidewalks have good buffers from the street with mature trees.
- Major cross streets (Pine and Fairgrounds) have adequate space between the curbs for the addition of median crossing islands and/or diverters.
- 2 Adequate right-of-way appears to be available to construct sidewalks where none exist today.
- 3 Some traffic calming already exists in the form of mini-circles at the intersections of Winter and Hood, and Maple and Locust.

Constraints

- Bus route located along segment from D Street to Market Street.
- Numerous mature trees are located in the area where sidewalk alignment would be, on the west side of Maple Avenue between Hickory and Locust Streets.
- Additional plantings appear to be located in the public right-of-way that would be used to add sidewalk between Locust Street and Bliler Avenue.
- The cost and complexity of adding a curb and gutter to construct a sidewalk on one or both sides of Maple Avenue north of Locust Street may be high.



Segment 3: Bliler Avenue to Salem Parkway

Needs

- Improved lighting along the pathway: The shared-use path today has one light along its length.
- Pedestrian accommodation on the south side of Auto Group Avenue and east side of Cherry Street: No sidewalks exist in these locations.
- 2 More comfortable and safer crossing for pedestrians and bicyclists at Salem Parkway to access the Salem Parkway Path
 - More comfortable bicycle accommodation, such as an off-street path, along Cherry Avenue that will appeal to a wider range of bicyclists by providing greater separation from higher traffic volumes and speeds.

Opportunities

- Redevelopment of the parcel south of Auto Group Avenue may provide an opportunity to install a sidewalk in the future.
- The existing pathway connecting the end of Maple Avenue to Auto Group Avenue provides a through connection for pedestrians and bicyclists.
- The crossing of Van Ness Avenue is low volume and would present little opportunity for conflicts with pedestrians and bicyclists traveling along the east side of Cherry Avenue between Auto Group Avenue and Salem Parkway.

Constraints

- 3 The south side of Auto Group Avenue is currently used for an informal parking area toward the western end.
- Utilities on the east side of Cherry Avenue would need to be moved for installation of a sidewalk or sidepath.
- Parking in front of Wiltse's Towing and the two driveways for this business present potential conflicts with pedestrians and bicyclists.
 - High volume area at Home Depot driveway exist creates many turning conflicts

Possible Treatments for Winter-Maple Corridor

The next section of this memo proposes possible infrastructure treatments that can be considered to address the needs outlined above. These are not final recommendations. Multiple treatments are listed at some locations, and evaluation of these options will be completed in the next phase of this project. In most locations, the multiple treatments listed are intended to be implemented together. Where options are listed that are *not* compatable with one another, this is made clear.

Planning-level assessment of the feasibility of treatments has been completed. However, traffic studies, engineering studies (e.g., turning movement modeling), and other design-level assessment have not been conducted. Further data about dimensions may be necessary to fully evaluate the options for treatments

All treatments included in the list of possibilities are further detailed in the toolkit at the end of this memo. Generic benefits and considerations of each treatment are outlined there. Where pertinent, site-specific considerations are included in this section.

Green Infrastructure

Some communities choose to use family-friendly bikeways as an opportunity to implement green infrastructure. When curbs are reconstructed for traffic calming features such as curb extensions, or mini-circles are added to an intersection, green infrastructure options should be considered.

At this stage of the planning process, it is not possible to determine exact locations for green infrastructure that treats stormwater. Design of such elements is wholly site specific.

Vertical Traffic Calming

There are recommendations for vertical traffic calming treatments such as speed humps and speed cushions throughout the corridor. Specific locations for these along each block are not defined in this memo. Locating such elements will be part of the conceptual design process.







Segment 1: **Bicycle Facility Options for Court Street to Mill Creek**

Currently, bicyclists share the roadway in this segment with automobiles. The higher traffic volumes and more complex movements of automobiles accessing and leaving parkings spaces create a less comfortable environment for bicyclists. Backing traffic out of the angled parking presents a particular issue for conflicts with bicyclists. Back-in angled parking might mitigate some of this issue, but bicyclists are still likely to be uncomfortable sharing the roadway with higher traffic volumes.

The three options presented below increase bicyclists' level of comfort and provide a level of accommodation more consistent with the rest of the corridor.



- · Bicyclists provided with wide buffered bike lanes to decrease friction with moving and parked cars.
- Parking loss of approximately 80 spaces.

Option 2: Two-way Separated Bike Lane with Angled and Parallel Parking



- · Bicyclists are completely separated from moving traffic by a physical barrier and parked cars.
- Two-way facility may present accommodation challenges at intersections.
- Parking loss of approximately 40 spaces.

Option 3: One-way Separated Bike Lanes with Parallel Parking



- Bicyclists are completely separated from moving traffic by a physical barrier and parked cars.
- One-way facilities are easier to accommodate with existing signal phasing.
- Parking loss of approximately 80 spaces.



Note: Linear bicycle facility treatments for this segment from Court Street to Mill Creek are addressed on page 9.

Winter Street at Court Street

- Install bicycle and pedestrian crossing warning signs.
- Stripe high visibility crosswalks and advance yield markings across Court Street.
 - Will increase driver awareness and pedestrian and bicyclist comfort.
- Install additional street lighting.
 - Street trees may shadow pedestrians waiting to cross here. Additional lighting could increase driver yielding.
- Construct raised intersection.
 - Gives clear priority to pedestrians and bicyclists crossing to the Capitol.
 - May not be compatable with higher traffic volumes at commute times.

Winter and Chemeketa Street

- Construct mini-roundabout with yield on entry.
 - Replaces existing stop control on Chemeketa.
 - Easier turning movements for bicyclists traveling onto/off of Chemeketa.
 - Increases traffic control compliance among bicyclists traveling on Winter Street.
 - Not compatable with curb extension recommendation.
- Install bicycle and pedestrian crossing warning signs.

Winter Street at Chemeketa, Center and Marion Streets

- 2 Construct curb extensions similar to existing at Winter and Court intersection.
 - Shortens crossing distances across Chemeketa, Center, and Marion, which are nearly 60 feet wide.
 - Provides space for bus stop amenities.
 - Curb extensions into the Winter Street right-of-way will make any later additions of dedicated bicycle space more difficult.



Note: Linear bicycle facility treatments for this segment from Court Street to Mill Creek are addressed on page 9.

Winter Street at D Street and Union Street

- Construct mini-roundabout with yield on entry.
 - Replaces existing all-way stop control.
 - Increases traffic control compliance among bicyclists traveling on Winter Street.
- Install bicycle and pedestrian crossing warning signs.

Winter Street at D Street

 Stripe standard crosswalks across both legs of D Street.

Winter Street from Mill Creek to D Street

- 2 Add shared lane markings.
 - Winter Street narrows north of the Mill Creek crossing, and parking transitions from angled to parallel.
 - Space is not available for another type of bicycle facility unless parking is removed.
 - A transition to shared lane markings prepares bicyclists for the shared lane condition for the rest of the corridor.
- Install speed cushions.
 - Cushions are more appropriate here to calm traffic while accommodating transit vehicles.
 - Chicanes not appropriate in spite of wider curb-to-curb measurement (40') because the offset to accommodate buses would not serve to slow other automobile traffic.

Segment 2: Bicycle Facility for Winter-Maple alignment from D Street to Bliler Avenue

Segment 2 is already a comfortable place to ride a bike for the majority of users. Pedestrians are well accommodated along street segments with sidewalks that are buffered from the street by a wide tree lawn. There are no recommendations to change the cross section along street segments here, but rather recommendations focus on crossing and intersection improvements to better accommodate pedestrians' and bicyclists' movements.



- Shared lane markings, or a branded pavement marking, help indicate that the street is used by bicyclists and that drivers should be aware of sharing space.
- Markings can also serve a wayfinding function at turns in the route.
- Lanes will be narrowed in some locations by curb extensions and mini-traffic circles.

Shared Lane Markings or Branded Pavement Markings



Entirety of Segment 2

- Add pavement markings.
 - Shared lane markings or custom markings for Family Friendly Bikeway.

Winter Street from D Street to Market Street

- Install speed cushions.
 - Cushions are more appropriate here to calm traffic while accommodating transit vehicles.
 - Chicanes are not appropriate in spite of wider curb-to-curb measurement (40') because the offset to accommodate buses would not serve to slow other automobile traffic.

Entirety of Segment 2 north of Market Street

Construct speed humps.

Winter Street at Market Street

- Stripe high visibility crosswalk on east leg.
- Stripe standard crosswalk on south leg.
- Install rectangular rapid flashing beacons (RRFB) for traffic on Market Street.
 - An RRFB can help increase yielding behavior at this school crossing.

Winter Street at Gaines Street

- 2 Construct raised crosswalk on south leg of the intersection.
 - Reconstruct existing high visibility crosswalk to a raised crosswalk to highlight the crossing between Grant Community School and Boys & Girls Club.

Segment 2: Fairgrounds Crosssing Options

Fairgrounds Road is one of two challenging unsignalized crossings along the corridor. A number of crossing options were evaluated in the process of developing possible treatments. Alternatives were investigated in an effort to move the bikeway crossing further from the existing marked school zone crosswalk at Cottage Street. See 1 below. Options are explained in the graphic below.

Ultimately, the best choice for crossing Fairgrounds Road was determined to be **Norway Street**, which places the bikeway less than 200' from the existing crosswalk. Further design work will evaluate whether the existing crosswalk should be retained and if the school-zone flashers should be moved north to include the new bikeway crossing. The existing north side flasher at 2 below.

FAIRGROUNDSRD

The Jefferson Street intersection is complicated by its six-legged nature. Major geometric changes would be needed here to make a safe and comfortable crossing.

The acute angles of the Cottage Street intersection make sight lines too challenging for a good crossing.

NORWAY S

IEFFERSON ST

Crossing at Shipping Street puts bicyclists on Church Street rather than Cottage Street, which is a longer route and a higher volume street.

IPPING ST



Winter Street at Hood Street

- Re-orient stop signs to stop traffic on Hood Street.
 - Enables bicyclists to legally travel in continuous motion at intersection with existing mini-circle that slows traffic.

Norway Street at Fairgrounds Road

- Construct median crossing islands and curb extensions on Fairgrounds for north and south leg crossings.
 - Provides refuge for pedestrians and bicyclists, enabling a two-stage crossing.
 - Calms traffic by narrowing lanes and creating yield condition.
 - Necessitates parking restrictions near interseciton on Fairgrounds Road.
 - Construction of both curb extensions and median island together preclude continuation of bike lanes on Fairgrounds Road which may be undesirable.
- Rectangular rapid flashing beacon (RRFB) installation for traffic on Fairgrounds Road.
 - Given width of the street, this likely includes four RRFBs: one at the edge of the roadway and one in the median island for each direction.
- Stripe high visibility crosswalks across Fairgrounds Road.

Cottage Street at Jefferson Street

- Re-orient stop signs to stop traffic on Jefferson Street.
 - Enables bicyclists to legally travel in continuous motion.

Cottage Street, Maple Avenue and South **Street Intersection**

Add directional shared lane markings to 1 supplement existing wayfinding signage.

• Pavement markings make the route alignment more clear to bicyclists.

Maple Avenue and Academy Street Intersection

Add two-way stop control for Academy Street to facilitate pedestrian and bicyclist movement along Maple Avenue.

Maple Avenue and Highland Avenue Intersection

Two options for traffic control:

- Add stop control for Highland Avenue, making an all-way stop controlled intersection.
 - Continues to require stop for bicyclists • traveling on Maple Avenue.
- Add mini-roundabout with yield on entry
 - Preferable for bicyclist travel as yield control legalizes continuous movement for bicyclists when other vehicles are not present to necessitate yield.

Maple Avenue at rail crossing

- Reconstruct sidewalk to create level crossing across rails.
- Construct small paved bicycle bump outs so riders can cross tracks perpendicularly.
- Perform landscaping maintenance to make full widths of sidewalks usable near track crossing, especially in the small triangular parcel.

Pathway between Maple Avenue and Spruce Street

Repave the pathway to make it accessible for bicyclists and users of wheeled mobility devices.

Maple Avenue at Pine Street

Construct full median diverter with bicycle cut-throughs to limit automobile traffic.

- Forces drivers to turn right onto Pine • Street from Maple Avenue.
- Raises driver awareness of possible pedestrian and bicyclist crossings.
- Creates two-stage crossing for pedestrians and bicyclists.
- Eliminates potential for lefthook crashes for bicyclists and pedestrians traveling along Pine Street, by removing left turn option for automobiles.

Maple Avenue at Hickory Street, Johnson Street, and Tryon Street

 Add two-way stop control for Hickory, Johnson and Tryon Streets to facilitate pedestrian and bicyclist movement along Maple Avenue.

Maple Avenue and Locust Street Intersection

- Re-orient stop signs to stop traffic on Locust Street.
 - Enables bicyclists to legally travel in continuous motion at intersection with existing mini-circle that slows traffic.

Maple Avenue from Hickory Street to Locust Street

- Construct sidewalk on west side of the street.
 - Curb and gutter already exist, so drainage impact is minimal.
 - Necessitates removal of a number of mature trees.

Maple Avenue from Locust Street to Bliler Avenue

Two options for providing pedestrian and bicyclist accommodation:

2 Construct sidewalk on both sides of the street.

- Bicyclists would share roadway as for majority of route.
- Construct sidepath on east side of street and sidewalk on west.
 - Bicyclists ride on the sidepath to connect with the shared-use path that begins at Bliler Avenue.
 - Would necessitate clear direction and information about how to transition to and from the south end of the sidepath at Locust Street.

Segment 3: Linear Facility for Cherry Avenue from Auto Group Avenue to Salem Parkway

This section of Cherry Avenue today has standard bike lanes provided in both directions. As determined through the Bicycle Level of Traffic Stress analysis, this is not a comfortable facility for the majority of bicyclists and represents a significant difference in level of accommodation from the rest of the Winter-Maple corridor.

Additionally, there is no existing sidewalk on the east side of the street from Auto Group Avenue to Van Ness Avenue, meaning pedestrians walk on an unimproved gravel surface which is not suitable for wheeled mobility devices.

Sidepath on east side of Cherry Avenue

- Sidepath is significantly more comfortable facility for all types of bicyclists than existing bike lanes.
- Provides similar level of accommodation for bicyclists as Salem Parkway shared use path and remainder of Winter-Maple corridor.
- Creates proper facility for pedestrians traveling on east side of Cherry Avenue.

Shared-use path from Bliler Avenue to Maple Avenue

- Remove bollards at south end of the path. • Best practice pathway design today
- does not include bollards.
 Stripe centerline for first 25' of the path from either end and add directional arrows.
- Install "No Motor Vehicles" (MUTCD R5-3) signs at both ends of the path.
- 2 Re-align north end of the path to the left of the gutter pan for the driveway to the adjacent car dealership.
- Install additional pedestrian-scale lighting for the pathway.

Maple/Auto Group Avenue from end to Cherry Avenue

Two options for pedestrian and bicyclist accommodation:

- 3 Construct sidewalk on the east and south sides of Maple and Auto Group Avenues, with shared lane markings for bicyclists.
 - Provides accommodation for pedestrians.
 - Bicyclists would transition to the recommended sidepath at the Cherry Avenue intersection.
 - Construct sidepath on the east and south sides of Maple and Auto Group Avenues.
 - Enables bicyclists to continue on a separated facility connecting the shared-use path to a recommended sidepath on Cherry Avenue.
 - Helps bicyclists avoid conflicts with drivers exiting Home Depot parking lot.

Cherry Avenue from Auto Group Avenue to Salem Parkway

- Construct sidepath on east side.
 - Supplements current bike lanes with a facility that is more comfortable to a wide range of users.
 - Provides pedestrian accommodation on east side of the street.
 - Opportunity for green infrastructure with use of permeable pavement.

Auto Group Avenue and Cherry Avenue Intersection

The design of this intersection is dependent upon decisions regarding construction of the sidepath on Cherry Avenue.

- With sidepath construction, facilitate bicyclists' movement onto and off of the sidepath via one of four options:
 - Stripe two-stage queue box.
 - Construct additional sidewalk-level queuing space for bicyclists on the southwest corner.
 - Construct corner island to create bicyclist queuing space.
 - Create bicycle-only signal phase that allows people to make diagonal movement through intersection without conflicts.
- Without sidepath construction, facilitate bicyclist left turns onto Cherry Avenue bike lanes:
 - Stripe pocket-left-turn bike lane to direct bicyclists' merge across the through/right lane to make the northbound left turn movement.
 - Add bicycle detection loop at the signal.

Cherry Avenue and Salem Parkway

- Paint green conflict-zone markings in the right-turn-lane/bike-lane weaving area.
- Create No Turn on Red phase for northbound automobile traffic.
- 2 Construct raised crosswalk across rightturn slip lane on northeast corner.
- Install bicycle and pedestrian crossing warning signs for all approaches.
- Install wayfinding/directional signage for bicyclists and pedestrians accessing shared-use path along the Parkway.

The final section of this memo outlines a toolkit of design treatments for this and future family friendly bikeway projects in Salem.

It includes 24 design treatments in the following general categories:

- Horizontal traffic calming
- Vertical traffic calming
- Intersection treatments
- Signage
- Green infrastructure

Each treatment is described along with general benefits, considerations, and costs. Costs are highly variable depending on context and design decisions; assumptions are given where possible.

Design Toolkit References:

FHWA. Pedestrian Safety Improvements Library.

IPBI, Alta Planning + Design, Portland State University. Bicycle Boulevard Planning and Design Guidebook. 2009.

NACTO. Urban Bikeway Design Guide. 2nd Edition.

NACTO. Urban Street Design Guide.

Portland Bureau of Transportation. Neighborhood Greenway Assessment Report. 2015.

SF Better Streets. Permeable Paving. 2015.

Toole Design Group. Draft Montgomery County Bicycle Master Plan Design Toolkit. 2016.

HORIZONTAL TRAFFIC CALMING

Horizontal traffic calming reduces speeds by narrowing lanes and/ or requiring horizontal deflection, which creates a sense of enclosure and additional friction between passing vehicles. Narrower conditions require more careful maneuvering around fixed objects and when passing bicyclists or oncoming automobile traffic. Some treatments may slow traffic by requiring motorists to yield to oncoming traffic.

CURB EXTENSION

BENEFITS

- Visually narrows the roadway.
- Reduces the width of the crosswalk, and bike and pedestrian crossing distances.
- Can be used to reduce or eliminate strop control at intersections.
- Extended sidewalk space can be used for plantings, street furniture, bicycle parking, artwork, or green stormwater infrastructure.

Curb extensions are sections of the sidewalk that extend into the parking lane. They are located at intersections and mid-block crossings and may include pedestrian curb ramps.

Use in street segments or intersections where street width contributes to higher motor vehicle speeds, especially where on-street parking has a low rate of occupancy during most times of day.

CONSIDERATIONS

- Must be designed to deflect motor vehicle traffic without forcing the bicycle path of travel to be directed into a merging motorist.
- Consider the turning radii of larger vehicles as appropriate, depending on design context.
- Landscaped curb extensions should use low growing shrubs to preserve sight distances.

COSTS

• \$13,000 for 1 crossing (2 extensions, 6' wide): curb work, detectable warnings, concrete only (no plantings).

CHICANE

BENEFITS

- Visually narrows the roadway.
- Forces vehicles to shift laterally, slowing traffic.
- Many possible designs and configurations depending on context.
- May be used as planters or for green stormwater infrastructure.

Chicanes are raised curbs located mid-block that create small horizontal shifts in the roadway.

Use in street segments where street width contributes to higher motor vehicle speeds, especially where on-street parking has a low rate of occupancy during most times of the day, and where long straightaways allow motor vehicles to pick up speed.

CONSIDERATIONS

- Consider use where long straight stretches of roadway allow vehicles to pick up speed.
- May be used in the parking lane (see photo above) or to narrow a wide travel lane.
- May be separated from the curb either to let bicycles pass or allow stormwater passage.
- Chicanes are often used in pairs on alternating sides of the street.

COSTS

• \$10,000 for 1 pair of chicanes, 10' x 20' each; assume no drainage impact (separate from curb).

MINI-CIRCLE

Mini-circles are similar to roundabouts, and are typically constructed as a curb-level landscaped circular island.

Used at local intersections where street width contributes to higher motor vehicle speeds, or where an alternative to a stop- or yield-controlled intersection is desired.

BENEFITS

- Visually narrows the roadway.
- Cars must maneuver around the center circle, slowing traffic slightly.
- Can reduce bicycle delay.
- Opportunity for neighborhood greening.

CONSIDERATIONS

- Should be considered at local street intersections to prioritize the through movement of bicyclists without increasing motorists speeds.
- Unlike mini-roundabouts, mini-circles may use stop control if necessary.
- Mini-circles only slow traffic within about 100 feet of the intersection.

COSTS

• \$15,000 for 1 curbed, planted, 16' diameter circle.

VERTICAL TRAFFIC CALMING

Vertical traffic calming forces motorists to drive at slower speeds. This lowers the speed differential between bicyclists and cars, increasing bicyclist comfort. These treatments are typically used where traffic controls are less frequent, for instance along a segment where stop signs may have been removed to ease bicyclist travel.

SPEED HUMPS

BENEFITS

- Highly effective method of slowing motor vehicles.
- Relatively inexpensive and easy to maintain.
- Minimal slowing for cyclists.

CONSIDERATIONS

speeding issues.

several hundred feet apart or less.

- Speed humps impact bicyclist comfort and should be designed with sinusoidal or flat-topped approach profiles.
- Speed humps can slow emergency vehicles substantially. Consider speed cushions where emergency vehicle passage is a priority.

Speed humps are sections of roadway raised several inches above grade. They can be made from many materials but are most commonly made from asphalt. Speed humps are often used in a series typically spaced

Speed humps can be designed with a variety of vertical profiles. Consider on roads with measured or observed

• Speed humps are typically designed with space between the hump and the curb for drainage.

COSTS

\$3,000 each (14' wide, includes chevron markings).

SPEED CUSHIONS

BENEFITS

- Speed cushions slow motor vehicles while allowing emergency vehicles to pass with minimal delay
- Minimize delay for bicycles, which can pass
 through the wheel gaps for emergency vehicles

Speed cushions are similar to speed humps, but with gaps spaced for an emergency vehicles wheelbases to pass through with minimal slowing.

Consider on roads with measured or observed speeding issues and on which emergency vehicle priority is high.

CONSIDERATIONS

• Speed cushions are less effective at achieving lower speeds than are continuously raised devices such as speed humps and raised crosswalks

COSTS

• \$5,000 for one installation of 3 pieces.

BENEFITS

- Highly effective method of slowing motor vehicles.
- In addition to the benefits of speed humps, raised crosswalks provide slowing and increased driver attention at conflict points with pedestrians.
- Can provide slowing where motor vehicles tend to take turns at high speeds.

RAISED CROSSWALKS

Raised crosswalks are similar to speed humps, but are located at a crosswalk, have flat tops, and typically meet the curb. They can be raised to sidewalk height or slightly below.

Consider raised crosswalks at mid-block crossings with measured or observed speeding issues or where vehicles fail to yield to pedestrians; or at intersections to slow traffic turning on to the neighborhood greenway from a major street.

CONSIDERATIONS

 Raised crosswalks impact bicyclist comfort and should be designed with sinusoidal or flat-topped approach profiles.

COSTS

• \$10,000 each (includes high visibility crosswalk, will necessitate drainage and curbside work).

RAISED INTERSECTION

BENEFITS

- Highly effective method of reducing speeds at major conflict points.
- Enhances the pedestrian environment and encourages motor vehicles to yield to pedestrians.
- Can have urban design and placemaking benefits.

Entire intersections can be raised to be flush with the sidewalk, to create safer, slow-speed crossings. The raised portion of the intersection includes the crosswalk.

Consider at minor intersections with measured or observed speeding issues, or where motor vehicles fail to yield to crossing pedestrians.

CONSIDERATIONS

- Raised intersections must be designed with attention to cyclist comfort, emergency vehicle access, and drainage.
- Bollards or other vertical separation should be used to separate motor vehicle from pedestrian space on the corners.

COSTS

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INTERSECTIONS

Intersections are the areas of neighborhood greenways that introduce the greatest levels of conflict between cyclists, pedestrians, and motor vehicles, as well as the greatest delay. Major street crossings must be addressed to provide safe, convenient and comfortable travel along the entire route. Treatments provide safe crossings for pedestrians and cyclists, waiting space for bicyclists, control cross traffic, or ease bicyclist use by removing traffic control for travel along the neighborhood greenway route.

BENEFITS

- Allows cyclists and pedestrians to cross wide roadways in multiple stages, shortening crossing distances.
- Visually narrows the roadway, providing traffic calming.
- Restricts left-turn movements by motor vehicles, reducing conflicts.

CONSIDERATIONS

islands at curb level.

- Provide sufficient space for multiple users and their bicycles at high-volume crossings. At least 8' - 10' width is preferred.
- The median may be located on just one side of the crosswalk, or may enclose the user on both sides.

Median islands divide road crossings into two halves, providing a protected refuge in the middle of the roadway for pedestrians and cyclists to pause and wait for gaps in traffic. Median islands are typically raised concrete

Consider use on wide roadways with multiple traffic

lanes, especially ones with high traffic speeds.

• Consider angling the refuge so that the user faces towards oncoming traffic before crossing.

COSTS

• \$20,000 - \$40,000 each (6' wide, 8' long).

DIVERTERS

Traffic diversion strategies are used to reroute traffic from a neighborhood greenway onto adjacent streets by installing design treatments that restrict motorized traffic from passing through, while allowing gaps or pathways for 2-way bicycle traffic.

Diverters can be designed to create partial or full roadway

Partial closure - permanent, signalized

Full closure

BENEFITS

- Maintain bicycle and pedestrian connectivity while substantially decreasing motorized traffic on neighborhood greenways.
- Can be designed with plantings or green stormwater infrastructure.
- Temporary materials may be used to test diversion impacts before permanent, curbed diverters are installed.

closures, or force a right or left turn. Diverters can be designed for uncontrolled, stop controlled and signal controlled intersections.

Diverters can be constructed from many different materials, including median islands, curb extensions, planters, bollards, and other barriers.

Partial closure - interim, stop-control

Diagonal diverter

CONSIDERATIONS

- Diversion is most applicable in areas with a grid of streets to disperse traffic.
- Diversion shifts trips from the neighborhood greenway onto adjacent streets. This change in traffic volume on other local streets must be identified and addressed during the planning, design and evaluation process.
- Consultation with emergency services will be necessary to understand their routing needs.
- Clear signage and/or pavement markings help bicycles and motorized vehicles know where they are and aren't allowed.

COSTS

- \$10,000 for single curb extension similar to partial closure photo above;
- \$25,000 \$80,000 for a median with cut throughs similar to the full closure photo above.

RECTANGULAR RAPID FLASHING BEACON (RRFB)

BENEFITS

- Have been shown to significantly increase driver yielding to pedestrians.
- Lower cost than traffic signals or PHBs.
- Typically solar powered, independent of power grid.
- Minimal disruption to motorized traffic flow.
- Minimizes driver habituation to signal, since it is dark when pedestrians aren't present.

RRFBs use a sign and flashing yellow lights to alert drivers to a marked pedestrian crossing. State law requires driver yielding to pedestrians at these locations, but RRFBs do not constitute a regulatory traffic control device. The beacons are activated through push buttons or automated pedestrian detection, and are dark when no pedestrian is present.

Consider use at unsignalized intersections and midblock locations.

CONSIDERATIONS

- Where there is more than one traffic lane in either direction, advance stop bars or yield markings are recommended.
- RRFBs are often paired with median islands. The island should contain a second RRFB installation.
- May require a traffic study.

COSTS

• \$25,000 each (assumes two RRFBs with warning signage per location).

BENEFITS

- Studies show very high motor vehicle compliance with PHBs, and reduced pedestrian and total roadway crashes.
- Minimal disruption to motorized vehicle traffic flow.
- Minimizes driver habituation to signal, since it is dark when pedestrians aren't present.

PEDESTRIAN HYBRID BEACON (PHB)

Pedestrian hybrid beacons (PHBs), also known as HAWK beacons, facilitate pedestrian and bicyclist crossings at unsignalized marked crosswalk locations. They consist of one yellow and two red lights that direct approaching motor vehicles to slow, yield, and stop for people crossing. Beacons are push button-actuated and remain dark when not activated.

Consider at major crossings where there are insufficient gaps for pedestrians and cyclists to cross.

CONSIDERATIONS

- Always pair with a marked crosswalk.
- Beacons have been shown to be more effective with signage telling cars to stop on solid red signal.
- Educational outreach to explain beacon use and function is recommended.
- May require a traffic study.

COSTS

• \$60,000 each (facing both directions of traffic, includes new poles, mast arms, and push buttons).

BIKE DETECTION

BENEFITS

- Reduces cyclist delay.
- Discourages cyclists from running red lights.

Typical roadway signal activation loops may not detect cyclists waiting at red lights, which can lead to long delays and encourage cyclists to run red lights. Signal activation loops can be calibrated and located in the pavement in such a way that cyclists will activate them, calling up the green light.

Consider use where green lights require vehicle detection loops and motor vehicle volumes are low.

CONSIDERATIONS

- Detection loops are often marked with a bicycle detector symbol to alert cyclists to the bike detection and show them where to optimally position themselves to trigger it.
- Consider installing activation loops in advance of the intersection so that cyclists trigger it as they approach, further reducing delay.
- Left turn pockets may need their own detection loops.

COSTS

• \$2,000 per approach (loop detector and modifications to signal box).

PUSH BUTTONS

BENEFITS

COSTS

• Reduces cyclist delay.

• \$1,000 per push button.

• Discourages cyclists from running red lights.

Push buttons are similar to bike detection, except that cyclists must manually push a button located near the intersection in lieu of automatic detection.

Many intersections already have push buttons for pedestrians, but these are inconveniently located for cyclists. Bicycle push buttons should be located at the edge of the roadway so that cyclists can press the button without dismounting their bicycles.

CONSIDERATIONS

- Left turn pockets may need their own push buttons.
- At many intersections it may be appropriate to have both pedestrian and cyclist push buttons to serve both groups.

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RE-ORIENTING STOP SIGNS

Cyclists are highly sensitive to delay. To reduce delay and create greater continuity for cyclists on neighborhood greenways, stop signs should be minimized. In locations where there is a two-way stop that gives right-of-way to the cross street, consider re-orienting the stop signs so that the greenway has right-of-way instead.

BENEFITS

- Reduces cyclist delay and provide more continuous route
- · Reduces cyclist incentive to run stop signs

CONSIDERATIONS

- Re-orienting stop signs may increase motor vehicle speeds and volumes on neighborhood greenways. Where this is observed, consider using speed humps, and diverters for full or partial road closures.
- May require a traffic study

COSTS

• \$300 per sign.

CROSSWALKS

Standard (transverse) marked crosswalks consists of two painted white lines, located along the two side edges of the crosswalk to mark its boundaries. High visibility crosswalks add thick painted horizontal stripes through the entire crosswalk (see photo at left).

Every intersection crossing is a legal crosswalk, whether or not it is marked. Pedestrians are granted the right-ofway when they step into a marked or unmarked crosswalk; cyclists must dismount to be given the right-of-way.

Crosswalks should be marked at all signal-controlled crossings, including at PHBs and RRFBs. Consider marking unsignalized crossings with higher vehicle volumes or multiple lanes. Consider mid-block crosswalks where there are long stretches between crossings, or where trails cross busy roadways. Also consider marking crosswalks near schools, parks, plazas, senior centers, transit stops, hospitals, campuses, and major public buildings.

BENEFITS

- Increase pedestrian visibility, particularly in the case of high visibility crosswalks.
- Alert pedestrians, cyclists, and motorists to an area of conflict.
- Reinforce pedestrian priority at crossings.

COSTS

\$2,600 (one leg of one 10' high visibility crosswalk).

CONSIDERATIONS

- Crosswalk marking decisions should be made with care, to avoid driver habituation through over-saturation.
- Crosswalks may need to be used together with other crossing safety tools such as median islands, PHBs or RRFBs, or traffic calming, especially where pedestrians cross multiple lanes traveling in the same direction (called the multiple-threat crash problem).

MINI-ROUNDABOUTS

BENEFITS

- Prioritize through-movement of cyclists without increasing motorist speeds.
- Reduce turning conflicts at intersections.
- Large vehicles can drive over the mountable surface.
- Can be alternatives to stop- or yieldcontrolled intersections.

Mini-roundabouts are small mountable circular islands placed at the center of low-volume intersections. They operate under yield control and slow traffic while eliminating the need for stop signs. They are typically hardscaped.

Consider at minor local intersections where street width contributes to higher motor vehicle speeds, especially where there is a desire to remove or decrease stop control.

CONSIDERATIONS

- Must be designed to deflect motor vehicle traffic without forcing the bicycle path of travel to be directed into a merging motorist.
- Speed reduction for motor vehicles limited to within about 100 feet of the intersection.
- Add modest delay for emergency vehicles.
- Consider using at constrained local intersections where truck or bus access is to be maintained.

COSTS

• \$50,000 - \$100,000 for one roundabout (16' diameter, stamped or stained concrete construction).

BENEFITS

- Increases cyclist left turn comfort, safety, and visibility.
- Cyclists can make left turns without merging into traffic; reduces turning conflicts with motor vehicles.
- Orient bicycles correctly for safe crossing.
- Separates turning from through cyclists, reducing conflicts.

COSTS

• \$600 per box.

TWO-STAGE QUEUE BOXES

Two-stage queue boxes help cyclists comfortably make a left from a right-side facility in two stages, by providing a designated area to wait for a gap in traffic.

Queue boxes are most commonly used at signalized intersections, but can be used in any context where bicycle left turns are common, or would benefit from greater clarity or safety. Two-stage queue boxes are often used for left turns onto neighborhood greenways.

CONSIDERATIONS

- Can also be used for right turns from a left-hand bicycle facility.
- Place box outside motor vehicle travelways and turning paths.
- At signalized intersections, right turns on red must be prohibited for motor vehicles.
- The use of a two-stage turn queue box requires FHWA permission to experiment.

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SIGNAGE

Traffic calming and well designed facilities are important parts of creating a safe, functional, continuous neighborhood greenway. A successful greenway also requires appropriate and thoughtful signage to provide information to cyclists and motor vehicles and increase legibility. Signage also offers opportunities for neighborhood greenway branding and identity.

WARNING

BENEFITS

- Alert drivers to the presence of cyclists and pedestrians, and encourage slowing, especially at crossings.
- Give advanced warning to roadway users when traffic calming or traffic control devices are present.

CONSIDERATIONS

- Warning signs are a standard or even required component of many traffic calming and crossing safety features.
- Even where not required, research suggests that warning signs make traffic calming and crossing safety features more effective.
- The MUTCD, AASHTO, NACTO, and other guides give guidance on when to use warning signs.

COSTS

• \$300 each for diamond warning signs.

BRANDING

BENEFITS

- Placemaking benefits: branding lets residents and visitors know that neighborhood greenways are special, distinctive places.
- Encourages drivers to slow down and be alert, particularly if signage underscores the family-friendly nature of greenways.
- Strong identity helps users instantly know when they are using a greenway.

COSTS

•

Many cities give their neighborhood greenways special identities through branding signage with distinctive symbols or colors. Signage is often as simple as specially designed Neighborhood Greenway signs placed along the route.

Branding signage can also be used at entrances to neighborhood greenways or on wayfinding signs

CONSIDERATIONS

- Emphasizing the family-friendly nature of neighborhood greenways encourages drivers to go slow and remain alert.
- Branding isn't limited to signage. Neighborhood greenways can also incorporate distinctive bike racks, seating, lighting, public art, or street signs.
- Avoid using colors reserved by the MUTCD for regulatory and warning signs; green and purple are common colors for greenway signs.

WAYFINDING

BENEFITS

- Helps cyclists stay on the greenway route.
- Makes cyclist navigation and connecting between bike routes in different parts of town simple and easy.
- Play roles in placemaking, branding and identity.

A clear wayfinding system is essential to a successful neighborhood greenway. The wayfinding system should use signage (as well as pavement parkings) to clearly alert cyclists to turns so that they can stay on the route.

Wayfinding signage also gives directions to major destinations such as neighborhoods, schools and universities, parks, commercial districts, transit hubs, and other bike routes, and directs cyclists from other routes to the greenway.

CONSIDERATIONS

- Install signage far enough in advance of turns that cyclists have time to consider the information, make a decision, and safely turn.
- In addition to direction, wayfinding signs to other routes or neighborhoods should give distance and/or estimated travel time to destinations.
- Two many signs can create clutter and reduce effectiveness.

COSTS

• \$500 per sign (single green panel with destination information).

GREEN INFRASTRUCTURE

Neighborhood greenways offer numerous opportunities to introduce green infrastructure for effectively and sustainably managing stormwater runoff. Green stormwater infrastructure on sewer systems.

STORMWATER PLANTERS

BENEFITS

- Replaces impervious surface with stormwater filtration or infiltration.
- Can be placed in existing underutilized spaces such as curb extensions.
- Beautification, placemaking and neighborhood greening.
- Cost-effective stormwater management.

Stormwater planters replace impervious surfaces with green catchbasins that capture stormwater and let it slowly seep into the ground, being filtered by plants and soil.

Planters can be installed in many traffic calming features such as curb extensions and chicanes. Consider installing in areas

CONSIDERATIONS

- Planters must be designed with appropriate soils and plantings, and appropriately sized to meet drainage objectives; see local stormwater guidelines.
- There is great deal of design flexibility and planters can be designed to meet almost any constraints and can fit into many conditions.

COSTS

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PERMEABLE PAVEMENT (SIDEPATHS)

BENEFITS

• Replaces impermeable surface with permeable surfaces.

Permeable pavement looks like ordinary pavement, but allows stormwater to filter through and into the soil below. Permeable pavements are generally made of systems that include a surface layer, a bedding layer, a transition layer, and a storage layer of permeable base rock.

Sidepaths are an opportunity for using permeable paving materials in neighborhood greenways.

CONSIDERATIONS

- There are a variety of possible permeable pavement materials, including permeable asphalts and concretes.
- Effective permeable pavement depends on the conditions of the soils on which it is installed.
- Permeable pavement typically have higher maintenance requirements than traditional paving materials.

COSTS

•

OTHER

LIGHTING

Street lighting is an important safety feature on neighborhood greenways, increasing pedestrian and cyclist visibility and creating comfortable and safe spaces for travel after dark.

BENEFITS

- Increases cyclist and pedestrian visibility, and visibility of signs, obstacles, and traffic calming features.
- Increases cyclist and pedestrian safety and comfort.

CONSIDERATIONS

- Pedestrian-scale lighting is particularly desirable, and has placemaking benefits as well as providing identity branding opportunities.
- It is particularly important that traffic calming features be well lit, since they require cars and cyclists to maneuver around them.

COSTS

• \$5,000 per Salem standard street light.

BENEFITS

- Route continuity and legibility.
- Alerts cyclists to turns in the route or connections to other bicycling routes.
- Encourages cyclists to ride in the travelway instead of near parked cars.

PAVEMENT MARKINGS

Pavement markings are an important part of neighborhood greenway wayfinding and legibility. Markings identify the route as a neighborhood greenway and indicate turns in the route and connections to other greenways or bike routes.

Different cities use different markings. Precedents include shared lane markings, medallions, or other bike-related pavement markings with directional arrows.

CONSIDERATIONS

- Markings should be spaced frequently enough that cyclists don't worry that they've "lost the trail."
- Place markings after each intersection, and near high volume driveways and other conflict points.
- Do not use neighborhood greenway markings within bicycle lanes.

COSTS

• \$4,200 per mile for shared lane markings spaced at 250'.