

# Stop-Controlled Intersections

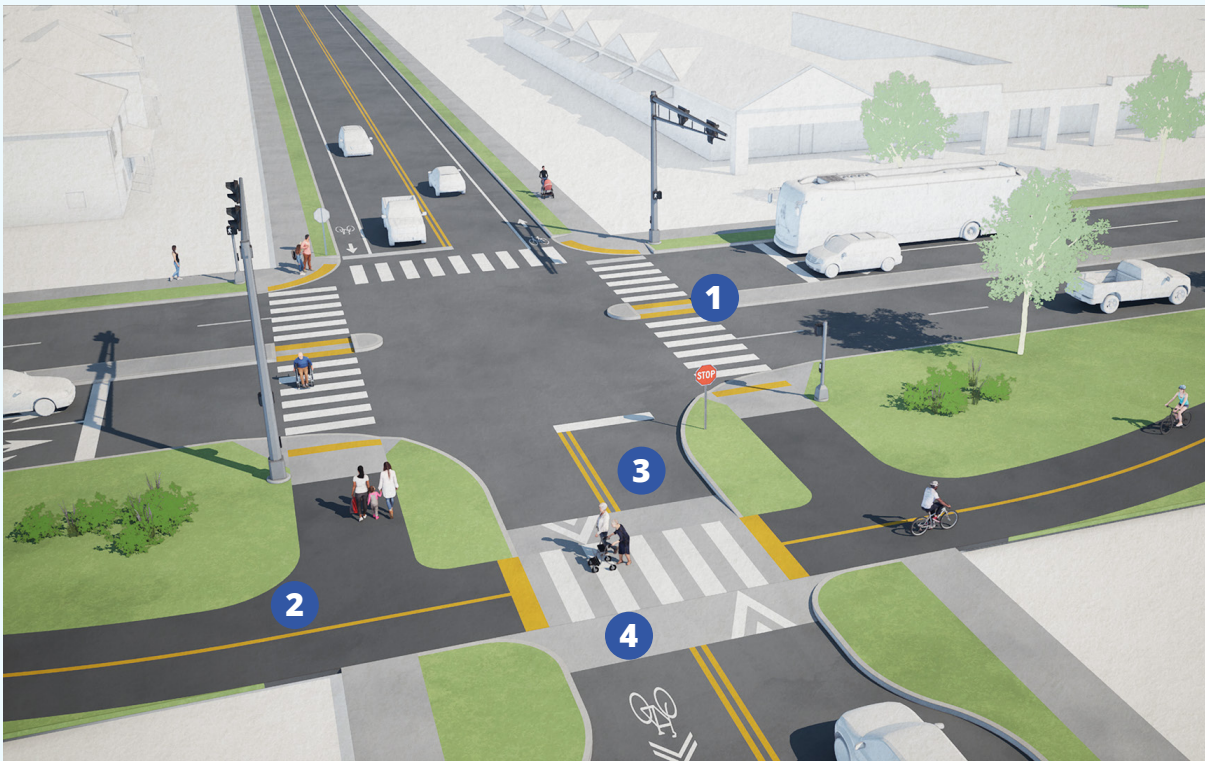
Stop-controlled intersections include any conventional intersection where one or more approaches are controlled by a STOP sign. However, there are significant differences between intersections with multi-way stop control (typically all-way stop, or AWS) and minor road stop (MRS) control.

## Design Features

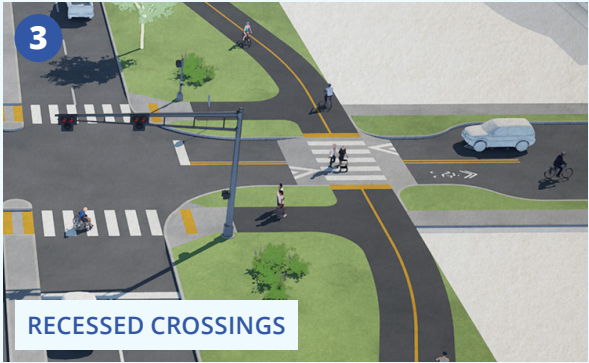
- Various countermeasures can be used to make pedestrians and bicyclists more visible and support improved driver awareness and yielding
- Countermeasures that should be implemented as often as possible include high-visibility crosswalks, effective intersection lighting, wide refuge islands, raised crosswalks (for MRS intersections) or tabled intersections (for AWS intersections).
- Stop-controlled intersections that involve more complex lane arrangements should be evaluated for treatments such as Rectangular Rapid Flashing Beacons (RRFBs) or Pedestrian Hybrid Beacons (PHBs) as appropriate.
- Install overhead lighting to illuminate bikeway and pathway networks and in advance of all intersection crossings.

## Benefits

- Generally, stop-controlled intersections tend to have smaller footprints, leading to shorter crossing distances for pedestrians and bicyclists (though additional through lanes or turn lanes add complexity to the intersection).
- Stop-controlled intersections, especially AWS intersections, can encourage mutual visibility among pedestrians, bicyclists, and drivers.



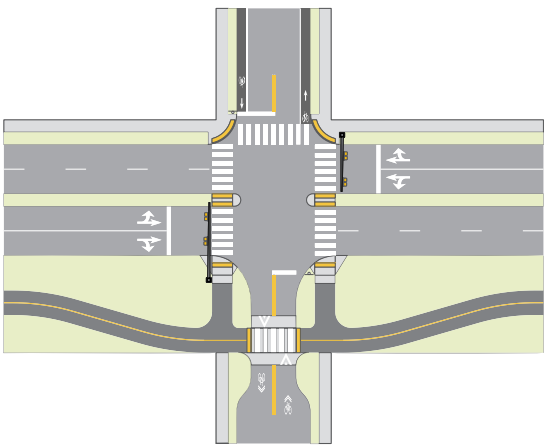
All graphics source: FHWA



## Intersection Types

### MINOR ROAD STOP (MRS)

Minor road stop (MRS) intersections feature stop signs controlling the minor road approach(es) while the major road approaches are uncontrolled.

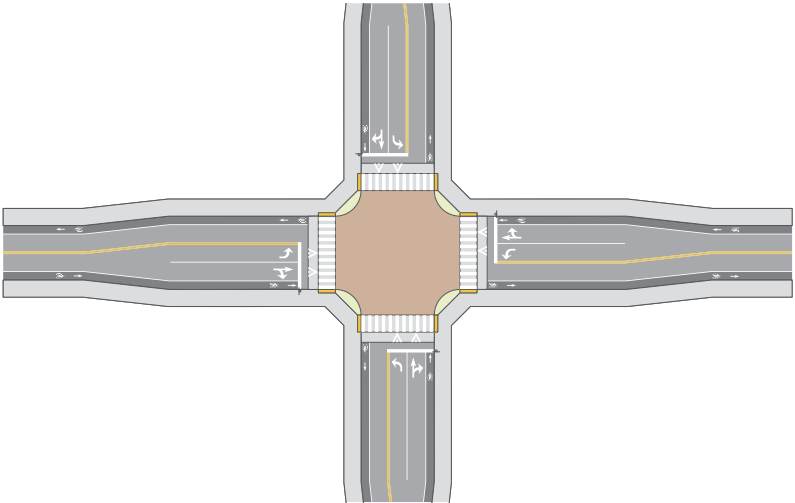


#### CONSIDERATIONS

- Crossing the uncontrolled approaches of a MRS intersection involves a higher risk to pedestrians and bicyclists because of the free-flow and higher-speed traffic conditions.
- Opportunities to cross may be less frequent due to the need to wait for a gap in major road traffic.
- Multi-lane uncontrolled pedestrian crossings should include additional countermeasures such as PHBs (shown) or RRFBs.
- A recessed crossing of approximately one car length provides space for drivers to yield to sidepath users and conflicting traffic as discrete events.

### ALL WAY STOP (AWS)

All-way stop (AWS) intersections feature STOP signs controlling all approaches.



#### CONSIDERATIONS

- Because stopping is mandatory for all movements, vehicle speeds at AWS intersections are typically lower and crossing opportunities for pedestrians and bicyclists should be frequent.
- Raised intersections provide sidewalk-level crossings at each leg of an intersection. They encourage drivers to yield and provide pedestrians and bicyclists with a continuous accessible path of travel without grade changes.

## References

FHWA (2021). Stop-Controlled Intersections. Federal Highway Administration, Washington, DC. Retrieved from <https://safety.fhwa.dot.gov/intersection/stop/index.cfm>.

FHWA (2021). Proven Safety Countermeasures: Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections [FHWA-SA-21-031]. Federal Highway Administration, Washington, DC. Retrieved from [https://safety.fhwa.dot.gov/provencountermeasures/syst\\_stop\\_control.cfm](https://safety.fhwa.dot.gov/provencountermeasures/syst_stop_control.cfm).

Blackburn, L., Zegeer, C., & Brookshire, K. (2018). *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations* [FHWA-SA-17-072]. Federal Highway Administration, Washington, DC. Retrieved from [https://safety.fhwa.dot.gov/ped\\_bike/step/docs/STEP\\_Guide\\_for\\_Improving\\_Ped\\_Safety\\_at\\_Unsig\\_Loc\\_3-2018\\_07\\_17-508compliant.pdf](https://safety.fhwa.dot.gov/ped_bike/step/docs/STEP_Guide_for_Improving_Ped_Safety_at_Unsig_Loc_3-2018_07_17-508compliant.pdf).





# Traditional Signalized Intersections

Traditional intersections are the most common traffic signal-controlled intersection type.

## Design Features

- Direct turning movements improve mobility for motor vehicles, but they increase the number of conflict points at the main intersection for motorists, bicyclists, and pedestrians. Increasing the number of turning movements may also lead to increased traffic signal cycle lengths, complexity, and delay for pedestrians and bicyclists.
- With added turn lanes, traditional intersections can lead to longer crossing distances without refuge for pedestrians and bicyclists.
- Channelized islands that accompany channelized right turns can provide refuge for pedestrians but may also encourage higher motor vehicle turning speeds.
- Install overhead lighting to illuminate bikeway and pathway networks and in advance of all intersection crossings.

## Benefits

- Traditional intersections are familiar to most road users and may facilitate the most direct paths across the intersection for pedestrians and bicyclists.
- Exclusive pedestrian and bicyclist traffic signal phases allow all pedestrian and bicyclist movements to cross the intersection separated in time from motor vehicle movements.



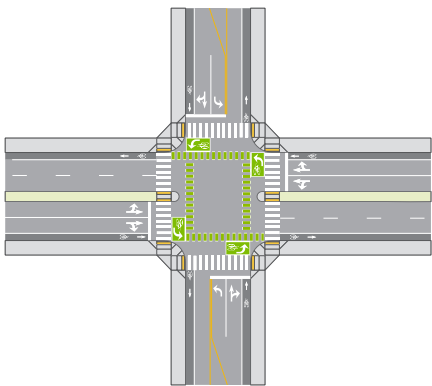
All graphics source: FHWA



## Intersection Types

### BIKE LANE

This design incorporates bike lanes for bicyclists and sidewalks with marked crosswalks for pedestrians.

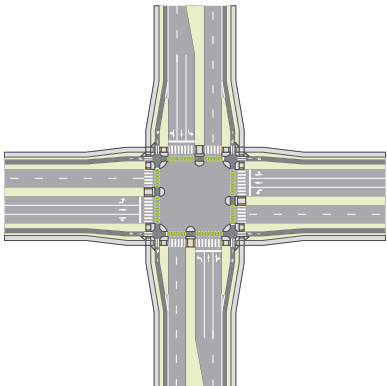


#### CONSIDERATIONS

- The bike lanes feature green colored pavement to emphasize continuity through the intersection, as well as two-stage left turn boxes to allow cyclists to make left turns without merging across lanes of through-moving vehicle traffic.
- Pedestrian refuge islands simplify the pedestrian crossing by reducing the number of lanes crossed in one stage.
- Traffic signal phasing plans will depend on the traffic volumes, sight distance, and context of the intersection.

### SEPARATED BIKE LANE

This design features bike lanes that are separated from motor vehicle traffic vertically and horizontally along the intersection approaches. Pedestrians travel on sidewalks that are separated from the bike lanes and cross through the intersection at marked crosswalks.

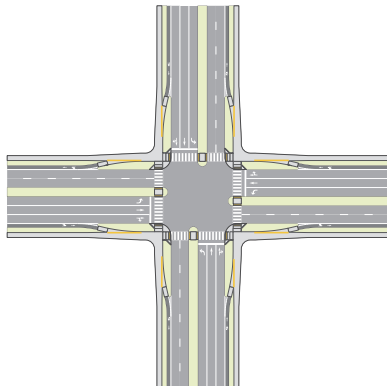


#### CONSIDERATIONS

- It is important to consider the interactions between pedestrians and bicyclists at the corners and at medians where people may wait in groups to cross the intersection.
- The separated bike lane crossings at the corners of the intersection allows cyclists to make left turns without merging across lanes of through-moving vehicle traffic, similar to two-stage left-turn boxes.

### SIDEPATH

Ramps allow cyclists to transition from the on-street bike lane to the sidepath upstream of the intersection and then return to the bike lane downstream of the intersection. Both pedestrians and bicyclists use the marked crosswalks and refuge islands to cross through the intersection.



#### CONSIDERATIONS

- Using a shared facility through the intersection consolidates conflict points between motor vehicles, bicyclists, and pedestrians.
- This design may lead to increased conflicts between pedestrians and bicyclists, especially at the corners of the intersection, and may be more difficult for pedestrians with disabilities to navigate.
- It is important to design the width of shared paths, crosswalks, medians, and queuing areas to accommodate groups of people of all abilities.
- Shared facilities may be appropriate even where only low volumes of bicyclists and pedestrians are expected to use the intersection.

## References

Chandler, B.E., Myers, M.C., Atkinson, J.E., Bryer, T.E., Retting, R., Smithline, J., ... & Izadpanah, P. (2013). *Signalized Intersections Informational Guide, Second Edition* [FHWA-SA-13-027]. Federal Highway Administration, Washington, DC. Retrieved from <https://safety.fhwa.dot.gov/intersection/signal/fhwasa13027.pdf>





# Roundabouts

Roundabouts are circular intersections characterized by channelized approaches and counterclockwise traffic flow around a center island.

## Design Features

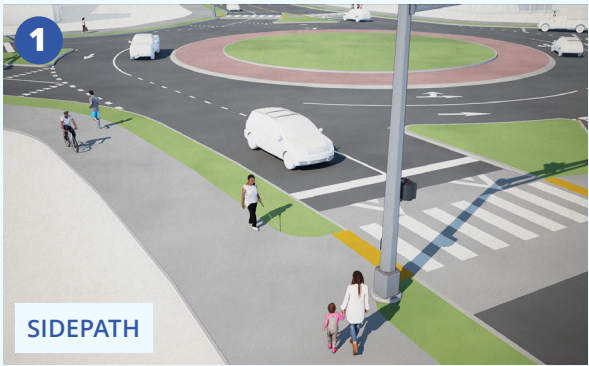
- Traffic approaching the roundabout yields to traffic already in the circular roadway.
- Splitter islands on each leg deflect approaching vehicular traffic and encourage slower speeds and driver yielding.
- Entries at roundabouts are yield-controlled and exits are uncontrolled. Consequently, pedestrian and bicycle crossings at both entries and exits must be carefully assessed to maximize the conditions for yielding. This is particularly important for making crossings accessible to pedestrians with low or no vision.
- While roundabout geometry encourages lower motorist speeds, bicyclists typically cannot accelerate at the same rates as motor vehicles. Riding in mixed traffic adds some complexity to the task of biking through a roundabout and may not be comfortable for bicyclists of all ages and abilities.
- Install overhead lighting to illuminate bikeway and pathway networks and in advance of all intersection crossings.

## Benefits

- Roundabouts are highly adaptable and have been proven to work across a range of contexts, from high-speed rural to low-speed urban.
- The splitter islands serve as pedestrian (and, potentially, bicyclist) refuge islands, allowing pedestrians to cross one direction of vehicular traffic at a time.
- Modern roundabout geometry encourages slower motor vehicle approach speeds of around 15-25 mph.
- Roundabouts can potentially reduce the total number of lanes to cross at the intersection because of improved operational performance.



All graphics source: FHWA



SIDEPATH



BIKE LANE TRANSITION



RAISED CROSSINGS

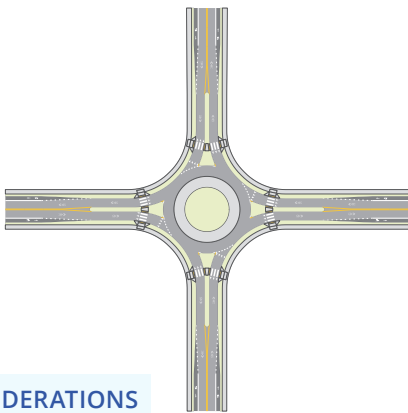


PEDESTRIAN HYBRID BEACONS

## Intersection Types

### SHARED LANE

This single-lane roundabout design features sidewalks with crosswalks for pedestrians and bike lanes for bicyclists. The bike lanes end shortly upstream of the roundabout entry, and bicyclists merge with motor vehicle traffic to navigate the intersection before returning to the bike lane after exiting.

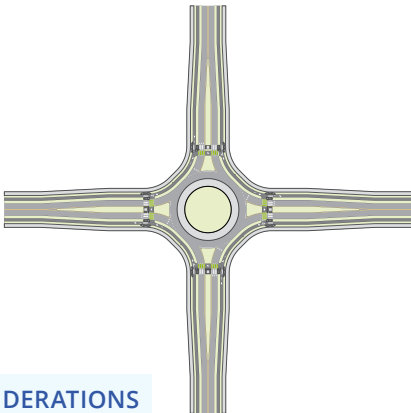


#### CONSIDERATIONS

- The crosswalks are perpendicular to the motor vehicle traffic that is deflected by the geometry of the roundabout circular roadway and splitter islands.
- Another bicycle facility option would be to provide a ramp from the bike lane onto a sidepath in advance of the roundabout and another ramp from the sidepath to the bike lane following the roundabout.

### SEPARATED BIKE LANE

This single-lane roundabout design features separated bike lanes with bicyclist crossings parallel to the marked pedestrian crosswalks.

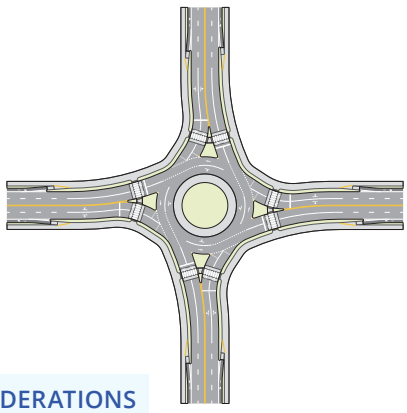


#### CONSIDERATIONS

- This design consolidates pedestrian and bicyclist activity to the same areas, improves driver visibility of crossing pedestrians and bicyclists, and minimizes conflict points between pedestrians and bicyclists.
- The interface between the separated bike lanes, bicycle crossings (marked here with green colored pavement), and pedestrian crosswalks are designed to provide enough room for bicyclists and pedestrians to maneuver separately.

### SIDEPATH

This multilane roundabout design transitions bike lanes to sidepaths upstream of the roundabout entrance.



#### CONSIDERATIONS

- Bicyclists have the option to transition from the bike lane to the sidepath or merge with motor vehicle traffic to continue through the roundabout.
- The multilane design increases crossing distances over the single-lane design.
- This design may also include raised crosswalks and Pedestrian Hybrid Beacons (PHBs) across the entering and exiting lanes of the roundabout. These are features that can be added to lower vehicle speeds and improve driver yielding behavior.
- Shared facilities may be appropriate even where only low volumes of bicyclists and pedestrians are expected to use the intersection.

## References

Rodegerdts, L., Bansen, J., Tiesler, C., Knudsen, J., Myers, E., Johnson, M., ..., & O'Brien, A. Roundabouts: An Informational Guide, Second Edition [NCHRP Report 672]. National Academies of Sciences, Engineering, and Medicine, Washington, DC. Retrieved from <https://www.trb.org/Publications/Blurbs/164470.aspx>.

Schroeder, B., Rodegerdts, L., Jenior, P., Myers, E., Cunningham, C., Salamati, K.,..., & Bentzen, B.L. (2016). *Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities* [NCHRP Report 834]. National Academies of Sciences, Engineering, and Medicine, Washington, DC. Retrieved from <https://www.trb.org/Main/Blurbs/175586.aspx>.



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For more information refer to *Improving Intersections for Pedestrians and Bicyclists Informational Guide* [FHWA-SA-22-017].



# Median U-Turn Intersections

Median U-Turn (MUT) intersections refer to any intersection replacing direct left turns at an intersection with indirect left turns that rely on a U-turn/right-turn combination.

## Design Features

- Direct left turns are prohibited from either or both major and minor roads.
- Conventional through movements and right turns are allowed from both the major and minor roads.
- The main intersection can operate with fewer traffic signal phases through the elimination of direct left turns.
- Install overhead lighting to illuminate bikeway and pathway networks and in advance of all intersection crossings.

## Benefits

- MUT intersections reduce the overall number of vehicular conflict points and present all users with fewer conflicting movements to cross at a time.
- The main intersection is signalized but requires fewer traffic signal phases than a traditional intersection due to the elimination of direct left turns, facilitating shorter traffic signal cycle lengths and less delay.
- Fewer turn lanes reduce the number of conflict points and lower pedestrian and bicyclist exposure. A large median provides more refuge (though it may increase total crossing distance).
- There is an opportunity to increase connectivity when controlled midblock crossings are incorporated with the downstream U-turn intersections.



All graphics source: FHWA



CROSSING ISLANDS



PROTECTED INTERSECTIONS



ENHANCED MIDBLOCK CROSSINGS

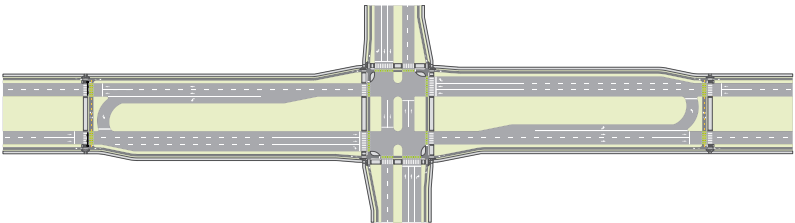


SEPARATION OF MODES

## Intersection Types

### SEPARATED BIKE LANE

This design features separated bike lanes parallel to the sidewalks and a protected intersection design. There are marked crosswalks and green colored pavement in the bike lanes through the intersection. The downstream U-turn intersections incorporate midblock crossings with signal control.

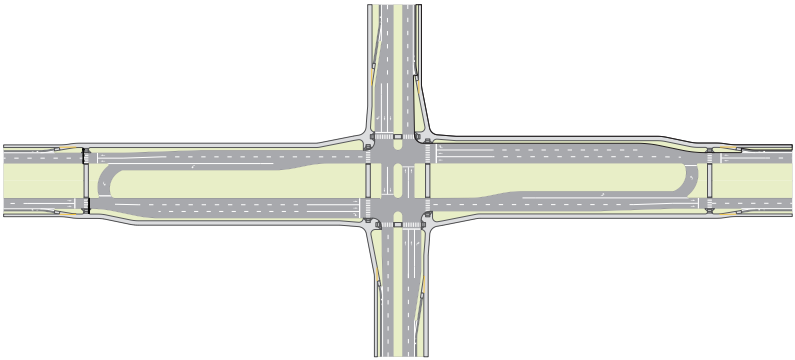


### CONSIDERATIONS

- The major road crossing may be times as a two-stage crossing for pedestrians. Consider timing as a one-stage crossing for bicyclists to reduce delay.
- Rectangular Rapid Flashing Beacons (RRFBs) or Pedestrian Hybrid Beacons (PHBs) may also be considered at the midblock crossings as appropriate.

### SIDEPATH

This design features sidepaths through the intersection. On-street bike lanes merge with the sidewalk using ramps upstream of the U-turn intersections. The downstream U-turn intersections incorporate midblock crossings with signal control.

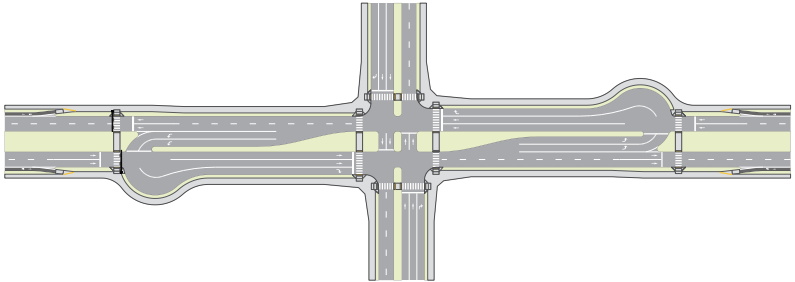


### CONSIDERATIONS

- Rectangular Rapid Flashing Beacons (RRFBs) or Pedestrian Hybrid Beacons (PHBs) may also be considered at the midblock crossings as appropriate.
- It is important to design the width of shared paths, crosswalks, medians, and queuing areas to accommodate groups of people of all abilities.
- Shared facilities may be appropriate even where only low volumes of bicyclists and pedestrians are expected to use the intersection under present and future conditions.

### SIDEPATH WITH BULB

This design features sidepaths along with U-turn bulbs, or "loons," at the U-turn intersections. These allow vehicles, especially large trucks, to make U-turns while minimizing the necessary median width (and thus reducing the overall intersection footprint).



### CONSIDERATIONS

- The narrowed median decreases pedestrian and bicyclist crossing distance while still providing refuge.
- The sidepath follows the curve of the bulb-out, and changes in direction of travel are a design consideration for bicyclists or pedestrians with disabilities. However, the separation between the sidepath and the travel lanes, usually landscaping of some kind, helps provide some contrast and non-visual guidance along the perimeter of the bulb-out.

## References

Reid, J., Sutherland, L., Ray, B., Daleiden, A., Jenior, P., & Knudsen, J. (2014). Median U-Turn Intersection Informational Guide [FHWA-SA-14-067]. Federal Highway Administration, Washington, DC. Retrieved from <https://safety.fhwa.dot.gov/intersection/rltci/fhwasa14069.pdf>.

FHWA (2020). Proven Safety Countermeasure: Reduced Left-Turn Conflict Intersections [FHWA-SA-18-048]. Federal Highway Administration, Washington, DC. Retrieved from <https://safety.fhwa.dot.gov/intersection/rltci/fhwasa18048.pdf>.



For more information refer to *Improving Intersections for Pedestrians and Bicyclists Informational Guide* [FHWA-SA-22-017].



# Restricted Crossing U-Turn Intersections

Restricted Crossing U-Turn (RCUT) intersections replace direct through and left-turn movements from the minor approaches with an indirect movement of a right-turn/U-turn combination.

## Design Features

- An RCUT may be signalized or unsignalized.
- Direct left-turn and through movements are prohibited from the minor road approaches.
- The main intersection requires fewer traffic signal phases than a conventional intersection through the elimination of minor road through and left-turn movements.
- Install overhead lighting to illuminate bikeway and pathway networks and in advance of all intersection crossings.

## Benefits

- RCUTs reduce the overall number of vehicular conflict points and present all users with fewer conflicting movements to cross at a time.
- When signalized, fewer phases are needed as compared to a traditional signalized intersection, resulting in shorter overall traffic signal cycle lengths and decreased delay.
- Specifically, the reduced number of conflict points and fewer number of conflicting movements crossed at a time can reduce risk while crossing.
- At signalized RCUT locations, shorter signal cycle lengths can result in less control delay, and signalized U-turns offer the opportunity for controlled midblock crossings, providing additional connectivity.



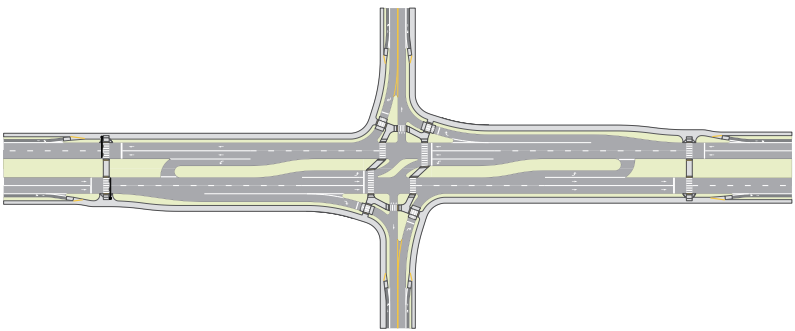
All graphics source: FHWA



## Intersection Types

### SIDEPATH

This design features sidepaths through the intersection, as well as crosswalk positioning that more closely resembles a traditional intersection.

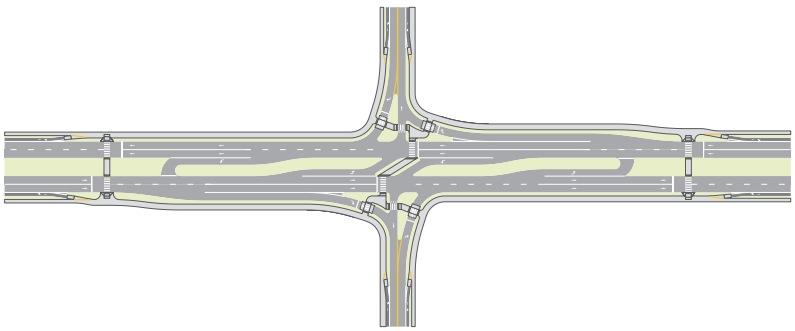


### CONSIDERATIONS

- The position of the channelizing islands facilitates staggered crosswalks, which can improve safety but may also make maneuvering more challenging for cyclists and pedestrians using mobility assistance devices or with vision disabilities.
- Shared facilities may be appropriate even where only low volumes of bicyclists and pedestrians are expected to use the intersection.
- Bulb-outs, or “loons,” can be implemented at the U-turn intersections to facilitate U-turns while decreasing the median width.

### SIDEPATH Z-CROSSING

The RCUT layout optimized for motor vehicles calls for a “Z-pattern” pedestrian crossing at the main intersection. This reduces conflict points between motorists, bicyclists, and pedestrians, but causes crossing pedestrians and bicyclists to travel out of their direct, intended path.

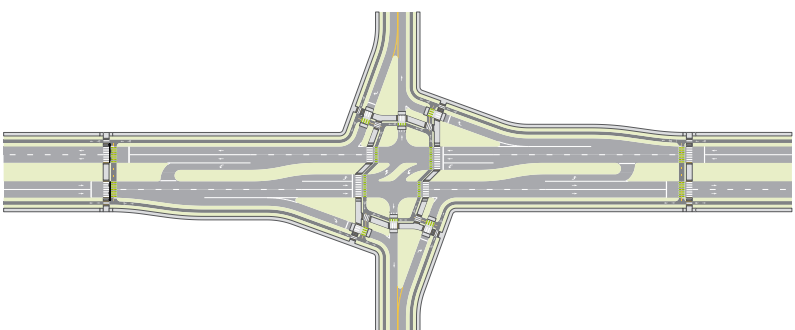


### CONSIDERATIONS

- Wayfinding signage and markings, APS, and carefully placed push buttons on corners and refuge islands are strongly encouraged to mitigate the complex routes for pedestrians with disabilities.
- Using high-angle channelized right turns provides refuge islands for pedestrians and bicyclists and encourages lower motor vehicle turning speeds, increased visibility, and driver yielding behavior.

### SEPARATED BIKE LANE

This RCUT design features separated bike lanes and a more direct and intuitive pedestrian and bicyclist crossing configuration at the intersection.



### CONSIDERATIONS

- In order to provide the needed traffic signal phases for pedestrians and bicyclists to cross, the left turns cannot operate simultaneously with the bicyclist and pedestrian movements crossing the major road unless multi-stage crossings are used.
- Using high-angle channelized right turns provides refuge islands for pedestrians and bicyclists and encourages lower motor vehicle turning speeds, increased visibility, and driver yielding behavior.

## References

Hummer, J., Ray, B., Daleiden, A., Jenior, P., & Knudsen, J. (2014). Restricted Crossing U-Turn Informational Guide [FHWA-SA-14-070]. Federal Highway Administration, Washington, DC. Retrieved from <https://safety.fhwa.dot.gov/intersection/rltci/fhwasa14070.pdf>.

FHWA (2020). Proven Safety Countermeasure: Reduced Left-Turn Conflict Intersections [FHWA-SA-18-048]. Federal Highway Administration, Washington, DC. Retrieved from <https://safety.fhwa.dot.gov/intersection/rltci/fhwasa18048.pdf>.



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For more information refer to *Improving Intersections for Pedestrians and Bicyclists Informational Guide* [FHWA-SA-22-017].



# Quadrant Roadway (QR) Intersections

Quadrant Roadway (QR) intersections feature one main intersection and two secondary, or auxiliary, intersections where left turns are displaced to a connector road in one quadrant of the main intersection.

## Design Features

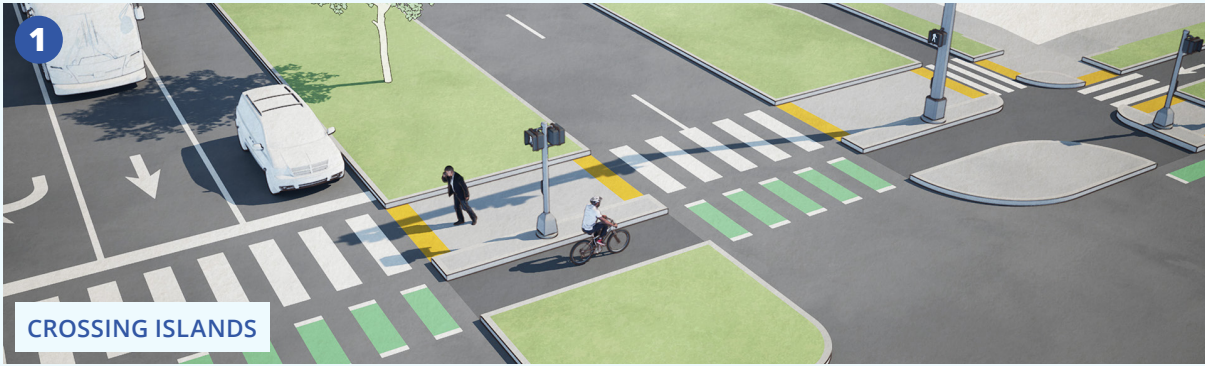
- No left turns are made at the main intersection. Instead, vehicles turning left from any of the four approaches to the intersection use the secondary intersections and quadrant connector road to complete the movement.
- Secondary intersections are normally signalized, though in some cases they may be unsignalized.
- In some cases, the “infield” of the quadrant roadway may be developed. If so, driveways typically provide access from the quadrant roadway to the destinations within.
- Install overhead lighting to illuminate bikeway and pathway networks and in advance of all intersection crossings.

## Benefits

- The absence of direct left turns and left-turn lanes at the main intersection decreases pedestrian and bicyclist crossing distances, shortens traffic signal cycle lengths and wait times, and eliminates left-turning conflicts with pedestrians and bicyclists. This is balanced somewhat by the introduction of additional movements at the secondary intersections.
- The main intersection is typically operated as a two-phase traffic signal, minimizing delay for all users.
- Signalized secondary intersections facilitate regular crossing opportunities for pedestrians and bicyclists.



All graphics source: FHWA



CROSSING ISLANDS



PROTECTED INTERSECTIONS

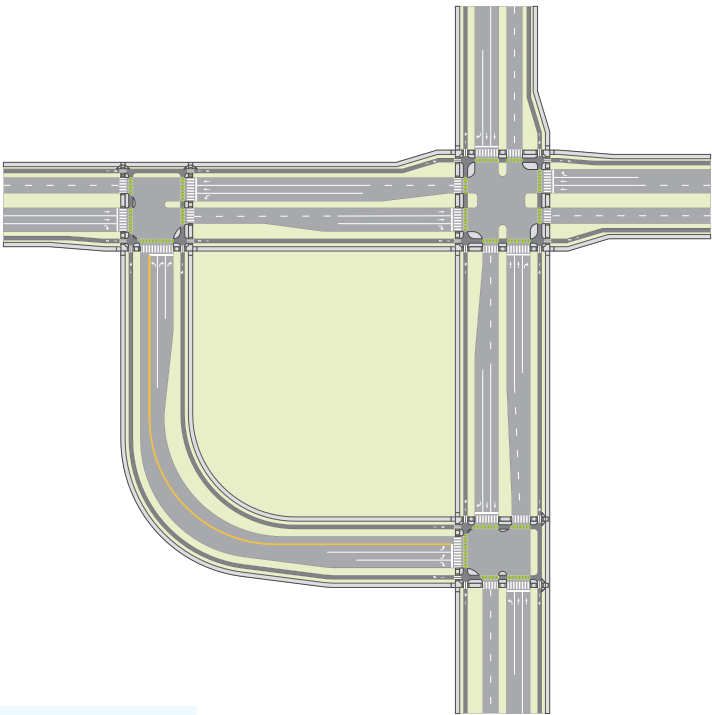


SIGNALIZED CROSSINGS

## Intersection Types

### SEPARATED BIKE LANE

This QR design shows separated bike lanes and sidewalks along the major road, minor road, and auxiliary road.

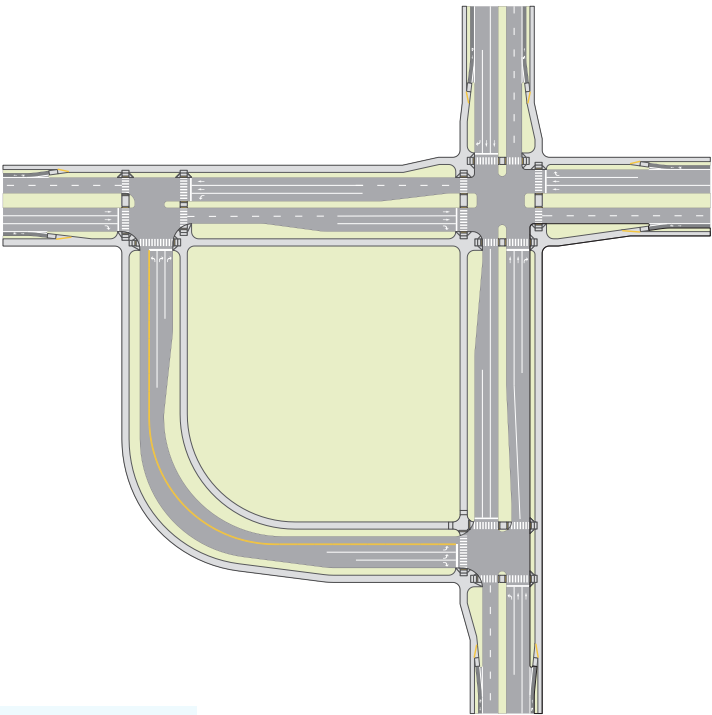


#### CONSIDERATIONS

- Depending on the surrounding land use context and other factors, speed management may be considered on the quadrant roadway.

### SIDEPATH

This design features on-street bike lanes transitioning to sidepaths upstream of the intersections. The sidepaths continue along the auxiliary roadway. Pedestrians and bicyclists travel through the intersections using the marked crosswalks.



#### CONSIDERATIONS

- It is important to design the width of shared paths, crosswalks, medians, and queuing areas to accommodate groups of people of all abilities.
- Shared facilities may be appropriate even where only low volumes of bicyclists and pedestrians are expected to use the intersection under present and future conditions.

## References

Reid, J.D. & Hummer, J.E. (2020). *Quadrant Roadway Intersection Informational Guide* [FHWA-SA-19-029]. Federal Highway Administration, Washington, DC. Retrieved from <https://safety.fhwa.dot.gov/intersection/other/fhwasa19029.pdf>.





# Displaced Left Turn (DLT) Intersections

Displaced Left Turn (DLT) intersections are crossover-type intersections that can be applied to high-volume signalized arterial intersections—especially those characterized by heavy left-turn volumes that conflict with heavy opposing through volumes.

## Design Features

- Left-turning vehicular traffic crosses over to the other side of opposing through traffic at signalized intersections upstream of the main arterial intersection, which allows through movements and left turns to occur simultaneously at the main intersection.
- A pedestrian or bicyclist crossing the intersection will cross vehicle streams traveling in alternating directions.
- The DLT is designed primarily to minimize vehicular delay and promote “continuous flow,” which can lead to long cycle lengths with increased delay for pedestrians and bicyclists.
- Install overhead lighting to illuminate bikeway and pathway networks and in advance of all intersection crossings.

## Benefits

- Most DLTs include channelizing features and medians to direct vehicle traffic. These also serve to provide refuge for pedestrians and bicyclists.
- If designed with pedestrians and bicyclists in mind, medians and raised channelization needed for vehicular separation can provide refuge and reduce the discomfort associated with longer crossings and the presence of higher speed traffic.
- Grade-separated pedestrian and bicyclist crossings may also be considered for DLT and other continuous flow intersection types.



All graphics source: FHWA



CROSSING ISLANDS



SIGNALIZED CROSSINGS



RAISED BIKE AND PEDESTRIAN CROSSINGS

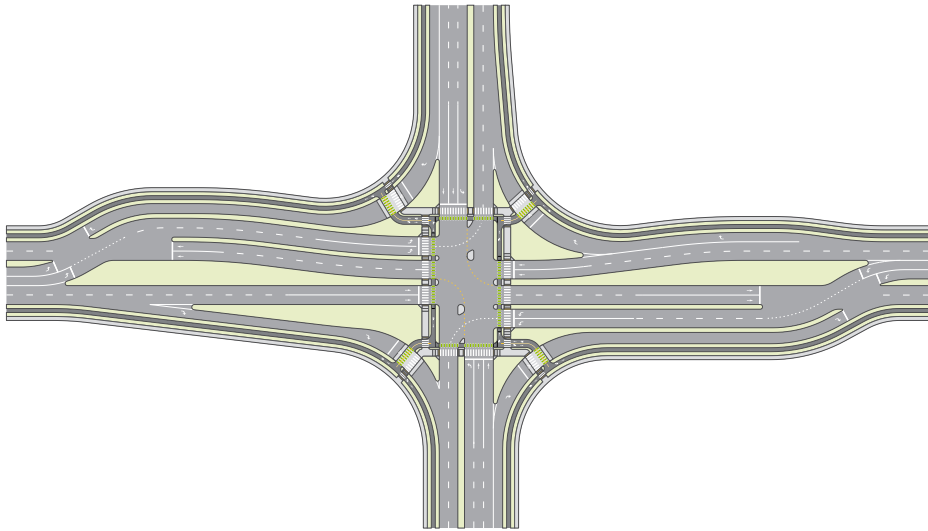
## Intersection Types

### SEPARATED BIKE LANE

This DLT design features separated bike lanes alongside sidewalks.

#### CONSIDERATIONS

- This design features channelized right turns, which provide refuge islands for pedestrians and bicyclists. High angle channelized right turns can encourage appropriate motor vehicle speeds, increased visibility, and driver yielding behavior.
- Raised crossings can be used at channelized right turns to encourage driver yielding and provide pedestrians and bicyclists with a continuous, accessible path of travel without grade changes.

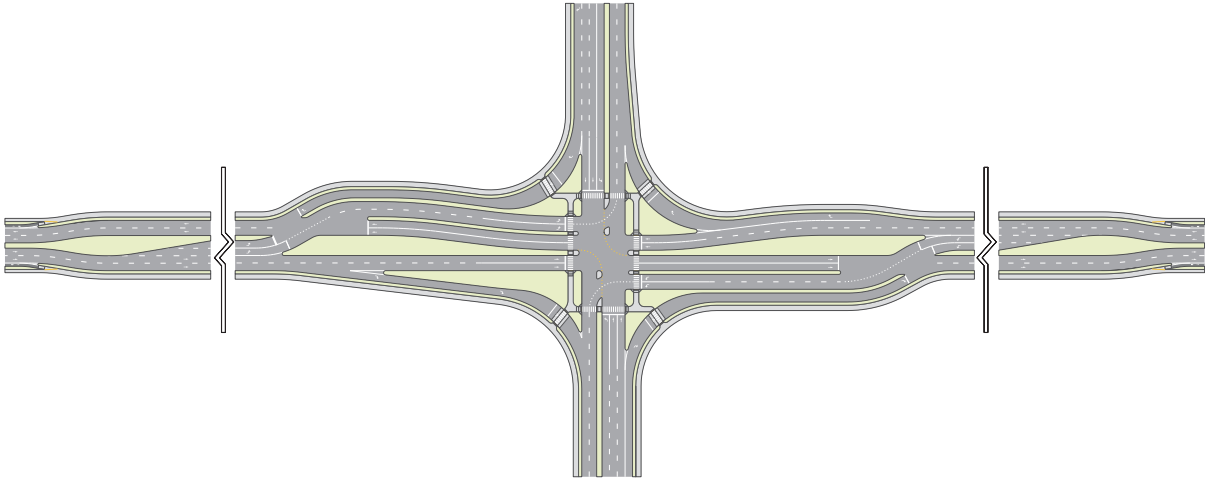


### SIDEPATH

This design features upstream ramps to bring bicyclists out of the bike lane and up to a sidepath at sidewalk level. Both pedestrians and bicyclists then use this sidepath to travel through the intersection. Downstream of the intersection the bicyclists diverge to the bike lane using a similar ramp.

#### CONSIDERATIONS

- It is important to design the width of shared paths, crosswalks, medians, and queuing areas to accommodate groups of people of all abilities.
- Shared facilities may be appropriate even where only low volumes of bicyclists and pedestrians are expected to use the intersection under present and future conditions.



## References

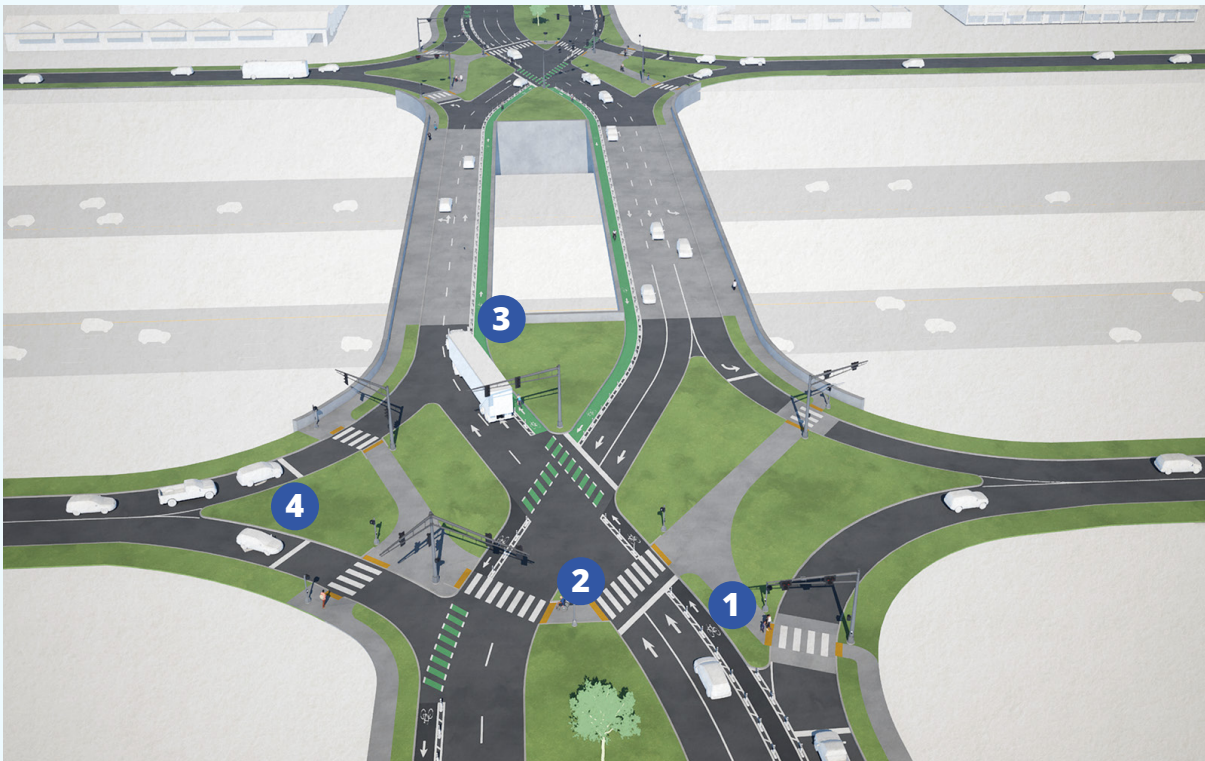
Steyn, H., Bugg, Z., Ray, B., Daleiden, A., Jenior, P., & Knudson, J. (2014). *Displaced Left Turn Informational Guide* [FHWA-SA-14-068]. Federal Highway Administration, Washington, DC. Retrieved from <https://safety.fhwa.dot.gov/intersection/crossover/fhwasa14068.pdf>.





# Diverging Diamond Interchange (DDI)

Diverging Diamond Interchanges (DDIs) are characterized by crossover intersections at the ramp termini where cross-street traffic crosses over to the left-hand side of the roadway between the ramps to allow unopposed left turns to and from the ramps. DDIs are used in situations with grade-separated interchanges.



All graphics source: FHWA

## Design Features

- Movements to and from the ramps should be controlled to improve crossings for pedestrians and bicyclists.
- Between the crossover intersections, pedestrian pathways and separated bikeways are integrated as either inside facilities (i.e., within the median) or outside facilities (i.e., beyond the outside edges of pavement).
- The DDI ramp terminal intersections typically operate as two-phase traffic signals.
- Install overhead lighting to illuminate bikeway and pathway networks and in advance of all intersection crossings.

## Benefits

- Two-phase signalization reduces traffic signal cycle length leading to reduced wait time and delay for pedestrians and bicyclists.
- The combination of lane arrangements and islands at DDIs facilitates crossing fewer conflicting movements and directions of traffic at a time.



RAISED CROSSINGS



SIGNALIZED PEDESTIAN CROSSING



SEPARATED BIKE LANES

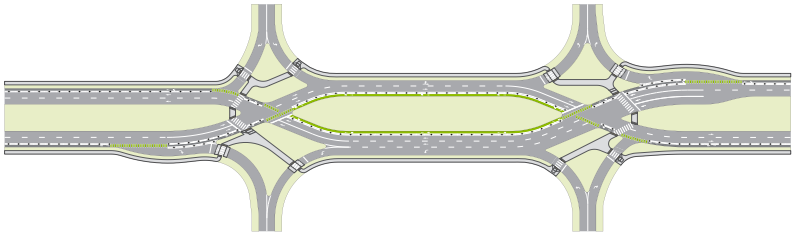


SEPARATED CONFLICT POINTS

## Intersection Types

### SEPARATED BIKE LANE (OUTER)

This DDI design shows separated bike lanes that follow the motor vehicle path, crossing over to the opposite side of the road on one edge of the interchange and crossing back at the other.

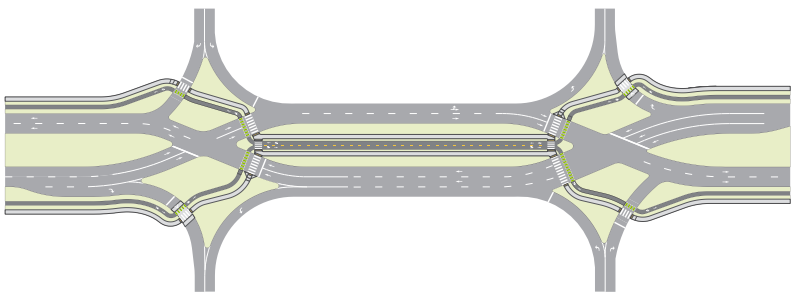


#### CONSIDERATIONS

- This arrangement may allow for bicyclists to take cues for wayfinding from motorists and can allow for signage to be consistent between motor vehicles and bicyclists.
- This also provides advantages for efficient use of available space.

### SEPARATED BIKE LANE (INNER)

This design makes use of separated bike lanes and sidewalks that cross the roadway and travel down the center of the median.

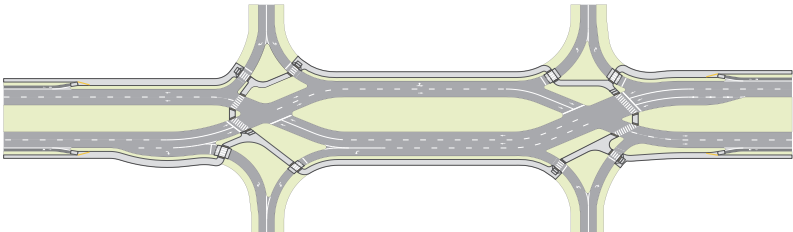


#### CONSIDERATIONS

- Housing the bicyclist and pedestrian facilities in the median of the interchange can minimize the needed right-of-way.
- Crossing to the middle of the road can make use of signal control to provide safe gaps for pedestrians and bicyclists.
- Barrier walls height should not produce an enclosed “tunnel effect” that reduces visibility at the crossings.

### SIDEPATH

This design incorporates sidepaths that travel along the outer edge of the interchange footprint.



#### CONSIDERATIONS

- Pedestrians and bicyclists cross over several entrance and exit ramps to navigate through the intersection. If these ramps are not signal-controlled, they may lead to issues with driver yielding and pedestrians and bicyclists may have difficulty finding adequate gaps in traffic.
- It is important to design the width of shared paths, crosswalks, medians, and queuing areas to accommodate groups of people of all abilities.
- Shared facilities may be appropriate even where only low volumes of bicyclists and pedestrians are expected to use the intersection.

## References

Cunningham, C., Chase, T., Deng, Y., Carnes, C., Pyo, K., Jenior, P., ..., Tanaka, A. (2021). Diverging Diamond Interchange Informational Guide: Second Edition [NCHRP Research Report 959]. Transportation Research Board, Washington DC. Retrieved from <https://www.trb.org/Main/Blurbs/181562.aspx>.

Mitman, M.F. & Ridgway, M.D. (2016). *Recommended Design Guidelines to Accommodate Pedestrians and Bicycles at Interchanges* [RP-039A]. Institute of Transportation Engineers, Washington, DC. Retrieved from <https://ecommerce.ite.org/IMIS/ItemDetail?iProductCode=RP-039A>.



U.S. Department of Transportation  
Federal Highway Administration



For more information refer to *Improving Intersections for Pedestrians and Bicyclists Informational Guide* [FHWA-SA-22-017].