STREETS FOR EVERYONE
Low-Stress Connections for the St. Louis Region
STREETS FOR EVERYONE

This Guide was designed and authored by Trailnet and The Street Plans Collaborative, with support from the Ten 8 Group, Carly Clark, and John-Mark Palacios.

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“Riding a bicycle should not require bravery. Yet, all too often, that is the perception among cyclists and non-cyclists alike.”

- Roger Geller
INTRODUCTION
St. Louis is on the rise to become one of the most livable regions in the country. It sits at the confluence of two great rivers, is rich with history, and has distinct architecture and neighborhoods, world-class parks and cultural institutions among many other assets. Active collaboration to ensure a high quality of life is strengthening among organizations and governments. East-West Gateway, the Metropolitan Planning Organization, has led the region through a multidisciplinary, multijurisdictional planning process, resulting in the creation of OneSTL—a regional plan for sustainable development. Trailnet’s role in moving St. Louis forward on this trajectory is to foster communities where walking, biking, and taking public transit are safe, comfortable, and convenient options for daily transportation.

WE WANT MORE TRANSPORTATION CHOICES
St. Louis residents have a long history of supporting multimodal transportation. In 1994 St. Louisans voted for a ¼ cent sales tax to expand the MetroLink light rail system; in 2010 they voted for even more transit—a ½ cent sales tax to expand MetroLink and maintain MetroBus.

St. Louisans began to significantly demand more amenities for walking and biking in 2000 when they voted to tax themselves to create more trails. Proposition C created the Great Rivers Greenway (GRG) tax district with the charge of building 600 miles of trails throughout St. Louis City, St. Louis County, and St. Charles County. In 2013, residents again voted to tax themselves to generate more money for faster expansion of trails, and to renovate the Gateway Arch grounds with improved accessibility. GRG has already built 104 miles of trails, 84 miles of on-street bikeways, and created the Gateway Bike Plan, a bike master plan for collector and arterial streets in the district’s geography.

The future is bright for the St. Louis region. Image: Street Plans

The trends in St. Louis mirror those nationwide: increased support for public transportation and bikeways reflect significant demographic and behavior shifts across the country. The largest segments of the American population are the Baby Boomers (born between 1946 and 1964) and the Millennials (born between 1980 and 2000). Baby Boomers are becoming empty nesters as Millennials are coming into the workplace,
demonstrating a strong preference for communities that are walkable, transit oriented, and contain a wide variety of houses and businesses. Fifty-eight percent of Baby Boomers and 62% of Millennials want such neighborhoods.

It is not only desire that indicates a strong demand for walkable, bikeable neighborhoods. People are driving less and walking and biking more. The average vehicle miles traveled per capita has decreased 6% since 2004. Millennials are leading the charge—between 2001 and 2009, their average vehicle miles traveled decreased 23% while biking and walking trips increased 24% and 16%, respectively. In the same time period, Baby Boomers’ per capita trips in private vehicles decreased 13%, while their share of bike trips increased 64% and transit trips increased 19%.

**PLANNING FOR THE “INTERESTED, BUT CONCERNED”**
While our region takes larger strides to create more walkable and bikeable communities, it is important that we not lose sight of why we are doing so and for whom we are planning. The goal is to create a quality of life where walking, biking, or taking transit is as efficient, safe, and comfortable as driving a car. Cultural shifts do not come easy. A planning approach is necessary to reach the largest segments of the popula-

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**THE 4 TYPES OF BICYCLISTS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Strong + Fearless</td>
<td>60%</td>
</tr>
<tr>
<td>Enthused + Confident</td>
<td>33%</td>
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<tr>
<td>Interested, but Concerned</td>
<td>6%</td>
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<tr>
<td>No Interest / Unable</td>
<td>1%</td>
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Source: *Four Types of Cyclists*, by Roger Geller, Portland Office of Transportation
tion while providing for the safety and comfort needs of the most vulnerable in our communities—our children, elderly, and disabled. If we design our communities for the most vulnerable, the needs of the rest of the population will be met in many ways.

In the world of planning bikeways, there are broadly four different categories of riders: “strong and fearless,” “enthused, and confident,” “interested, but concerned,” and “no way, no how.” A bicycle coordinator from a major metropolitan city devised this methodology for calculating how much of the population fit into each category. The strong and fearless and enthused and confident riders will ride with few to no amenities, making up ~8% of the population. We design bikeways for the majority (60%) “interested, but concerned”—those who would bike if it was not for their fears. Other cities have found their populations to have similar percentages of residents in the “interested, but concerned” category.

**GIVE THE PEOPLE WHAT THEY WANT — LOW STRESS CONNECTIONS**

Experience and research has led Trailnet and many other bicycle planners and engineers to believe a bicycle network’s most fundamental attribute should be low-stress connectivity to attract the widest possible segment of the population. Low-stress connectivity provides routes between people’s origins and destinations that do not require bicyclists to use links that exceed their tolerance for traffic stress, and that do not involve an undue level of detour. In “Low-stress Bicycling and Network Connectivity” published by the Mineta Transportation Institute, researchers propose a new scheme for classifying road segments for cyclists by

**LOW-STRESS CONNECTIONS GENERATE ECONOMIC VALUE**

The Indianapolis Cultural Trail has gained international attention for its many community and economic benefits. The eight-mile trail strengthens community identity by connecting neighborhoods, incorporating beautiful and engaging public art, and using high-quality signage and materials. Much development has occurred because of the Cultural Trail. According to a study performed in 2009, the trail is expected to create more than 11,000 jobs and $863 million in economic benefits. Learn more about the Indianapolis Cultural Trail at indyculturaltrail.org.)
one of four levels of traffic stress (LTS):

- LTS 1: the level that most children can tolerate
- LTS 2: the level that will be tolerated by the mainstream adult population
- LTS 3: the level tolerated by American cyclists who are “enthused and confident” but still prefer having their own dedicated space for riding
- LTS 4: a level tolerated only by those characterized as “strong and fearless”

While this type of classification for roadways is only in the beginning stages of testing and adoption, many cities in the U.S. have begun using bicycle facilities classified as low-stress. NACTO (National Association of City Transportation Officials) includes cycle tracks and bicycle boulevards among low-stress bicycle facility types. The low-stress scheme also applies to pedestrians. Building low-stress bicycle connections creates low-stress pedestrian connections due to traffic-calming design and the creation of public spaces.

The benefits described in this guide are inspiring communities to build low-stress connections and include their ability to spur economic development and attract high numbers of cyclists. After buffered bike lanes were installed on Philadelphia’s Spruce and Pine Streets, bike traffic increased 95% and the number of bicyclists riding on the sidewalks decreased by up to 75%. After two streets in Minneapolis were converted to be more bicycle-friendly, bike traffic increased 43%, total vehicle crashes decreased, traffic efficiency was maintained, and parking revenues remained consistent. Due to an intense focus on creating low-stress connections in New York City, bicycling increased 102% since 2007 and 289% compared to 2001.

This guide is Trailnet’s call to the community to build low-stress bicycle and pedestrian connections. Though St. Louis has many assets, a missing piece is the seamless ability for residents and visitors to connect to destinations by walking and biking, the preferred method for Baby Boomers and Millennials. St. Louis is poised for success with low-stress connections because the street grid system easily connects neighborhoods with destinations. We have the opportunity to bypass the learning steps of other communities and benefit from planning experimentation that has led model U.S. cities to adopt low-stress connections as the priority in their planning.

**HOW TO USE THIS GUIDE**

The primary audiences for this guide are municipal staff, policymakers, elected officials, and advocates. Basic information about the design elements, costs, benefits, best practices for implementation, and common concerns of low-stress connections is provided. Municipal staff can use this guide to begin initial planning for these desired connections. Policymakers, elected officials, and advocates can use this guide as an educational tool, a way to identify existing policies that may prohibit the creation of low-stress connections and those needed to make their creation likely; and a way to identify the most compelling message for winning low-stress connections for communities.
“ABOUT FOUR OR FIVE YEARS AGO SOUTH COUNTY HAD VERY FEW SIDEWALKS. BUT WITHIN THE LAST FIVE YEARS THEY HAVE ACTUALLY PUT SIDEWALKS OUT HERE AND IT MAKES MY LIFE A LOT EASIER. REALLY AND TRULY, IT’S BEEN A GREAT IMPROVEMENT.”

- JEFF HOGAN

JEFF HOGAN, RESIDENT

South St. Louis County resident Jeff Hogan has been in a wheelchair all of his life and knows the streets of South County very well. “I am a person who goes everywhere. I’m always on the move. It takes a daredevil type of person to be living in the manner that I live in.”

Jeff calls himself a daredevil because he has lived in South County for 25 years and has spent most of those years getting around on streets because there are very few sidewalks. Jeff knows the profound impact quality pedestrian connections can make.

“About four or five years ago South County had very few sidewalks. But within the last five years they have actually put sidewalks out here and it makes my life a lot easier. Really and truly, it’s been a great improvement.”
“People have always lived on streets. They have been the places where children first learned about the world, where neighbors met, the social centers of towns and cities...”

- Donald Appleyard
PUTTING THE “EVERY” IN EVERYONE

Communities across the country are putting policies and procedures in place to ensure that underserved populations are meaningfully included in creating biking and walking connections. We encourage the communities of the St. Louis region to do the same and pay special attention to the following populations.

THE AMERICANS WITH DISABILITIES ACT (ADA)

The ADA was signed into law on July 26, 1990 and requires new construction and altered facilities to be “accessible to and usable by” people with disabilities. Though it has been over 20 years since the Act’s passage, there is still much to be done to put the needs of the disabled front and center. When planning low-stress connections, be sure to include members of the disabled community from the beginning of the planning process.

WOMEN

Bicycle planners and engineers use three to five miles as the threshold at which average people will bike to reach their destination. Half of all trips made by Americans are three miles or less; fewer than 2% of those trips are made by bicycle, while 72% of them are driven. When we look at encouraging people to bike for these “bike possible” trips, women are important to consider.

Women take more and shorter trips than men. Women also trip-chain more than men, indicating the high importance of convenience and connectivity in encouraging them to bike. “Trip-chaining” is linking trips to several destinations before reaching your final destination. A 1999 study finds that 61.2% of women make at least one stop after work, and 28.3% make at least two stops or more, while 46.4% of men make one stop after work, and 17.7% make two or more stops. A study from 2012 looked at two-adult households with no children and with children under five years of age and found that overall, women trip-chained 54% more than men.

Women are more risk-averse than men. Jennifer Dill’s study Where Do People Bicycle? The Role of Infrastructure in Determining Bicycling Behavior looked at the effect of different types of bike-ways on bicycling in Portland, Oregon. The study found women were less
likely than men to try on-street bike lanes and more likely to go out of their way to use neighborhood greenways - quiet residential streets with special traffic-calming features for bicycles (see page 16).

These reasons and others have led planners and engineers to consider women the “indicator species” of the bike-friendliness of a community’s bicycle network. Similarly, women’s needs should also be strongly considered for pedestrian projects.

**DISADVANTAGED POPULATIONS**

Improving the quality of life in our region must include collaboration with communities containing pockets of poverty and disinvestment to identify solutions for moving their community forward. Planning for low-stress connections can be an asset to such communities, but they must be planned with residents in a meaningful way.

Once provisions to create low-stress connections within disadvantaged communities have been made, it is important to realize that many have had much planning in the past that resulted in few to no results. Low-stress connections can be created using the principles of “tactical urbanism” (see Pilot Projects on page 67) to allow for hands-on activities that glean on-the-ground knowledge from residents, build community trust, produce fast results, and attract additional resources.

Turn to page 81 to learn about the Overton Broad Connector, a cycle track that began with tactical urbanism. The Connector has helped transform a disadvantaged community.

**LOW-STRESS FACILITY SUMMARY**

The table at right coordinates 16 types of low-stress bikeway and pedestrian facilities with five normative context zones found in the St. Louis region and three generic street types: Local, Collector, and Arterial.

These treatments are by no means comprehensive, as site specific design is encouraged and local calibration essential to the success of developing appropriate low-stress walking and bicycling facilities and networks.

Each of the 16 treatments is discussed, illustrated, and applied to one or more of the “Before” and “After” photosimulations, and section/plan scenarios drawn from typical street and roadway conditions found in the St. Louis region.
### ST. LOUIS REGIONAL LOW-STRESS FACILITY SUMMARY

<table>
<thead>
<tr>
<th></th>
<th>Rural</th>
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<th>General Urban</th>
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<td>High-visibility crosswalks</td>
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<tr>
<td>Median refuge islands</td>
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<td>L, C, A</td>
</tr>
<tr>
<td>Rectangular rapid flashing beacons</td>
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<td>C, A</td>
<td>L, C, A</td>
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</tbody>
</table>

*Z = Context zone

L = Local
C = Collector
A = Arterial

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DEFINITION
Neighborhood greenways are residential streets transformed into low-stress, family friendly routes that encourage walking and biking. A variety of traffic calming measures are used to reduce the volume and speed of motorized vehicles and priority is given to people walking and bicycling.

Neighborhood greenways features:
• Low speed limits
• Low motor-vehicle traffic volumes
• Preferential right-of-way along the designated route to allow continuous travel without stops for people walking, jogging, or bicycling
• A variety of intersection traffic control treatments to help people easily cross major collector and/or arterial thoroughfares
• Distinctive markings or signs to make all users aware that the street is prioritized for active forms of travel (bicycling, walking, etc.)

PURPOSE + BENEFITS
Neighborhood greenways are intended to make walking and bicycling more comfortable because they provide safe, convenient, and appealing routes on low-traffic streets, through stressful intersections, and between other links in the network, such as off-street paths, cycle tracks, and bicycle lanes.

Neighborhood greenways provide multiple opportunities to achieve environmental goals because they often combine traffic calming infrastructure with landscaping to manage stormwater, improve a neighborhood’s tree canopy, and, subsequently, reduce the urban heat island effect — increased temperatures in urban areas due to high asphalt coverage. It is also believed that the design of neighborhood greenways improves a neighborhood’s walkability, quality of life, and identity. Much like living in proximity to shared use paths or other greenways, neighborhood greenways may contribute to higher property values.
DESIGN ELEMENTS
Neighborhood greenways utilize a wide variety of design elements, such as signs, pavement markings, and speed and volume management techniques that discourage through automobile traffic. Some specific design elements include, but are not limited to:

- Speed limit signing of 25 mph or below
- Branded wayfinding signs, pavement markings, and bicycle boxes
- Traffic diverters and speed tables
- Median refuge islands
- High visibility crosswalks
- Bicycle signals, signal detection, advanced warning signs, active warning beacons
- Bicycle signals, signal detection, advanced warning signs, active warning beacons
- Chicanes, curb extensions, and mini-traffic circles

CONTEXT
Neighborhood greenways are most appropriate for local streets in residential neighborhoods, mainly within suburban and general urban contexts. Ideally, such streets already feature low speeds and low traffic volumes and are part of a gridded street network rather than a discontinuous, circulation system.

IMPLEMENTATION
Neighborhood greenways are appropriate for streets in the St. Louis region that feature:

- Speeds of 25 mph or less (20 mph or less is preferred)
- Traffic volumes of fewer than 3,000 vehicles per day (below 1,500 VPD is preferred)
- Run parallel and in close proximity to major thoroughfares
- Are continuous for at least one mile and connect to other greenways and destinations (schools, libraries, parks etc.)
- Opportunities to include the design elements necessary to provide wayfinding and improve crossing opportunities at intersections

Because Neighborhood Greenways are a relatively new concept for most communities, the implementation process should be accompanied by robust neighborhood outreach, education, and public involvement campaign. Additionally, the first installation may be treated as a pilot project (see page 67) that includes substantial before/after data collection to inform future improvements to existing and future neighborhood greenways.

MAINTENANCE
Maintenance of neighborhood greenways is important so they remain attractive, safe, and functional for as wide a group of users as possible. Because of the many benefits neighborhood greenways provide, including the maintenance cost savings associated with more people walking and biking, local streets designated as neighborhood greenways should be prioritized over other residential streets in the repaving or spot improvement schedule.

As multi-modal streets, planning for neighborhood greenways should incorporate cost estimates of continued sidewalk maintenance including sidewalk ramps, signals, and crosswalks. Because neighborhood greenway corridors are typically branded as such, all signs, signals, and pavement markings should be visible and kept to a legible and safe standard.

Where used, landscaping and other stormwater management/beautification treatments must be maintained to preserve their benefits.

Finally, in climates with winter weather, municipal policy should include, if not prioritize, the plowing, sanding, and salting of neighborhood greenways.
This lowly-trafficked residential is pleasant for bicycling. However, existing traffic diverters make thru bicycle movements more challenging.

The addition of bicycle-thru access, shared use lane directional markings (sharrows) and wayfinding signs create a neighborhood greenway.
LOW-STRESS CONNECTIONS

STREET TYPE: URBAN LOCAL

1. Shared use lane markings (sharrows)
2. Bicycle diverter crossing
3. Neighborhood greenway wayfinding signs
This low-volume and low-speed residential street is already a hospitable place. However, the existing traffic diverter prevents thru-bicycle movement.

Redesigning and rebranding the street as a neighborhood greenway starts with providing bicycle and pedestrian access through the existing diverter.
Mandatory right turns for motorists and a thru bicycle pocket lane with loop signal detection makes crossing this intersection less stressful for people bicycling. *Image: Street Plans*

Neighborhood traffic circles help manage motor vehicle speed, create an opportunity for beautification/stormwater management, and help people bicyclists maintain their momentum. *Image: Street Plans*

Neighborhood greenways keep motor vehicle speeds lower than 20 mph and may include distinct signs that brand the network. *Image: Street Plans*

A median bicycle refuge and banned left-turns allow people bicycling navigate a busy arterial intersection more comfortably. *Image: Street Plans*

Chicanes that include planted rain gardens and trees help maintain watershed health and manage traffic speeds so that walking and bicycling is more comfortable. *Image: Street Plans*

Speed tables combined with high-visibility crossings can manage speeds and bring greater comfort for people walking, and bicycling. *Image: Street Plans*
DEFINITION
Parking-protected cycle tracks are on-street bike-ways located between a parking lane and the curb/sidewalk. The parked cars provide a physical buffer that separates bicycles from car traffic.

PURPOSE + BENEFITS
Parking-protected cycle tracks are intended to lower the stress of bicycle travel by providing substantial separation from moving cars. Parking-protected cycle tracks are more attractive to bicyclists than conventional bicycle lanes because they reduce the fear of colliding with passing vehicles; reduce the risk of ‘dooring’; and reduce the risk of the bicyclist being run over by a motor vehicle if they have a collision with an unforeseen impediment or obstacle, such as an opening door, pothole, or pedestrian.

The design of parking-protected cycle tracks also prevents double-parking in the bikeway, a common problem associated with conventional bicycle lanes. Finally, parking-protected cycle tracks are fairly inexpensive to implement because they creatively re-allocate existing street space without having to construct new curbs, sidewalks, pavement, or other costly infrastructure.

DESIGN ELEMENTS
Parking-protected cycle tracks feature a variety of unique design elements. By definition, the cycle track is located between a “floating” parking lane and the curb/sidewalk. The bicycle lane should have a minimum width of 5 feet (not including the gutter pan) and include a buffer (striped, curb, etc.) of at least 3 feet in width. If the buffer area is striped, then diagonal (45 or 60 degree) angled cross-hatching or chevron markings should be used to clearly delineate the buffer zone. The bike lane portion should be bordered by two solid 4” – 8” white line. In some contexts, protected cycle tracks may feature a “mixing zone”. A mixing zone is where the cycle
track merges with right-turning vehicles as both that approach the intersection; its purpose is to encourage right-turning motorists to yield to through-moving bicyclists. Mixing zones should begin at least 30 feet from the intersection and use best practices for sign and pavement marking type and placement. (See page 27 for a variety of other appropriate treatments.)

CONTEXT
Parking-protected cycle tracks are suitable within suburban, general urban, urban center, and urban core contexts. They may be considered along collector and arterial thoroughfares that include parallel parking, an ADT (Average Daily Traffic) count in excess of 10,000, and where a minimal number of driveways, curb cuts, and/or minor street crossings occur.

IMPLEMENTATION
Parking-protected cycle tracks are appropriate for streets in the St. Louis region that feature:

• Potential for or existing high numbers of bicycles
• Motor vehicle travel speeds exceed 30 mph
• High motor vehicle volumes, parking turnover, and/or high amounts of truck or bus traffic

When some or all of the above conditions exist, parking-protected cycle tracks should be considered as an alternative to an existing or proposed conventional bicycle lane. The determination of feasibility will require an analysis of existing curb-to-curb width, traffic volumes, and/or movement/parking lanes that are wide enough to be reduced in number and width to allow for a parking-protected cycle track (see pages 40-45, 69 for more information about road diets).

When proceeding with parking-protected cycle tracks, potential intersection conflicts can be effectively mitigated by removing one or several parking spaces closest to the intersection, adding peg-a-tracking (parallel dashed lines and chevrons outlining the trajectory of the bicycle lane) through the intersection, creating mixing zones, and the use of other signalized intersection treatments. Special consideration should also be given to accessibility for the disabled and how the bikeway interacts with any existing or planned bus or rail transit.

Compared to raised cycle tracks (see page 28), parking-protected cycle tracks are relatively inexpensive and easy to implement. As such, they may be developed initially as pilot projects (see page 67) so that operational and design challenges may be addressed before investing in long-term, permanent infrastructure.

MAINTENANCE
The following may be required to maintain safe and attractive parking-protected cycle track facilities:

• All signs, pavement, markings, and signals should be visible and kept to a legible and safe standard.

• Special snow removal and street sweeping equipment may be needed if the combined width of the cycle track (including the buffer) is too narrow for existing street maintenance equipment. In order to avoid snowmelt across the cycle track, snow removal should minimize the creation of snow banks in the buffer zone.

• Bollards or flexible delineators may be removed in winter to provide improved access for snow removal equipment.

• Due to falling leaves, street sweeping may have to be done more frequently in the fall.
The addition of a parking-protected cycle track and pedestrian refuge islands provide low-stress connections for people bicycling and walking.

BEFORE

Five lanes of moving traffic and wide underutilized parking lanes leave little space for bicycling and make crossing the street on foot a daunting task.

AFTER
LOW-STRESS CONNECTIONS

STREET TYPE: URBAN ARTERIAL

1. Colored pavement highlights parking-protected cycletrack
2. Buffer space with planters
3. Landscaped pedestrian refuge island
4. Peg-a-tracking
5. Bicycle detection + bicycle signal
Automobile space: 76%
People space: 24%

This wide suburban arterial right-of-way has been designed with little consideration for non-motorized mobility or economic value capture. The streets could be redesigned to still move high volumes of automobile traffic while also providing a more balance for people bicycling, walking, and waiting for the bus.

Automobile space: 62%
People space: 38%

The street design shown above is more balanced, as it provides a low-stress parking-protected bicycle lane and pedestrian safety refuge islands for people walking across this busy arterial street.
Other Parking-Protected Cycle Track Treatments

Mixing Zones increase the visibility of bicyclists as they approach the intersection and facilitate safe right-turns. *Image: Street Plans*

Colored pavement may be used to further define the cycle track. *Image: Street Plans*

Where motor vehicle turning movements are prohibited, pedestrian refuges provide more comfort for people walking and provide landscaping opportunities. *Image: Street Plans*

Separate signal phases for people walking and bicycling reduce stress and conflicts at intersections. *Image: Street Plans*

This parking-protected bikeway further substantiates the buffer between the parked cars and passing bicyclists. *Image: Street Plans*

This parking-protected cycle track includes high-visibility crosswalks, peg-a-tracking and a temporary pilot pedestrian refuge help complete *Image: Street Plans*
DEFINITION
Raised cycle tracks are bikeways separated from motor vehicle traffic and may be elevated to the sidewalk level or exist at a height between the sidewalk and the pavement. Many are paired with a furnishing or landscape zone and include amenities like benches, bike racks, and plants located between the cycle track and motor vehicle travel lane and/or pedestrian area. A raised cycle track may allow for one-way or two-way travel by bicyclists.

PURPOSE + BENEFITS
Similar to parking-protected cycle tracks, raised cycle tracks are intended to relieve the stress of bicycle travel by providing complete physical separation from motor vehicle traffic. When designed properly, raised cycle tracks provide the most comfort for all bicyclists.

Raised cycle tracks are more attractive to users than conventional bicycle lanes and parking-protected cycle tracks because they eliminate the fear of collision with vehicles and the risk of ‘dooring’. Raised cycle tracks also help remedy other safety and operational issues associated with conventional bicycle lanes, like double parking. These benefits help explain why bicycle use increases, sometimes dramatically, after separated facilities like raised cycle tracks are implemented.

Raised cycle tracks also provide opportunities to add valuable streetscape amenities, such as tree plantings, public art, rain gardens, and bicycle racks. These amenities combined can create a strong identity for neighborhood districts that lead to a host of community and economic benefits. A study conducted by the New York City DOT reveals that projects with cycle tracks can lead to increased retail sales.

A RECENT STUDY FOUND THAT BICYCLING ON SEPARATED FACILITIES LIKE CYCLE TRACKS IS SAFER THAN RIDING ON STREETS WITHOUT BICYCLE FACILITIES. CYCLISTS WERE ALSO 2.5 TIMES MORE LIKELY TO RIDE ON THE CYCLE TRACKS THAN ON THE STREETS.

The Cultural Trail in downtown Indianapolis is a national precedent for using bicycle and pedestrian infrastructure to create public health, economic, environmental and social benefit. Image: Flickr user walkingsf.
DESIGN ELEMENTS

Raised cycle tracks include a variety of potential design options and elements. Such lanes may be implemented at two different vertical levels—at the level of the adjacent sidewalk, or at an intermediate level between the adjacent street and the sidewalk, to further separate the cycle track from the pedestrian area.

One-way raised cycle tracks should be a minimum of 5 feet in width. When placed adjacent to a travel lane, they should include a mountable curb to allow entry and exit from the bikeway so that bicyclists may make turns onto intersecting streets. The mountable curb width should not be considered part of the bikeway’s width.

Surface material may be pavement, concrete, or similarly durable hardscape material. Raised cycle tracks may also be separated from adjacent sidewalks and parallel-parked cars by low-lying planting zones, physical barriers, street furniture, and other amenities. For a variety of other appropriate low-stress treatments turn to page 33 for images and additional summary descriptions.

CONTEXT

Raised cycle tracks are suitable for select corridors within suburban, general urban, urban center, and urban core contexts. They may be considered for collector and arterials with ADT (Average Daily Traffic) counts in excess of 10,000, and where a minimal number of driveways, curb cuts, and/or minor street crossings occur.

IMPLEMENTATION

Raised cycle tracks are appropriate for streets in the St. Louis region that feature:

- Potential for or existing high volume of bicycles
- Motor vehicle travel speeds exceeding 30 mph
- High parking turnover
- High motor vehicle volumes, and/or high amounts of truck or bus traffic
- Connectivity between noted destinations and corridors of local and regional importance

When some or all of the above conditions exist, raised cycle tracks may be considered as a serious alternative to conventional shoulders, wide shared lanes, or conventional bicycle lanes. At intersections, raised cycle tracks may be designed to descend to street level through the intersection and ascend back to sidewalk level on the other side of the intersection. Alternatively, they may remain at sidewalk level through intersections. Peg-a-tracking intersection markings and dedicated bicycle signals may be used to increase visibility and to reduce conflicts.

Special consideration should also be given to accessibility for the disabled and bikeway interaction with existing or planned bus or rail transit. Finally, special consideration should also be given to accessibility for the disabled and how the facility interacts with any existing bus or rail transit.

MAINTENANCE

While more expensive to construct initially, raised cycle track maintenance is fairly straightforward.

- All signs, pavement, markings, and signals should be visible and kept to a legible and safe standard and should be kept free of pavement damage, broken glass, and other debris.

- Normal sidewalk snow removal and sweeping equipment may be used; there should be enough space between the adjacent street and the bikeway so that snow is not stored on the raised cycle track.
EXISTING

Removing a travel lane in each direction slows traffic and allows a top-notch raised cycle track to be implemented alongside a variety of other amenities.

AFTER

Wide sidewalks and mixed-use urban buildings put many destinations within close proximity, however there are no dedicated bicycle facilities.

Removing a travel lane in each direction slows traffic and allows a top-notch raised cycle track to be implemented alongside a variety of other amenities.
LOW-STRESS CONNECTIONS
STREET TYPE: SUBURBAN LOCAL
1. Raised cycle track
2. Bioswale
3. Bicycle parking
4. Planted median / pedestrian refuge
This wide urban right-of-way has been designed to move as many cars as possible, without concern for pedestrian access or bicycle mobility. Given the mixed-use “main street” building forms and land use patterns the current street design is inappropriate and preventing realization of the street’s economic, social, and environmental potential.

The street design shown above is much more appropriate for the land use context, as it provides a variety of low-stress amenities for people walking and bicycling along and across the street. The proposed median with shade trees, bioswale buffer, and bicycle parking are valuable amenities that help boost retail sales and provide a stronger ‘sense of place.’
OTHER RAISED CYCLE TRACK TREATMENTS

Raise cycle track ramps should be clearly marked. *Image: Street Plans*

This advanced warning sign alerts bicyclists to slow at the cycle track’s terminus. *Image: Street Plans*

The visibility of this two-way cycle track is enhanced by curb extension rain gardens and pavement coloration at the end/start of each block. *Image: Street Plans*

Peg-a-tracking, a bicycle signal, and banned left-turns limit intersection conflicts and help manage access onto this raised cycle track. *Image: Street Plans*

To avoid delay and conflicts with passengers loading and unloading, this cycle track is routed between the station and the sidewalk. *Image: Street Plans*

Overly wide skip lines and a well-placed bicycle symbol warn people driving and bicycling about a potential conflict zone. *Image: Street Plans*
DEFINITION
Buffered bicycle lanes are conventional bicycle lanes that include a painted buffer separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane.

PURPOSE + BENEFITS
Buffered bicycle lanes provide a buffer between people biking and walking, and people driving or exiting from parked cars. They are intended to provide additional comfort for a wider range of existing and potential bicyclists and drivers exiting parked vehicles.

Additional benefits include providing space for people bicycling to pass each other without moving into the adjacent motor vehicle travel lane, and encouraging people to ride outside the door zone when the buffer is between parked cars and the bicycle lane.

DESIGN ELEMENTS
Buffered bicycle lanes feature the same basic features (stripes, markings, and signs) as conventional bicycle lanes, but also include some or all of the following design elements:

- A striped buffer area of at least 18” in width that is bordered by two solid 4” – 8” white lines
- If the buffer area is 3’ in width or wider, then diagonal (45 or 60 degree) angled cross-hatching or chevron markings should be used to clearly

A buffered bicycle lane provides extra space between motorists and bicyclists. Image: Mike Lydon

A curbside bicycle box with green colored pavement, as applied to a residential street. Image: Mike Lydon

FEWER BICYCLE-MOTOR VEHICLE CONFLICTS CAN BE EXPECTED FOR AN INTERSECTION WITH A BIKE BOX.
delineate the space and discourage people from driving across it.

• The buffer area may be comprised of a different, bicycle-friendly paving material to more clearly delineate the bicycle lane from the adjacent motor vehicle movement lane.

Buffered bicycle lanes may also be paired with other low-stress bikeway enhancements featured in this guide, including, but not limited to, the bicycle box, peg-a-tracking, bicycle signals, loop detectors, and colored pavement treatments (see a sample of additional treatments and configurations on page 39).

**CONTEXT**

Buffered bicycle lanes are suitable wherever conventional bicycle lanes exist or are being considered. This includes suburban, general urban, urban center, and urban core contexts, along urban and suburban arterial thoroughfares, urban and suburban collectors, and certain urban local streets.

**IMPLEMENTATION**

Buffered bicycle lanes are commonly implemented as part of a “road diet” project. Road diets reallocate roadway space to increase space for walking or bicycling. They are typically done following a traffic analysis demonstrating that removing travel lanes will cause little to no travel delay or safety concerns. Where the removal of a motor vehicle lane is not advised, simply narrowing the striped width of the existing travel and/or parking lane(s) may free up enough space to add a striped buffer to existing conventional bicycle lanes with little to no impact on the safety or efficiency of motor vehicle travel.

Road diet and re-striping projects are most commonly programmed into a municipality’s roadway resurfacing project schedule and therefore can be done incrementally and relatively inexpensively. The following conditions are also appropriate for buffered bicycle lane implementation:

• A conventional bicycle lane is being considered and the thoroughfare right-of-way width allows for the inclusion of a striped or material buffer.

• People bicycle in contextually high volumes and/or must endure motor vehicle travel speeds of 30 mph or higher, motor vehicle volumes exceed 10,000 ADT, and/or high amounts of truck or bus traffic are present.

• Traffic volumes are low enough and/or travel lanes are wide enough to allow for the removal of one or more travel lanes to convert them into a buffered bicycle lane(s).

• Locations where adjacent curbside parking turnover rates are particularly frequent due to loading zones or drop-off/pick-up patterns at hotels, schools etc. In such cases, the buffer should be placed between the parking lane and the bicycle lane.

**MAINTENANCE**

Buffered bicycle lanes may require additional re-striping maintenance due to the greater use of pavement markings and materials used to delineate the buffer. Like conventional bicycle lanes, routine maintenance should keep the lanes free of potholes, broken glass, and other roadway debris and impediments. Markings and striped lines should be maintained to a legible standard for bicyclists and motorists. Due care should also be taken to clear all bicycle lanes of snow and ice during inclement winter weather.
The replacement of excess vehicular space with buffered bicycle lanes, high-visibility crosswalks, and a pedestrian refuge safety median.

A conventional suburban arterial and collector intersection with narrow sidewalks, barely visible crosswalks, and no bicycle facilities.
LOW-STRESS CONNECTIONS

STREET TYPE: SUBURBAN ARTERIAL

1. High-visibility crosswalk
2. Tactile warning ramps
3. Buffered bicycle lane with green colored pavement
4. Sidewalk curb extension (bumpout)

5. Peg-a-tracking
6. Bike box with green colored pavement
7. Planted median / pedestrian refuge
An auto-dominated intersection that does the bare minimum to accommodate people walking and nothing to accommodate bicycling.

A balanced and attractive intersection capable of moving high volumes of people on foot, by bicycle, and by car.
Buffered bicycle lanes can provide more visual definition and facility clarity than shoulders along high-speed rural roadways. *Image: Street Plans*

The buffer may be placed on either side of the bicycle lane, or both. In this instance, the regularity of school pick-ups and drop-offs warranted a parking lane-side buffer. *Image: Street Plans*

Cobble stones or other materials are often used to delineate the buffer zone. *Image: Street Plans*

Located at a “T” intersection, this bicycle box facilitates safe left-turn movement by bicyclists leaving the buffered bicycle lane. *Image: Street Plans*

A bike box with red colored pavement is being piloted along a multi-lane arterial roadway near downtown Madison, WI. *Image: Street Plans*

Green colored pavement is used to highlight the presence of the bike box and intersection peg-a-tracking. *Image: ITDP*
DEFINITIONS
A road diet is the conversion of underutilized or unwanted motor vehicle space into other uses. Road diets reduce the width of existing travel lanes (lane diet), and/or reduce the total number of travel lanes in order to make way for a wide variety of landscaping, bicycle, transit, and walking facilities.

High-visibility mid-block crossings utilize bold design treatments that alert people driving to expect to see people crossing the street at desirable, non-intersection locations.

PURPOSE + BENEFITS
Road diets increase safety and access for all street users by creating facilities that encourage walking, biking, and transit use. Extensive research demonstrates that road diets and the accompanying street redesign lowers vehicular speeds and the number and severity of crashes. Road diets also lead to increased walking and bicycling and deliver community quality-of-life benefits such as improved aesthetics and stronger community identity. When applied to commercial streets, road diets can create positive economic impacts for local merchants.

High-visibility mid-block crossings are intended to emphasize the primacy of people walking by helping them cross streets conveniently and predictably at desirable locations. Research conducted by the Federal Highway Administration (FHWA) demonstrates that high-visibility crossings have been shown to increase motorist yielding and help direct pedestrians to safe crossing locations. When such crossings are added to road diets:

- The total number of collisions went down 31 percent and collisions resulting in an injury went down 73 percent.
- Collisions between cars and cyclists went down to zero.

Hamburg, NY put their main street on a diet with new bicycle lanes and mid-block crossings. Image: flickr user Complete Streets
crossings include pedestrian median refuges, landscaping can be added to improve the environmental and aesthetic quality.

**DESIGN ELEMENTS**

Due to the wide variety of options involved with road diets, this section focuses on creating high-visibility mid-block crossings.

- High-visibility mid-block crossings utilize a variety of pavement markings, signing, and infrastructure design treatments, including, but not limited to, the following:
  - Wide longitudinal striped crosswalk markings (zebra, continental, or ladder pattern) at no less than 10 feet in width, or as wide as the adjacent sidewalk if greater than 10 feet.
  - Curb ramps for sidewalks and mid-block refuges that feature tactile warning strips per federal accessibility guidelines.
  - The use of signing, signalization, or other special treatments such as high visibility signs, rapid rectangular flashing beacons (RRFBs), special pavement materials, and/or raised crosswalks.
  - Mid-block curb extensions.
  - Decorative furniture and street lighting oriented toward the crossing.

A sample of additional treatments and configurations is available on page 45).

**CONTEXT**

High-visibility mid-block crossings are appropriate in certain suburban, general urban, urban center, and urban core contexts. They are particularly relevant along urban and suburban arterials; urban and suburban collectors; and select urban local roads where:

- Pedestrian activity is high and specific land use destinations lead to walking patterns featuring consistent mid-block crossings not served by an existing crosswalk.
- Block lengths and/or the distance between marked crossings is long (greater than 600 feet).
- Roadways are comprised of three or more lanes designated for people driving.
- Crash statistics reveal elevated collision risks between people walking and people driving.

**IMPLEMENTATION**

The design of roadways should emphasize people crossing the street as a fundamental part of daily living, not as an intrusion into the free-flow of car traffic. High-visibility mid-block crossings are not needed everywhere, but should be considered seriously as a part of road diet projects, especially in areas where known populations of senior/elderly/disabled people require extra time crossing the street.

**MAINTENANCE**

While the cost of implementing and maintaining high-visibility crossings is relatively low, they may be phased-in using low-cost temporary materials to address immediate safety concerns while capital funding is secured (see Pilot Project on page 67). Mid-block crossings may require additional striping maintenance due to the greater use of material used to improve the visibility of the crosswalk. Pedestrian refuges should be plowed and kept free of snow and ice along with adjacent sidewalks; snow should not be piled within the refuge. All traffic controls, such as flashing beacons and signals, may need routine maintenance to ensure their proper function.
A 4-lane to 3 road diet makes way for high-visibility crosswalks, including a rapid flashing beacon, median refuges, and buffered bicycle lanes.

A four-lane commercial arterial thoroughfare where crosswalks and bicycle facilities are noticeably absent.
LOW-STRESS CONNECTIONS

STREET TYPE: SUBURBAN ARTERIAL

1. High-visibility cosswalk
2. Tactile warning ramps
3. Buffered bicycle lane
4. Peg-a-tracking
5. Mid-block crossing
6. Pedestrian refuge island
7. Push-button activated rectangular rapid flashing beacons


**SECTIONS**

**BEFORE**

Automobile space: 77%
People space: 23%

A four-lane, undivided suburban arterials are the most common candidates to be retrofitted with road diets so that pedestrian and bicycle facilities may be added.

**AFTER**

Automobile space: 42%
People space: 58% (with pedestrian safety refuge islands)

The addition of buffered bicycle lanes and a high-visibility mid-block crossing transforms the corridor into a more balanced thoroughfare.
A common feature of the four-lane to three road diet is to add bicycle lanes and center-turn lanes. *Image: Flickr user Complete Streets*

“Sharks teeth,” high-visibility crosswalks and solar powered rapid flashing beacons alert people driving to be cautious of people crossing the street. *Image: Steven Vance*

Mid-block crossing with rapid flashing beacons are particularly appropriate for school zones.

Road diets may be used to develop combo bus only/bike lanes. *Image: Street Plans*

Along select corridors, road diets can include robust bikeways like this two-way parking-protected cycle track. *Image: Flickr user Derek Severson*

Push buttons allow people walking to immediately activate rapid flashing beacons. *Image: Flickr user NorthBendEric*
DEFINITIONS
A shared use path is a dual-direction path that is physically separated from motor vehicle travel lanes and usually shared by people walking, running, bicycling, and skating.

Bicycle loop detectors are in-pavement sensors that can be set to recognize the presence of a bicycle in order to advance the signal to green more quickly.

PURPOSE + BENEFITS
Shared use paths are intended to serve a variety of functions and uses, including operating as transportation routes, recreational facilities, habitat preserves and economic development tools. The benefits are well documented and include increasing the value of nearby property, influencing people to become more physically active, and preserving community open space.

While video detection is believed to be more effective, bicycle detector loops are a low-cost way to help minimize delay for bicyclists by sensing their presence at intersections.

DESIGN ELEMENTS
The design of shared use paths depends on the land use context, number of expected users, length, topography, and a variety of other factors. However, certain design elements are important for the successful and safe operation of almost all shared use paths. These include the width of the path, how intersections with roadways or other shared use paths are handled, the grade of the path, sight distances, drainage, surface
material, lighting, preventing unauthorized motor vehicle use, signage, and markings.

Bicycle detector loops are identified by a pavement marking that indicates the location of the wire, which is usually accompanied by signage explaining the marking to cyclists. The marking is a small bicycle symbol bookended by two aligned 4 x 18" white stripes placed in front of an intersection stop bar and/or the crosswalk.

Shared use paths and bicycle detector loops may also be paired with other low-stress bikeway enhancements featured in this Guide, including, but not limited to, a buffered bicycle lane, a bicycle box, peg-a-tracking, and bicycle signals. See other treatments on page 51 for more information.

CONTEXT
While shared use paths are appropriate in almost all rural to urban contexts, their application varies greatly and should be tailored to a wide variety of land use, topographic, and roadway contexts.

Bicycle detector loops may be used at most signalized intersections, but are most appropriate where the designated bikeway is located along minor collector and local streets and intersects with arterial roads.

IMPLEMENTATION
From taking advantage of unused rail corridors to utilizing existing road right-of-way or large tracts of preserved land, shared use paths are implemented in a wide variety of ways. Due to general space constraints in urban areas, shared use paths are typically developed within parks and parkways, or along underutilized or unused rail utility corridors where continuous land assembly has already taken place.

Shared use paths in more rural or suburban areas can be developed less expensively and in conjunction with residential, commercial, or park/preserve development projects. Some communities impose small sales tax increases to help develop their path systems as the St. Louis region has done through the Great Rivers Greenway tax district, while other communities require developers to build and connect the path system.

Regardless of context, Stop signs, advanced warning signs, peg-a-tracking, and bicycle refuges are just a few appropriate intersection treatments.

There are a variety of detector loop configurations, however the quadrupole loop (a figure-8 shaped wire placed in the pavement) is believed to be the most effective in recognizing the presence of bicycles. Yet the biggest challenge remains getting the bicyclist to recognize the presence of the loop and to ride close enough to the wire within the quadrupole to be detected. A number of unique pavement markings and signs have been developed to improve the recognition of detector loops. In more urban areas, where two or more bikeways intersect, detector loops may be paired with a bicycle box (see pages 34-39) to further their effectiveness.

MAINTENANCE
Shared use paths require routine maintenance so that potholes, broken glass, and other debris are addressed as quickly as possible. They should also be plowed routinely during inclement winter weather. Paths will also have to be resurfaced over the years as wear and tear reduces pavement quality.

Bicycle detector loop markings should be maintained to a legible standard for bicyclists and motorists. They should also be monitored periodically for effectiveness and tuned on an as needed basis to ensure proper function.
A shared use path meets the needs of a variety of users, while bicycle-friendly shoulders and detector loops enhance the experience for skilled cyclists.

Before
The intersection of two rural roads provides no recreational amenity or transportation option for those wanting to travel by foot or on a bicycle.
LOW-STRESS CONNECTIONS

STREET TYPE: RURAL COLLECTOR/ARTERIAL

1. Bicycle detector loop
2. Peg-a-tracking
3. Shared use path
4. Bicycle-friendly shoulder

SHARED USE PATH + LOOP DETECTORS ➔ 49
The intersection of two rural roads provides no realistic opportunities for people to walk or bicycle.

The introduction of a shared use path, peg-a-tracking, more bicycle-friendly shoulders, and bicycle detector loops creates a much more accessible and lower stress opportunities for walking and bicycling.
**OTHER SHARED USE PATH TREATMENTS**

Peg-a-tracking at this rural intersection directs bicyclists into a buffered bicycle lane or a shared use path. *Image: Street Plans*

Removable bollards ensure motor vehicles don’t mistake the path for a roadway, but also allow emergency vehicle access. *Image: Street Plans*

These symbols indicate the presence of bicycle loop detectors, which trigger the light signal so as to reduce delay for bicyclists. *Image: Street Plans*

Underpasses increase safety and reduce the user stress associated with crossing high speed rural roadways. *Image: Street Plans*

Overpasses reduce travel delay, enhance safety and comfort for users and may become a point of civic pride when well-designed. *Image: Street Plans*

When shared use paths intersect with surface streets like this suburban collector road, median refuges scaled to bicycle use provides safe at grade passage. *Image: Street Plans*
"Restore human legs as a means of travel. Pedestrians rely on food for fuel and need no special parking facilities."

- Lewis Mumford
INTRODUCTION

The following cost estimates for the low-stress bicycle and pedestrian connections in this guide were developed using averages from Missouri and Illinois state roadway projects awarded between October 2011 and November 2012. The estimates are derived specifically from projects located in counties surrounding St. Louis including Jefferson, Franklin, Gasconade, St. Charles, St. Louis, and St. Louis City. These are primarily the counties in the St. Louis MoDOT regional district. Illinois costs were gleaned from a broader region, including the counties of Pike, Calhoun, Scott, Greene, Jersey, Madison, St. Clair, Monroe, Sangamon, and others within 100 miles of St. Louis.

The projects used for source estimates were not necessarily bicycle infrastructure projects due to limited data. Costs of each individual component – curbing, striping, signals, median refuges, etc. – were combined to create reasonable estimates for what the proposed low-stress bicycle and pedestrian connections contained in this guide might cost in the near future.

The companion maintenance costs were estimated in the same manner as construction costs using individual components. Sources included the Missouri DOT Tracker, April 2013; the Meet MoDOT publication; and the Green Values “National Stormwater Management Calculator.” In some cases, maintenance costs were considered proportionate to the estimated construction costs. Maintenance costs shown are only the additional costs associated with the improvements in the below tables, and take into account savings from removal of some roadway elements through road diets.

While it is reasonable to assume that construction and maintenance costs may continue to grow in the future, the benefits of investing in these bicycle and pedestrian connections outweigh the costs by providing a significant return on investment. See Chapter 4 for more information on the benefits of bicycle and pedestrian infrastructure.
### NEIGHBORHOOD GREENWAY

Creating bicycle access through existing traffic diverters, shared lane bicycle markings, and signage as shown in Chapter 1 are included in the below estimate as well as additional treatments that could be used to calm traffic and eliminate excessive stop signs for bicyclists. It should be noted that the top-branded neighborhood greenway sign cannot be paid for by Federal funding because it is not a standard sign in the Manual of Uniform Traffic Control Devices (MUTCD). However, the directional signage underneath the top sign meets MUTCD standards and is therefore eligible for Federal funding.

The combined, per mile cost listed below assumes one crossing, one traffic circle, and one neckdown is placed at an average of every 2000 feet (2.6 per mile), and chicanes with and without landscaping every 1000 feet (5.3 per mile). Shared lane markings are assumed to be paired with signage, placed every 250 feet, on both sides of the street (21 pairings per mile). See Chapter 1, page 16 for imagery and a more detailed description of these treatments.

#### PHOTO-ILLUSTRATION TREATMENTS

<table>
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<tr>
<th>Treatment</th>
<th>Cost</th>
<th>Units Per Mile</th>
<th>Total Cost Per Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bike crossing through diverter</td>
<td>$3,000</td>
<td>2.6</td>
<td>$7,000</td>
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<td>Signage + pavement markings (Wayfinding signs + “Bicycles May Use Full Lane”) and shared lane markings on both sides of the street</td>
<td>$3,400</td>
<td>21</td>
<td>$72,000</td>
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#### OTHER POTENTIAL TREATMENTS

<table>
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<th>Treatment</th>
<th>Cost</th>
<th>Units Per Mile</th>
<th>Total Cost Per Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>One chicane with no landscaping</td>
<td>$1,600</td>
<td>5.3</td>
<td>$8,000</td>
</tr>
<tr>
<td>One chicane with rain garden</td>
<td>$3,000</td>
<td>5.3</td>
<td>$16,000</td>
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<td>Traffic circle</td>
<td>$10,000</td>
<td>2.6</td>
<td>$26,000</td>
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<tr>
<td>Neckdown (2 corner curb extensions)</td>
<td>$8,000</td>
<td>2.6</td>
<td>$21,000</td>
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**COMBINED TREATMENT COSTS**

$150,000

#### ANNUAL MAINTENANCE PER MILE

<table>
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<tr>
<th>Treatment</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Signage and shared lane markings</td>
<td>$2,600</td>
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<tr>
<td>Traffic circle</td>
<td>$600</td>
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<tr>
<td>Chicane with rain garden</td>
<td>$500</td>
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**TOTAL ANNUAL MAINTENANCE COSTS**

$3,700
### PARKING-PROTECTED CYCLE TRACK

**PHOTO-ILLUSTRATION TREATMENTS**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Cost</th>
<th>Units Per Mile</th>
<th>Total Cost Per Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stripping (5’ Bike lane with 5’ buffer on both sides of the street, parking lane, center turn lane)</td>
<td>$212,000</td>
<td>-</td>
<td>$212,000</td>
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<tr>
<td>Green paint for bike lanes and conflict zones on both sides of the street (100’ segment)</td>
<td>$9,000</td>
<td>52.8</td>
<td>$467,000</td>
</tr>
<tr>
<td>Pedestrian refuges</td>
<td>$36,000</td>
<td>5.3</td>
<td>$188,000</td>
</tr>
<tr>
<td>High visibility crosswalks for all crossings at each intersection</td>
<td>$7,000</td>
<td>5.3</td>
<td>$35,000</td>
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<tr>
<td>Bike signals with video detection</td>
<td>$34,000</td>
<td>5.3</td>
<td>$178,000</td>
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<tr>
<td><strong>COMBINED TREATMENT COSTS</strong></td>
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<td>$1,080,000</td>
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**ANNUAL MAINTENANCE PER MILE**

<table>
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<th>Treatments</th>
<th>Cost</th>
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<tr>
<td>Roadway striping</td>
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<td>Green paint for bike lanes</td>
<td>$13,000</td>
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<tr>
<td>High-visibility crosswalks</td>
<td>$300</td>
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<tr>
<td>Pedestrian refuges (landscaping, curb, etc.)</td>
<td>$1,000</td>
</tr>
<tr>
<td>Bike signal with video detection</td>
<td>$5,000</td>
</tr>
<tr>
<td><strong>TOTAL ANNUAL MAINTENANCE COSTS</strong></td>
<td>$21,000</td>
</tr>
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</table>

The colored bicycle lanes account for a significant portion of the combined construction cost, and also the majority of maintenance costs. Several different coloring products are currently on the market with widely varying life spans, so the actual maintenance costs will vary depending on the product specified per project. If the roadway is being resurfaced, color can also be added to the asphalt mix instead of applying paint afterwards. Motor vehicle traffic volumes also affect the durability of colorization products, particularly where there are high numbers of vehicles crossing the bicycle lane. See Chapter 1, page 22 for imagery and a more detailed description of these treatments.

This estimate is similar to those that include buffered bike lanes, though the configuration is different. The key difference is the addition of bike signals with video detection, intersection pedestrian refuges located in the buffer area/parking lane, and green painted bike lanes along the length of the bicycle facility. The green bike lane per mile cost assumes continuous green, including painting through intersections—a conflict zone. In some projects, only conflict zones are painted. Coloring the entire length of the bike lane would require 52.8 units of 100’ segments, resulting in a per mile cost of $467,000. Pedestrian refuges, high visibility crosswalks, and bicycle signals with video detection are assumed at intersections every 1000 feet (5.3 per mile). Peg-a-tracking costs are negligible and were therefore omitted.
RAISED CYCLE TRACK

Greatly enhancing the quality of bicycle facilities can have high upfront costs, but can lead to great economic returns for a community. The premium, raised cycle track shown includes the conversion of a 5-lane section into a street divided by a median that would include bicycle signals at each intersection. While some cycle tracks would widen the sidewalk, move the curb line, and adjust drainage structures, this was not included in the estimate. A less expensive cycle track, as estimated in the table, could be installed by keeping the curb line and providing gaps in the buffer area for water to flow to the existing drainage structures.

The bike signal was estimated with video detection, which performs better than using basic loops with bicycle stencil markings, yet costs about $15,000 more per intersection. The combined per mile cost assumes one intersection every 1000 feet will be outfitted with bike signals (5.3 per mile).

See Chapter 1, page 28 for imagery and a more detailed description of these treatments.

<table>
<thead>
<tr>
<th>PHOTO-ILLUSTRATION TREATMENTS</th>
<th>COST</th>
<th>UNITS PER MILE</th>
<th>TOTAL COST PER MILE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raised cycle track on each side of the street</td>
<td>$1,500,000</td>
<td>-</td>
<td>$1,500,000</td>
</tr>
<tr>
<td>Landscaping</td>
<td>$332,000</td>
<td>-</td>
<td>$332,000</td>
</tr>
<tr>
<td>12’ wide median with trees</td>
<td>$1,130,000</td>
<td>-</td>
<td>$1,130,000</td>
</tr>
<tr>
<td>Bike signals with video detection</td>
<td>$34,000</td>
<td>5.3</td>
<td>$34,000</td>
</tr>
<tr>
<td><strong>COMBINED TREATMENT COSTS</strong></td>
<td></td>
<td></td>
<td><strong>$3,140,000</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ANNUAL MAINTENANCE PER MILE</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscaping maintenance</td>
<td>$23,000</td>
</tr>
<tr>
<td>Median (landscaping, curb, etc.)</td>
<td>$2,000</td>
</tr>
<tr>
<td>Bike signals with video detection</td>
<td>$5,000</td>
</tr>
<tr>
<td><strong>TOTAL ANNUAL MAINTENANCE COSTS</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Buffering Bike Lane + Bike Box

#### Photo-Illustrations Treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cost</th>
<th>Units Per Mile</th>
<th>Total Cost</th>
<th>Per Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Striping (6’ bike lane with 4’ buffer on both sides of the street)</td>
<td>$115,000</td>
<td>-</td>
<td>$115,000</td>
<td></td>
</tr>
<tr>
<td>Green paint for bike lanes</td>
<td>$11,000</td>
<td>52.8</td>
<td>$560,000</td>
<td></td>
</tr>
<tr>
<td>2’ widening for bike lane on one side of the street</td>
<td>$91,000</td>
<td>-</td>
<td>$91,000</td>
<td></td>
</tr>
<tr>
<td>Sidewalk widening, moving curb</td>
<td>$1,040,000</td>
<td>-</td>
<td>$1,040,000</td>
<td></td>
</tr>
<tr>
<td>10’ Median with trees and landscaping</td>
<td>$1,090,000</td>
<td>-</td>
<td>$1,090,000</td>
<td></td>
</tr>
<tr>
<td>High visibility crosswalks for all crossings at each intersection</td>
<td>$7,000</td>
<td>10.6</td>
<td>$70,000</td>
<td></td>
</tr>
<tr>
<td>Green bike boxes at each intersections</td>
<td>$12,000</td>
<td>10.6</td>
<td>$125,000</td>
<td></td>
</tr>
<tr>
<td>Bulbouts for side street intersection (one side of each corner, all four corners)</td>
<td>$4,000</td>
<td>10.6</td>
<td>$43,000</td>
<td></td>
</tr>
<tr>
<td><strong>Combined Treatment Costs</strong></td>
<td><strong>$3,130,000</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Annual Maintenance Per Mile

<table>
<thead>
<tr>
<th>Maintenance Per Mile</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffered bike lane striping</td>
<td>$1,000</td>
</tr>
<tr>
<td>Green paint for bike lanes</td>
<td>$15,000</td>
</tr>
<tr>
<td>Widened roadway section</td>
<td>$1,000</td>
</tr>
<tr>
<td>Median (landscaping, curb, etc)</td>
<td>$2,000</td>
</tr>
<tr>
<td>High visibility crosswalks</td>
<td>$600</td>
</tr>
<tr>
<td>Green bike boxes</td>
<td>$4,000</td>
</tr>
<tr>
<td><strong>Total Annual Maintenance Costs</strong></td>
<td><strong>$24,000</strong></td>
</tr>
</tbody>
</table>
costs are negligible and were therefore omitted. See Chapter 1, page 34 for imagery and a more detailed description of these treatments.

This estimate shows bike boxes at $6,000 each. Madison, Wisconsin installed colored bike boxes at several intersections in May 2010, at a cost of approximately $8,000 each. Accounting for some size variations, this indicates that the Green painted bike boxes (and lanes) estimate is consistent with regional costs for similar products.

INVESTING IN HIGH-QUALITY INFRASTRUCTURE

The Indianapolis Cultural Trail is a good example of a premium cycle track built in the Midwest. It flush with the sidewalk and required numerous small sub-projects where the curb had to be moved outwards to properly accommodate people walking and bicycling.

The cultural trail is 8 miles long and connects several neighborhoods. The total project cost $63 million — approximately $7.9 million per mile.
## ROAD DIET + MIDBLOCK CROSSING

<table>
<thead>
<tr>
<th>PHOTO-ILLUSTRATION TREATMENTS</th>
<th>COST</th>
<th>UNITS PER MILE</th>
<th>TOTAL COST PER MILE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Striping (Bike lane with 3’ buffer on both sides of the street, parking lane, center turn lane)</td>
<td>$160,000</td>
<td>-</td>
<td>$160,000</td>
</tr>
<tr>
<td>Pedestrian refuge island</td>
<td>$8,000</td>
<td>1</td>
<td>$8,000</td>
</tr>
<tr>
<td>High visibility crosswalk</td>
<td>$1,300</td>
<td>1</td>
<td>$1,300</td>
</tr>
<tr>
<td>Rapid rectangular flashing beacons</td>
<td>$13,000</td>
<td>1</td>
<td>$13,000</td>
</tr>
</tbody>
</table>

**COMBINED TREATMENT COSTS**

$182,000

<table>
<thead>
<tr>
<th>ANNUAL MAINTENANCE PER MILE</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway Striping</td>
<td>$1,000</td>
</tr>
<tr>
<td>Rapid rectangular flashing beacon</td>
<td>$1,000</td>
</tr>
</tbody>
</table>

**TOTAL ANNUAL MAINTENANCE COSTS**

$2,000

## ROAD DIET + MIDBLOCK CROSSING

The proposed treatments are primarily a restriping effort, which can be combined with any future routine resurfacing projects. Since the lanes are being narrowed in order to include bike lanes, the restriping cost includes striping for the center turn lane, the parking lanes, and the buffered bike lanes on both sides. The mid-block crossing includes high visibility crosswalks with rapid rectangular flashing beacons (RRFB) on both sides of the street and in the pedestrian refuge islands. peg-a-tracking costs are negligible and were therefore omitted.

See Chapter 1, page 40 for imagery and a more detailed description of these treatments.
RURAL SHARED USE PATH + LOOP DETECTORS

<table>
<thead>
<tr>
<th>PHOTO-ILLUSTRATION TREATMENTS</th>
<th>COST</th>
<th>UNITS PER MILE</th>
<th>TOTAL COST PER MILE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shared use path</td>
<td>$880,000</td>
<td>-</td>
<td>$880,000</td>
</tr>
<tr>
<td>Shoulder widening</td>
<td>$450,000</td>
<td>-</td>
<td>$450,000</td>
</tr>
<tr>
<td>Loop detectors (2 per intersection)</td>
<td>$6,500</td>
<td>1</td>
<td>$6,500</td>
</tr>
<tr>
<td>Stop signs for path at intersections</td>
<td>$1,300</td>
<td>5.3</td>
<td>$7,000</td>
</tr>
</tbody>
</table>

**COMBINED TREATMENT COSTS** $1,340,000

---

ANNUAL MAINTENANCE PER MILE

<table>
<thead>
<tr>
<th>TREATMENTS</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shared use path</td>
<td>$2,000</td>
</tr>
<tr>
<td>Widened shoulder section</td>
<td>$2,000</td>
</tr>
<tr>
<td>Stop signs</td>
<td>$3,000</td>
</tr>
</tbody>
</table>

**TOTAL ANNUAL MAINTENANCE COSTS** $7,000

RURAL SHARED USE PATH + DETECTOR LOOPS

This estimate includes two facilities used separately or together: shoulder widening, though not shown in the photo-illustration, and a shared use path parallel to the roadway. The biggest variable in both of these components is the amount of available right of way and the topography of the corridor. The estimate assumes existing slopes at 1:6 (1 foot vertical for every 6 feet horizontal) away from the roadway and does not include any retaining walls. Expect higher costs where right-of-way is constrained or slopes are steeper, and lower costs in areas where slopes are flatter. Tying back into the existing slope accounts for over half of the shared use path costs. The signal detection in this estimate consisted of loop detectors with signage and pavement markings indicating to the bicyclists where to trigger the signals. Costs are estimated at one signalized intersection per mile. Since unsignalized intersections may still require path control, stop signs were estimated every 1000 feet (5.3 per mile). Peg-a-tracking costs are negligible and were therefore omitted.

See Chapter 1, page 46 for imagery and a more detailed description of these treatments.
## COST COMPARISONS

The above cost comparison numbers are from Missouri DOT Tracker, April 2013 edition for resurfacing and new construction. Because the Missouri DOT does not publish average widening or lane addition costs, these numbers were estimated using FHWA’s Highway Economic Requirement System (HERS).

<table>
<thead>
<tr>
<th>Neighborhood Greenway ($150,000)</th>
<th>Parking-Protected Cycle Track ($178,000)</th>
<th>Road Diet + Midblock Crossing ($182,000)</th>
<th>Shared Use Path + Detector Loops ($1,340,000)</th>
<th>Buffered Bicycle Lane + Bike Box ($3,130,000)</th>
<th>Raised Cycle Track ($3,140,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PER MILE COST COMPARISON</strong></td>
<td><strong>PER MILE COST COMPARISON</strong></td>
<td><strong>PER MILE COST COMPARISON</strong></td>
<td><strong>PER MILE COST COMPARISON</strong></td>
<td><strong>PER MILE COST COMPARISON</strong></td>
<td><strong>PER MILE COST COMPARISON</strong></td>
</tr>
<tr>
<td>Resurfacing 2-Lane Road ($264,000)</td>
<td>Resurfacing 4-Lane Road ($528,000)</td>
<td>New 2-Lane Road ($2,392,000)</td>
<td>+ 1 Lane in Each Direction (Rural) ($4,000,000)</td>
<td>New 4-Lane Road ($4,652,000)</td>
<td>+ 1 Lane in Each Direction (Urban) ($5,200,000)</td>
</tr>
<tr>
<td>Neighborhood Name</td>
<td>Built</td>
<td>Total Cost</td>
<td>Length (miles)</td>
<td>Cost per Mile</td>
<td>Elements</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------</td>
<td>------------</td>
<td>----------------</td>
<td>---------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>North Concord</td>
<td>2010</td>
<td>$185,000</td>
<td>2.57</td>
<td>$71,985</td>
<td>Added stop signs, turned stop signs at minor intersections, added speed bumps, added shared lane markings, crossing improvements</td>
</tr>
<tr>
<td>SW Westwood</td>
<td>2010</td>
<td>$36,000</td>
<td>.75</td>
<td>-</td>
<td>Raised crosswalk, installation of traffic island to realign roadway, shared lane markings</td>
</tr>
<tr>
<td>NE Holman</td>
<td>2011</td>
<td>$530,000</td>
<td>2.01</td>
<td>$263,000</td>
<td>Pocket park expansion and diverter, crossing improvements, speed bumps, turned stop signs at minor intersections</td>
</tr>
<tr>
<td>North Portland Connector</td>
<td>2011 - 2012</td>
<td>$400,000</td>
<td>3.28</td>
<td>$122,000</td>
<td>Pathway connection to existing trail, crossing improvements, barrier, crosswalks, peninsula, stop sign, speed bumps, shared lane markings</td>
</tr>
</tbody>
</table>

**CASE STUDY: PORTLAND**

The City of Portland, Oregon is a pioneer in designing and implementing neighborhood greenways. Neighborhood greenways there generally cost around $122,000 per mile and their bike plan budgets for $250,000 per mile.

*Small interventions make a big difference along Portland’s neighborhood greenways. Image: City of Portland*
“This is something everyone knows: A well-used city street is apt to be a safe street. A deserted city street is apt to be unsafe.”

- Jane Jacobs
PRIORITIZING INTERSECTIONS

INTRODUCTION
FHWA research shows 40% of all reported crashes occur at intersections. Prioritizing the design of intersections to safely accommodate all of modes of travel is an important aspect in developing low-stress connections.

IMPLEMENTATION STRATEGIES
Cities and towns have implemented a variety of intersection treatments/design strategies that improve the safety of people walking and bicycling. In general, safety for all users should start with reducing the speed of motorized vehicles which may be accomplished through any number of traffic-calming strategies. One of the most effective strategies overall is to reduce the paved area available for driving. Road diets (see page 40, 69) ensure that drivers travel more slowly through intersections and also reduce the distance required for people walking and bicycling to travel to cross the road.

Another design strategy is to provide well-marked or protected space in the road for pedestrians and bicyclists needing to cross the street. The bicycle box (See page 34), pedestrian refuge (see page 40), peg-a-tracking, and curb extensions are all elements that have been shown to increase visibility and decrease the risk of collisions at intersections. In addition to these design treatments, many cities have installed signals that give pedestrians a head-start when crossing the street, bicycle signals, and bicycle detection loops to improve intersection safety (see page 46).

One of the most important, cost-effective, and easy-to-implement intersection safety treatments is to ban right or left turns on red. This prevents motorists from quickly turning through an intersection when people walking should have priority.

WHY DO IT
Road diets, refuges, bicycle boxes, peg-a-tracking, banned right or left turn on red, and other low-cost treatments lead to safety gains for all users and increased rates of walking and bicycling.
PILOTING PROJECTS

INTRODUCTION
Cities typically plan infrastructure improvements years in advance, leading to significant time delay between when a need is identified and when it is addressed. Some projects are understandably complex, yet there are many low-stress improvements that can be implemented quickly and inexpensively as pilot projects. This approach allows cities to be more responsive to residents by delivering projects at the time when they are most needed, and can improve functionality and effectiveness.

IMPLEMENTATION STRATEGIES
Together with the FHWA, the City of Minneapolis is currently wrapping up a two-year pilot test of a new low-stress treatment called advisory bike lanes, which are marked with a solid white line on the right (next to parked cars) and a dotted line to the left (see photo). The markings used create flexible space that can be used in different ways, depending on whether bicyclists are present or not. Bicyclists are given space to ride, and motorists are allowed to enter the advisory bike lane if space is needed to pass oncoming vehicles.

In anticipation of upcoming street reconstruction, local planners sought to test the safety and use of the treatment before undertaking full street reconstruction. Detailed before/after safety and use data collection, a critically important part of pilot projects, revealed that overall safety increased for cyclists and motorists, and the street averaged between 300 and 400 cyclists a day.

While partnering with state or federal agencies is one way to test pilot projects, cities and citizens are more commonly undertaking short-term “tactical urbanism” projects that utilize low cost weekend, week-long, or month-long experiments intended to build public support for investing in long-term change.

WHY DO IT
Municipal planners’ ability to test, observe and implement in real time – and make adjustments if necessary before committing to permanence - leads to a more responsive and cost projects.
SIGNAL DETECTION + OPTIMIZATION

INTRODUCTION
Walking and bicycling facilities are the most visible and effective part of any low-stress network. However, providing signal detection and optimization can further reduce stress and enhance the appeal of walking and bicycling.

IMPLEMENTATION STRATEGIES
The City of Santa Cruz recently equipped over 40 signalized intersections with the ability to detect bicyclists, either through video detection or inductive loop technology (see page 46). The City tested each signal to ensure functionality, while also performing outreach to educate bicyclists on how to be properly detected at the light. In conjunction with bicycle detection, separate bicycle signals (see image above) make crossing intersections safer by clarifying when someone bicycling should cross the intersection, and by reducing conflicts with vehicles.

Similar to bicycle signals, leading pedestrian interval signals (LPIs) prioritize people walking at intersections by displaying a walk signal for a period of time before a green light is displayed for people driving. This treatment improves the visibility and safety of people walking by giving them a chance to begin crossing before people driving turn across the crosswalk.

Finally, signal timing can also be optimized along certain corridors to keep people on bicycles moving. The so-called “green wave” synchronizes traffic signals to provide a continuous green light for those bicycling at or greater than the set signal time (approximately 12 mph).

WHY DO IT
Providing signal detection and optimization for bicyclists and leading pedestrian intervals for pedestrians can significantly improve the comfort and convenience of bicycling and walking, result in fewer crashes, and produce higher rates of physical activity.
ROAD DIETS

INTRODUCTION
A road diet is the conversion of under-utilized vehicular space for other uses. Road diets reduce the width of existing travel lanes (lane diet), and/or reduce the total number of travel lanes.

IMPLEMENTATION STRATEGIES
Unlike shared streets (see page 70) or neighborhood greenways (see page 16), road diets are not intended to divert traffic, but to accommodate the existing levels of motorized traffic in less road space. Road diets help make using a street a better experience for the range of people using it, typically without restricting vehicle volumes or delaying travel times. While road diets may be applied to a variety of street configurations, including one-way streets, the most common conversion is four-lanes to three-lanes, which includes a traffic lane and a bicycle lane in each direction as well as a center median and/or a shared center turn-lane. The space made available can also allow for several of the following amenities:

- Wider sidewalks and planting zones
- Medians and pedestrian refuges
- Protected bicycle facilities
- Transit accommodations

While it varies from context to context, good candidates for four-to-three lane road diets are thoroughfares with average daily traffic (ADT) counts that do not exceed 22,000 vehicles per day.

WHY DO IT
Research demonstrates that road diets help achieve safety goals without negative transportation impacts. Studies conducted by the FHWA indicate that road diet treatments can lead to a 29% average reduction in total crashes along a route due to traffic calming, increased visibility of bicyclists and pedestrians, and the safety design elements they provide. As for economic benefits, wider sidewalks, dedicated bicycle facilities, and shade trees create a more desirable address. This helps to explain why merchants are often strong proponents for these projects, as reduced travel speeds allow for easier and safer parking, and improved walking, bicycling, and livability conditions.
SHARED STREETS

INTRODUCTION
A shared street (sometimes called shared space) uses urban design techniques to give equal priority to people walking, bicycling, and driving. They are typically narrow streets without some or all of the following elements: curbs, sidewalks, painted markings, traffic signs, and/or signalization controls.

IMPLEMENTATION STRATEGIES
To be successful and safe, shared streets must slow vehicular traffic below 20 mph, and ideally below 15 mph. Along with the removal of normal traffic control devices, slowing traffic may be accomplished by narrowing the width of the travel lane(s) and strategically placing trees, planters, parking areas, and other amenities within or directly adjacent to the street.

Shared streets are appropriate for residential street or commercial streets that do not serve as important local or regional travel routes. When considering application to the latter, high levels of foot traffic should already be commonplace and restaurants, cafes, retail shops, street vendors, and other outdoor commercial uses should already exist or be permitted.

While only a handful of cities in the U.S. have experimented fully with the shared street concept, they have been applied successfully throughout Europe. Communities looking to apply shared street designs may begin with week or weekend-long pilot projects (see pages 67, 81) to test the concept. In New York, one community in Queens spearheaded an effort to use a neighborhood street as a variation of a shared street called a play street for one day. The success of their first event led to an expanded shared street program the next year, and a permanent shared street only a few years later.

WHY DO IT
Shared streets greatly reduce crashes and provide a wide range of benefits, including the creation of streets that invite physical activity and are highly sociable for people of all ages.
MAINTENANCE AND CONSTRUCTION COSTS

INTRODUCTION
How can communities pay for and maintain low-stress connections when they have never built them before? Finding resources is a matter of priority. Though the majority of Americans overwhelmingly agree that federal dollars should maintain or increase funding for sidewalks and bike lanes, decreases in spending means communities have to be more creative in how they fund and maintain their facilities. Experience has shown that if there is enough political will for low-stress connections, a community will find a way to make it happen (see Overton Broad Connector story on page 81). Although construction and maintenance costs vary widely, they are relatively inexpensive compared to costs associated with projects focused purely on increasing vehicular mobility (see page 62 for cost comparisons). Additionally, a good number of social, economic, environmental, and health benefits accrue when communities choose to build low-stress connections, which can result in more dollars to put toward construction and maintenance.

IMPLEMENTATION STRATEGIES
Inexpensive low-stress connections can be layered easily into existing roadway maintenance programs. As a result, most communities incorporate their construction and maintenance costs into their annual budgets without incurring large increases. For more expensive low-stress connections, sales tax increases, such as the ones funding Great Rivers Greenway to build trails in the St. Louis region, and/or public-private partnerships, like the ones that created the Indianapolis Cultural Trail, can be used to source dollars.

Constructing and maintaining a safe and appealing network of low-stress bicycle and pedestrian connections is best accomplished through developing bicycle and pedestrian master plans that include realistic cost and maintenance estimates. The development of these plans should consider how building new facilities, as well as maintaining those that already exist, benefit all roadway users.
MAINTENANCE LOGISTICS

INTRODUCTION
In communities that have never built low-stress connections there are often concerns about frequency of maintenance, how their equipment will adapt to maintaining them, and other unknowns.

IMPLEMENTATION STRATEGIES
Pedestrian and bikeway concerns that need to be addressed include filling potholes and cracks and removing debris in the roadway or from the sidewalk. The presence of wet leaves, rocks, gravel, sand, snow, ice, vegetation/branches, and glass need to be handled through regular sweeping (at least seasonally) and/or plowing so that acceptable levels of service are provided to all roadway users. Additionally, any striping, pavement markings, and road signs need to be kept legible, and signals and signal actuators need to be kept in working order. Routine spot checks of the conditions above and the development of phone or web-based maintenance mapping tools can help municipalities identify and address maintenance needs as quickly as possible.

Maintaining existing roadway and bicycle and pedestrian facilities is just as important as developing new ones. Maintenance and eventual resurfacing/reconstruction projects should be considered in the life cycle cost estimates associated with developing new facilities. While most existing maintenance equipment is capable of servicing low-stress connections, consideration for maintenance equipment should be part of maintenance cost estimates.

In many communities, local maintenance agreements are developed with individual property owners, neighborhood associations, or business improvement districts (BIDs). The terms should be kept clear and oversight provided to ensure maintenance is being carried out as agreed upon.

Whether used for transportation, recreational, or utility purposes, bicycle and pedestrian facilities need to be maintained to ensure that the public dollars invested continue to leverage the myriad benefits associated with their development or expansion.
ACCOMODATING EMERGENCY RESPONSE VEHICLES

INTRODUCTION
Accommodating emergency response vehicles (police, fire, ambulance) is of critical importance when designing low-stress bicycle and pedestrian connections. There are many positive benefits associated with bicycle and pedestrian-friendly neighborhoods, including that the provision of emergency services cost less money because they are needed less often.

IMPMENTATION STRATEGIES
Emergency response professionals are key stakeholders and must be consulted in the planning, design, and implementation phases of street changes. This is also the time to clearly communicate that facilities reduce the need for crash and fatal collision responders, and can also provide more access. Because physically separated cycle tracks, for example, push the normal barrier of parked cars away from the curbside, the cycle track can also double as an emergency response access zone. Bicycle lanes, especially curbside lanes, also do not impede emergency services because there is no functional difference between two 15-foot travel lanes and two 10-foot travel lanes with two 5-foot bicycle lanes; they both provide space for people driving to yield to passing emergency vehicles. Other street design techniques like mountable street corner curbs, traffic circle aprons, and flush medians slow traffic and also provide the turning radii required by large emergency vehicles, such as fire trucks.

Municipalities should consider requiring new development to meet street connectivity standards for safety and financial reasons. Highly connected networks not only facilitate safe walking and bicycling, they reduce the need for taxpayers to shoulder the financial burden of building additional fire and police stations to maintain adequate response times. An emergency response study in Charlotte, NC found that fire stations in areas with street grids cost $159 per capita, compared to $740 in less connected areas. Emergency response services save lives, but so too does good urban design.
"The bicycle is the most efficient machine ever created. Converting calories into gas, a bicycle gets the equivalent of three thousand miles per gallon."

- Bill Strickland
INTRODUCTION

Whether you get around by foot, bike, car, bus, or train this section is intended to share some of the most compelling economic and social benefit research available. We have put together some snapshot infographics and case studies to make a simple point: the St. Louis region can’t afford not to invest in Streets for Everyone.

Most people know that biking and walking are healthy, and good for the planet. Indeed, a significant and growing body of research confirms the important role moving about by foot and on a bicycle plays in achieving public health and environmental sustainability goals.

Less well known are the many economic benefits – greater retail sales, higher property values, increased health care cost savings – that result from the development of safe, low-stress walking and biking connections. The impact of increased walking and bicycling in making our communities more accessible, equitable, and vibrant is clear. A wide variety of research demonstrates that Americans are increasingly choosing to live, work, and shop in walkable and bikeable communities.

PROPERTY VALUES

The correlation between walkable and bikeable communities and property values is becoming increasingly recognized. Shifting values, access to technology, the economy, and the price of gas have all helped move the real estate market in a new direction. Studies predict that in the next 25 years, real estate values in walking friendly communities will rise faster than non-walking friendly communities. This is exhibited in a study by the Urban Land Institute, which found that people said they would pay a $26,000 premium for homes that are located in walking friendly communities.

This research is consistent with recent work from Joe Cortright’s “Walking the Walk: How Walkability Raises Housing Values in U.S. Cities” that looked at data from 94,000 real estate transactions in 15 major markets. The findings revealed that in 13 of the 15 markets, higher levels of walkability, as measured by Walk Score, were directly linked to higher home value. More specifically, homes with above-average levels of walkability were fetching a premium of about $4,000 to $34,000 over those with just average levels of walkability.

Property values are also improved by access to trails and greenways. Single-family property values in Surrey, B.C. were 1% to 20% greater when bordering a greenway or trail. Similarly, a study of properties near greenbelts in Boulder, CO found that the average value of properties adjacent to a greenbelt/trail system were approximately 32% higher than properties located a mere 3,200 feet away from a greenbelt. The study found that housing prices declined an average of $4.20 for each foot of distance from a greenbelt for up to 3,200 feet. In the Cincinnati metro area, living near the Little Miami Trail...
brings financial benefit for homeowners and other nearby neighborhoods according to a 2011 study from the University of Cincinnati. Housing prices increased by $9.00 for every foot closer to the trail’s entrance according to the study, concluding that homeowners were willing to pay a $9,000 premium to be located 1,000 feet closer to the trail.

RETAIL SALES
A number of cities have increased retail sales for merchants by adding bikeways and pedestrian amenities in the last few years. Studies indicate the amenities help more people walk or bike in areas close to commercial businesses, thereby increasing the number of potential customers.

In Minneapolis, MN, an American city with a similar population to St. Louis, a 14% increase in retail sales was found in the same district after pedestrian improvements were made. Similar studies in Atchison, KS, Durham, NC, and Pomona, CA show all witnessed greater than 15% increases in retail sales after streets were made more attractive for walking.

Similarly, following a recent pedestrian-oriented project in downtown Lodi, CA the district added 60 new businesses,

WALKABILITY IS THE NEW REAL ESTATE PARADIGM
In the 2012 study The WalkUP Wake Up Call Christopher Leinberger explains how communities can take walkability all the way to the bank. Leinberger looks at 43 WalkUPs (walkable, urban places) in the Washington, DC area, most of which have been created in the last two decades. Although WalkUPs only occupy 1-2 percent of the D.C. land area, they generate tax revenues far out of proportion to the land they consume and they account for 29 percent of the income-producing property.

The real estate paradigm is no longer city versus suburb, it is walkable versus drivable, says Leinberger. “Up until the 1980s, drivable suburban office space commanded a premium rent over WalkUPs, but this position has reversed. There is currently a 75 percent premium for WalkUP office rent, giving such places a market advantage.”

Many of the new WalkUPs in the D.C. area are in the suburbs, including suburban town centers like Rockville and Silver Spring that have been revitalized.
One of the nation’s highest rates of women bicyclists is in the Twin Cities, where increased cycling infrastructure has led to more women on two wheels.

The increase in retail sales adjacent to New York City’s first physically-protected cycle track vs. retail sales borough-wide.

49% vs. 3%

The amount of sales growth most businesses on Greenville, SC’s new Swamp Rabbit Trail saw after it opened in 2011.

30% - 50%

its vacancy rate dropped from 18% to 6% and it produced a 30% increase in gross sales tax revenue. The project included $4.5 million to widen sidewalks; add sidewalk curb extensions at intersections; and install street trees, lighting, benches and other amenities.

In Greenville, South Carolina, the Swamp Rabbit Trail has become a catalyst for new business and increased retail revenue since opening to bikers and walkers in 2010. The 17.5 mile trail, which connects two cities and a university, had 359,000 users the year it opened and increased to 403,000 in the second year. A survey of business managers and owners that relocated near the Trail reported a 30 percent to 50 percent increase in sales. The survey found annual revenue from trail users ranged from $50,000 to $400,000.

Finally, the New York City Department of Transportation released a study in 2012 that reported retail sales increases in many of the locations where bikeway and pedestrian upgrades had been implemented. The study found that local businesses on 9th Avenue, adjacent to the city’s first parking-protected cycle track, experienced up to a 49% increase in retail sales compared to a 3% sales uptick borough-wide.
JOBS CREATED + OTHER ECONOMIC IMPACTS

Many studies show that roadway and infrastructure projects that include walking and bicycling facilities are a good way to create more construction jobs, unlock potential property value, and boost retail sales.

An analysis done by the University of Massachusetts’ Political Economy Research Institute (PERI) found a link between bicycle and pedestrian construction projects and increased job creation. PERI’s research team looked at 58 projects in 11 different American cities and found that an average of 11.4 jobs were created (within the state of the project) for every $1 million spent on bicycling infrastructure projects. The same study found that pedestrian-only based projects created 10 jobs per $1 million spent and multi-use trails create nearly as many, at 9.6 jobs per $1 million. Infrastructure that combines road construction with pedestrian and bicycle facilities creates slightly fewer jobs for the same amount of spending and road-only projects create the least, with a total of 7.8 jobs per $1 million.

Job creation and economic results were also linked in a 2003 study entitled “Pathways to Prosperity” published by the North Carolina Department of Transportation (NCDOT). Based on conservative estimates, the DOT found that a $6.7 million public investment in bicycle facilities has helped deliver an annual economic impact of $60 million in the Outer Banks. Bicycling, which is done by 17% of visitors, also helps support 1,407 jobs. The economic return of the initial expenditure has yielded an annual economic return approximately nine times the state’s annual in investment.

A study looking at the impacts of bicycling in Iowa found an approximate $3 million dollar annual investment for bicycling has helped create $435 million per year in economic activity. The economic benefits can be attributed to the following groups:

$365 million - Recreational cyclists
$52 million - Commuter cyclists
$18 million - Bicycle retailers
Walking and biking offer many benefits beyond being affordable and enjoyable transportation choices. Evidence-based research links increased levels of walking and bicycling with safer streets, reduced crashes, weight loss, and healthcare cost savings.

A 2012 Economic Analysis of Bicycling in Boston refers to the Safety in Numbers theory, which routinely reveals that as bicycle ridership increases, so does safety. Leading cities in Europe and the United States have experienced improved safety numbers for all forms of transportation alongside increased bicycle per capita ridership. The story in Boston, once ranked America’s worst city in which to cycle, is similar as ridership has doubled since 2007, while the number of reported crashes has stayed relatively flat. Cities like New York and Minneapolis have also experienced great increases in cycling while the total number of crashes has not increased or declined.

The 2012 New York City DOT study reports that the addition of parking-protected cycle tracks and pedestrian refuge islands created a 35% decrease in injuries to all street users along 8th Avenue and a 58% decrease in injuries to all street users along 9th Avenue. Similar results have been found throughout the city wherever protected bikeways and enhanced low-stress pedestrian connections have been implemented.

A 2011 cost-benefit analysis in Portland reveals that investments in bicycling are cost-effective, even when only a limited selection of benefits is considered. By 2040, Portland’s bicycling investments (estimated at $138 to $605 million) are anticipated to result in health care cost savings of $388 to $594 million, fuel savings of $143 to $218 million, and savings in value of lives lost to traffic violence of $7 to $12 billion.

The use of active transportation instead of motorized transportation has many health benefits and subsequent reductions in health care costs. Active transportation, including both walking and bicycling, reduces air pollution, increases physical activity, and increases road safety. Bicycling rather than driving prevents from being released four pounds of emissions per mile traveled. The emissions include carbon monoxide, sulfur dioxide, lead hydrocarbons, and particulates in the air that are breathed while sitting in a car or walking near a car.

Bicycling improvements to an area exhibit health benefits for both bicycle commuters and recreational riders. Health benefits and health care savings can be calculated based on achieving a sufficient level of physical activity as recommended by the Centers for Disease Control and Prevention, which is 30 minutes of moderate physical activity almost every day. The physical activity of biking exercises your lungs, heart, and muscles while helping the immune and digestive systems.

Studies find that the health benefits savings of reducing short car trips and increasing bicycling are approximately $13.3 million in Iowa for bicycle commuters and $73 million for recreational riders. This study and those similar to it exhibit the potential for bicycling improvements in an area to reduce health care costs when both commuters and recreational riders have increased access to safe and convenient bicycle infrastructure.
The Overton Broad Connector in Memphis, Tennessee will be a 2-mile, physically-protected cycle track. It’s costs are projected at $1.5 million dollars ($750,000 per mile), though the project may be completed for less.

Using the best practices of tactical urbanism, Livable Memphis, the Broad Avenue Arts District and other advocates and leaders made the homemade cycle track shown above as a means of calming traffic and bringing new life to a neighborhood. Creating a celebration around the temporary cycle track drew 15,000 people, $8 million in private investment based on the promise of a permanent cycle track, 15 new businesses and nearly 30 properties renovated, and calmed traffic.

The Overton Broad Connector is projected for completion in summer 2013. Memphis is one of six focus cities part of the Bikes Belong Foundation’s Green Lane Project.
“Cycle tracks will abound in Utopia.”

- H.G. Wells
CONCLUSION

The world is changing. We now live in the digital era, when virtually any task can be completed remotely. People are driving less and the majority now wants to live in walkable and bikeable places. These factors and others converge to put a premium on the quality of a place as the next generation looks globally to choose where to innovate, recreate, and put down roots.

There is no reason St. Louis cannot become a “place of choice” on the global stage. For three years, East-West Gateway Council of Governments has worked with municipalities, groups, and hundreds of residents to identify what it will take through OneSTL—a framework for sustainable development to lead the region into a prosperous 21st century. Low-stress bicycle and pedestrian connections relate to all of the goals within OneSTL and has particular relevance for the goals of creating an economically competitive, connected, efficient, inclusive, green, distinctive region.

Low-stress connections are about so much more than serving those who use them. They are about building economic strength and identity by connecting people, neighborhoods, destinations, and assets. Given the relatively small investment it takes to build low-stress connections, and the significant, impressive economic and community gains, we hope you will use this guide to bring high quality low-stress connections to your community.
"Better conditions for bicyclists invite more people to ride bikes...improving the conditions for pedestrians, we not only strengthen pedestrian traffic, we also — and more importantly — strengthen city life."

- Jan Gehl
WORKS CITED
The following work was referenced or the basis of the information contained within the making of the Streets for Everyone Guide:

INTRODUCTION


http://www.scientificamerican.com/article.cfm?id=getting-more-bicyclists-on-the-road

NEIGHBORHOOD GREENWAYS


**PARKING-PROTECTED CYCLE TRACK**


Active Transportation Alliance. Complete Streets, Complete Networks; A Manual for the Design of Active Transportation.

**RAISED CYCLE TRACK**


**BUFFERED BICYCLE LANE + BIKE BOX**


**ROAD DIET + MID-BLOCK CROSSING**
Active Transportation Alliance. Complete Streets, Complete Networks; A Manual for the Design of Active Transportation.


**SHARE USE PATH + DETECTOR LOOPS**


http://www.bicyclinginfo.org/engineering/paths-details.cfm

**BEST PRACTICES + COMMON CONCERNS**

http://www.minneapolismn.gov/bicycles/bicycling101/advisory-bike-lane

http://nacto.org/cities-for-cycling/design-guide/bicycle-signals/

http://www.walkinginfo.org/engineering/calming-street.cfm

http://www.americantrails.org/resources/trans/bikemaintpima.html


**COST ESTIMATES**

http://www.modot.org/about/Tracker.htm

http://www.modot.org/newsandinfo/

http://greenvalues.cnt.org/national/cost_detail.php

http://www.fhwa.dot.gov/asset/hersst/pubs/tech/tech00.cfm

**BENEFITS**


U.S. Department of Transportation, 2009 National Household Travel Survey
In the U.S., 24% of all bicycle trips are made by women and 76% are made by men.


http://greenvillerec.com/studies-surveys
