4.5

VEHICLE DESIGN ELEMENTS

ROADWAY ZONE

TRAVEL LANES

Functional Emphasis \ Frontage Context	Des. Comm.	Comm.	Mixed	Civic & Uni.	Near NBH
Pedestrian	✓	✓			
Transit		✓	✓	✓	
Vehicle		✓	✓	✓	
Bicycle		✓	✓		✓
Balanced		✓	✓	✓	✓

DESCRIPTION & INTENT

Travel lanes are the portion of the roadway marked for the movement of vehicles. The width of travel lanes is a critical dimension that affects many aspects of the street including vehicle speed, pedestrian crossing distances, signal cycles, and the amount of roadway impervious surface.

In most cases, the minimum acceptable lane width should be used in urban street design. This minimum dimension may vary depending on the street type and the type and frequency of vehicles using the lane.

Travel lanes may be used by both motorized vehicles and bicycles. Lanes intended for travel are not to be used for loading or parking.

Turn lanes provide a space for vehicles to move out of the general flow of traffic into a dedicated space to wait for a gap in pedestrian and/or on-coming vehicle traffic in order to complete a turn. Turn lanes, particularly center-turn lanes, significantly improve vehicle flow. Often, reducing four-lane, bi-directional streets one-lane in each direction with a center-turn still maintains vehicle capacity and creates space for other uses such as bicycle facilities, wider sidewalks, or a parking lane.

USE & APPLICATION

Location

- Travel lanes are required on all street types irrespective of Frontage Context or Functional Emphasis to allow public and privately owned vehicles transportation access through the public right-of-way.

Related Design Elements

- Travel lanes must be assembled together with other roadway elements, such as additional lanes in the same or opposing directions, turning lanes, parking lanes, bicycle facilities, transit lanes and/or stops, and sidewalk facilities.
- The assemblage of travel lanes can have a substantial effect on the street experience, especially for pedestrians. Although a “typical section” taken at a mid-block location may result in a relatively narrow cross-section, inclusion of right- and/or left-turn lanes at intersections can dramatically increase the total roadway width and pedestrian crossing distances.

DESIGN & OPERATIONS

Design Requirements

- The width of travel lanes varies based on the type of street, land uses, and typical vehicles expected to use them. Research has shown that narrower lane widths reduce traffic speeds without decreasing safety, and that wider lanes are not correlated with safer streets.

A **Travel Lane Width**: Lane widths of 10 feet are appropriate for Ann Arbor's downtown and shall be desired width unless wider lanes are warranted.

» For designated transit and truck routes, one travel lane may need to be 11 or 12 feet to accommodate larger vehicles. Wider lanes for trucks and transit should be evaluated on a case-by-case basis and considers trade-offs with other modes of travel and the overall street context.

» Travel lanes for transit vehicles and/or trucks should be located in the outermost lane.

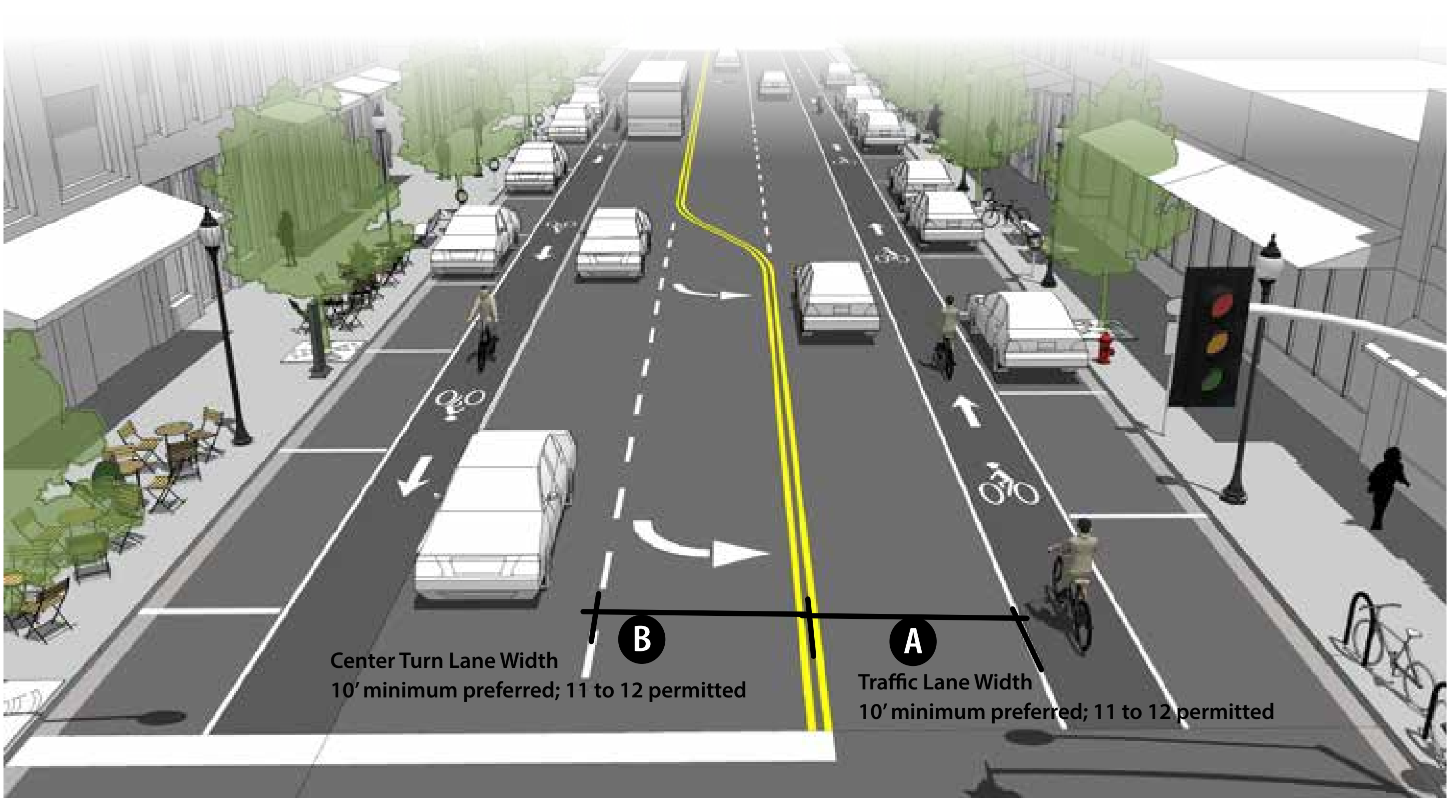
» Wider travel lanes may be necessary at tight turns as vehicles require more horizontal space while turning than while traveling straight.

» Travel lane widths need to be considered within the assemblage of the full street. Narrow travel lanes adjacent to minimally dimensioned bicycle or parking lanes may introduce some friction between uses.

B **Center Turn Lane Widths**: Center-turn lanes can vary from 10 to 12 feet in width. 10 is generally preferred but may be increased to 11 or 12 feet where transit and/or truck traffic is frequent.

Additional Design Considerations

- **Special District Materials**: Established Downtown Character Districts may require or recommend certain paving materials be used in lieu of standard asphalt treatments. For example, reinstalled and/or continuing the extent of historic brick paving in the Kerrytown district may be recommended for street projects in that character district.



Utility Considerations

- Utilities will often be located under travel lanes. Manholes and access portals must be flush with the roadway surface. Utility work in a travel lane should resurface the whole of the travel lane for a smooth travel surface.

Sustainability Considerations

- Minimizing lane widths minimizes overall paved and impervious surfaces, which contribute to stormwater runoff and water quality.

Design References

- Policy guidelines recommend travel lane widths in the range of 9 to 12 feet, with 9 foot lanes only used on very low volume residential local streets. The AASHTO Green Book recommends 10 to 12 foot travel lanes and 10 to 12 foot turn lanes.
- A number of states have endorsed narrower lanes. The Florida Department of Transportation found that narrower lane widths do not impact street capacity "So long as all other geometric and traffic signalization conditions remain constant, there is no measurable decrease in urban street capacity when through lane widths are narrowed from 12 feet to 10 feet."
- The Institute of Transportation Engineers "Designing Walkable Urban Thoroughfares: A Context Sensitive Approach" recommends a range of 10 to 12 feet for travel lanes on urban arterial and collector streets. Narrower travel lane widths are recommended on lower volume and lower speed streets.
- The MMUTCD provides standards and specifications on travel lane marking and signage.

MAINTENANCE & MANAGEMENT

General Maintenance

- Travel lanes require periodic sweeping and pavement marking re-striping.

Seasonal Use & Maintenance

- **Snow Removal**: Travel lanes, together with bicycle lanes and sidewalks, are the top priority for snow removal and may not be used for snow storage. Black ice and other dangerous conditions are common in Michigan. Pavement surfaces are designed and treated to minimize these risks.
- **Special Events:** Travel lanes may be used for seasonal events such as the Ann Arbor Art Fair and other street closures. Design of the assembled roadway width may wish to take layouts of special events into account.

Reviews & Approvals

- The Ann Arbor Engineering Unit determines appropriate travel lane number, design and operation on city-owned streets. MDOT governs these decisions on state routes.

INTERSECTION ZONE

CORNER GEOMETRY

Functional Emphasis \ Frontage Context	Des. Comm.	Comm.	Mixed	Civic & Uni.	Near NBH
Pedestrian	✓	✓			
Transit		✓	✓	✓	
Vehicle		✓	✓	✓	
Bicycle		✓	✓		✓
Balanced		✓	✓	✓	✓

DESCRIPTION & INTENT

Every element of a street influences and affects how travelers behave on the street and the comfort, safety, and operational efficiency of the street. Lane widths and corner turn radii significant impact driver behavior and their interaction with other users.

As discussed in the travel lane section, wider travel lanes do not necessarily correlate with fewer crashes and improved flow. In fact, research has found that lanes as narrow as 10 feet have little to no discernible affect on vehicle flow but these narrower lanes have substantial positive effects in reducing vehicle speed. Slower travel speeds are positively correlated with reduced severity of crashes and reduced pedestrian crossing distance which making walking safer and more pleasant.

Corner curb radii also directly affect pedestrian crossing distances and vehicle turning speeds.

Corner curb radius refers to the arc of the curb protecting the sidewalk at an intersection. For comparison, a 5 foot curb radius is a very tight corner that comes almost to a point where two streets intersect, while a 50 foot curb radius is a wide sweeping curb.

Three factors play the greatest role in determining the geometry of corner curb radii:

- **Intersection Angle**: Where two streets meet at an angle, the acute angle corners of the intersection commonly have very tight curb radii, while the obtuse angle corners have much larger curb radii. Angled intersections may result in very long pedestrian crossing distances. Downtown Ann Arbor is fortunate that the majority of intersections join at near 90 degree angles and permit short crossing distances.
- **Roadway and Distribution**: Roadway refers to only that portion of the street between the typical curb lines. Distribution refers to how that roadway space is allocated, for example a roadway may be distributed between parking lanes, bicycle lanes, and travel lanes. The point in the roadway from which a vehicle begins to make its turn and the width and function of the receiving street determine how wide (or not) a vehicle may safely swing in order to complete the turn without adversely affecting other roadway operations.
- **Vehicle Type**: Larger vehicles make wider turns. Large vehicles include municipal and school buses, tractor trailers, and larger fire trucks. The largest vehicle routinely using a turn is referred to as the “design vehicle.”

There are two measures of curb radius – the actual curb radius and the effective curb radius. The actual curb radius is the actual radius of the built curb at an intersection. The effective curb radius is the arc that is possible for a vehicle to follow from the departing travel lane to the receiving lane. Because vehicles may begin their arc from a travel lane located outside of a bicycle facility and/or a lane of parking, it is common that the effective curb radius is significantly larger than the actual curb radius.

Curb radii directly affect pedestrian crossing distances. Larger actual curb radii, without bumpouts, result in wider crossings and reduce the amount of pedestrian space at a sidewalk corner. This forcing pedestrians to wait further from the motorist's line of sight.

Corner radii affect the location and design of accessible curb ramps. Small radii typically permit the ramp and both flares on the straight edge curb. As radii size increases, ramps either become integrated into the corner or crosswalks must be moved back.

Using the smallest possible curb radii helps manage vehicle turning speeds and increase. Wide corner radii may facilitate smoother and faster turns by large vehicles but concurrently permit or even invite private autos to take turns faster.

Although corner bumpouts typically have larger curb radii than the underlying natural curb, they nonetheless help to manage vehicle turning speeds by establishing a tighter effective radius. Corner bumpout radii are designed to accommodate the necessary design vehicle.

USE & APPLICATION

Location

- Corner geometries exist wherever two streets intersect. They are ubiquitous throughout downtown.

Related Design Elements

- **Intersections**: Curb radii and corner geometries are critical in the assemblage of intersections. Radii affect pedestrian crossing distances, traffic turning speeds, and overall safety and operation of the intersection.

DESIGN & OPERATIONS

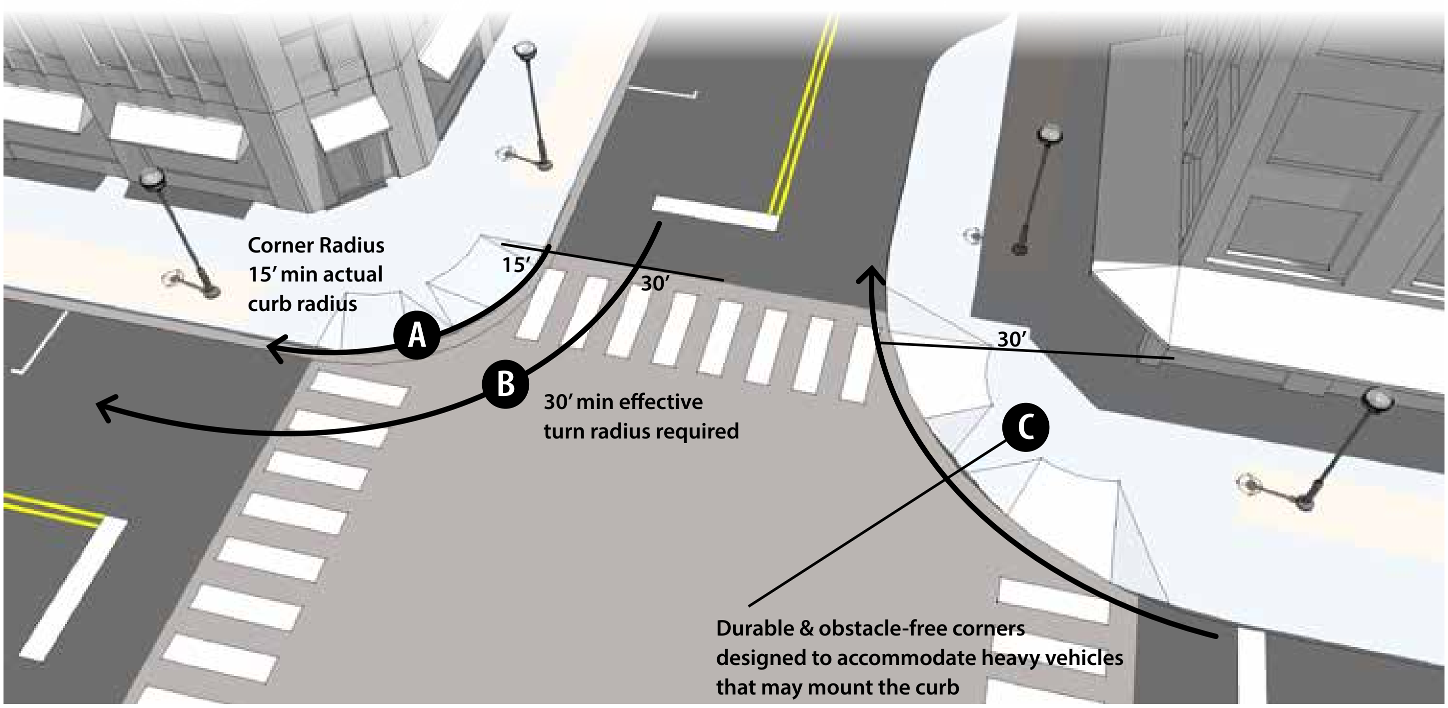
Design Requirements

- **Corner Radius**: Corner curbs shall be designed using the smallest radius possible to accommodate the necessary design vehicle(s).

A In a gridded urban area like Ann Arbor, 15 foot actual curb radii are viable where parking lanes provide a larger effective turn radius.

B Effective intersection radius must be a minimum 30 feet.

» Corner radii may be simple or complex curves.



- **Design Vehicle**: Selected design vehicles should be vehicles routinely expected to navigate a corner. When selecting a design vehicle, consider relative frequencies and volumes.
  - » At signalized intersections, larger vehicles may be permitted to use all available receiving lanes to complete their turn. This should be reflected in turn modeling. If so, large vehicles may not turn right on red. Vehicles must complete turn into the nearest receiving lane.
- **No-Turn Corners**: Corners where no legal turn is possible, such as from a one-way street onto another one-way street, can have a very minimal curb radius.
- **Parking Lane**: On-street parking permits tighter actual curb radii as no vehicle will be turning directly from curb lane to curb lane along the actual curb radius, vehicles will be turning from outside the parking lane to outside the parking lane. Where permanent on-street parking exists on both streets, bumpouts may be utilized.

C **Durable & Obstacle-free Corners**: Corners shall be designed to accommodate heavier vehicle loads and diminish damage where transit vehicles or trucks may occasionally mount the curb (see City of Ann Arbor Standard Specifications, DDA Sidewalk Detail).

Utility Considerations

- Keep utility cabinets, hand holes and other fixtures off corner curb areas to the extent possible. Where utility cabinets are necessary, they should be in subsurface vaults or in nearby locations clear from the intersection.
- Locate stormwater inlets to effectively drain the street while not precluding curb ramps and corner bumpouts.

Design References

- The NACTO Urban Street Design Guide provides additional guidance on corner geometries.

MAINTENANCE & MANAGEMENT

Seasonal Use & Maintenance

- Snow should be removed all the way to the vertical curb face of a corner.
- “Sneckdowns” are tracks in fresh snow that reveal precisely the actual turn radii and frequency of turning vehicles and may inform locations where tighter curb radii and/or bumpouts are viable.

Reviews & Approvals

- The Ann Arbor Project Management Unit designs and/or approves corner geometries.

PEDESTRIAN AREAS

DRIVEWAYS & CURB CUTS

Functional Emphasis \ Frontage Context	Des. Comm.	Comm.	Mixed	Civic & Uni.	Near NBH
Pedestrian	⊗	⊗			
Transit		■	■	■	
Vehicle		■	■	■	
Bicycle		⊗	■		■
Balanced		■	■	■	■

DESCRIPTION & INTENT

Driveways provide access in and out of private property. While they are an important part of the public realm, too many driveways create an unpleasant pedestrian environment and increase conflicts between motorists and other street users. They also take away space that may otherwise support planting, street furniture, and curbside parking. Coordinating the design of driveways together with the sidewalk contributes to a higher-quality pedestrian realm and reduces dangerous conflicts.

USE & APPLICATION

Location

- Driveways and curb cuts are generally undesirable in downtown and building service access should be provided off alleys whenever possible. While restricted and undesirable on most street types, private property which is not an alley may require a curb cut.
- Driveways and curb cuts are not appropriate for Destination Commercial and Commercial Frontage Contexts and should be avoided.
- Likewise driveways and curb cuts should be severely limited in Commercial contexts. They are expected in all other frontages, though should be sensitively located and designed to minimize conflict with pedestrians, bicycles and transit operations.
- Regardless of context, the number of driveways should be minimized. Use a single common curb cut to provide access to several businesses or properties.
- On residential streets, driveways should be restricted within 20 feet of unsignalized intersections, and at least 40 feet from signalized intersections as measured from the close end of the intersection curb radius along the curb line. On commercial streets, driveways should always be at least 100 feet from intersections. Driveways generally conflict with bus stops and should be avoided in bus stop locations.

Related Design Elements

- **Traffic Calming**: As a location where vehicles frequently enter and exit a street, driveways are excellent opportunities to introduce traffic calming elements to the street (e.g. mid-block bumpouts) to ensure that motorists are aware of their surroundings and do not drive in a way that endangers other road users.
- **Bumpouts**: Driveways can be used in conjunction with bumpouts. Move the driveway apron out to the bumpout and make it flush with the sidewalk level."

Policy References

- The Downtown Ann Arbor Design Guidelines provide guidance on how to manage driveways on public streets. It recommends providing a continuous street edge at street level to reduce the number of interruptions by driveways.
- Ann Arbor Code, Title IV Chapter 47, 4:20 provides requirements on driveway placement, frequency, and geometry.

DESIGN & OPERATIONS

Design Requirements

While driveways are often necessary for building access and loading, their design should indicate to motorists that pedestrians and cyclists, and through vehicle traffic have the right-of-way across a driveway. Driveway entrances and curb cuts are an opportunity to provide traffic calming to reduce the potential for conflicts.

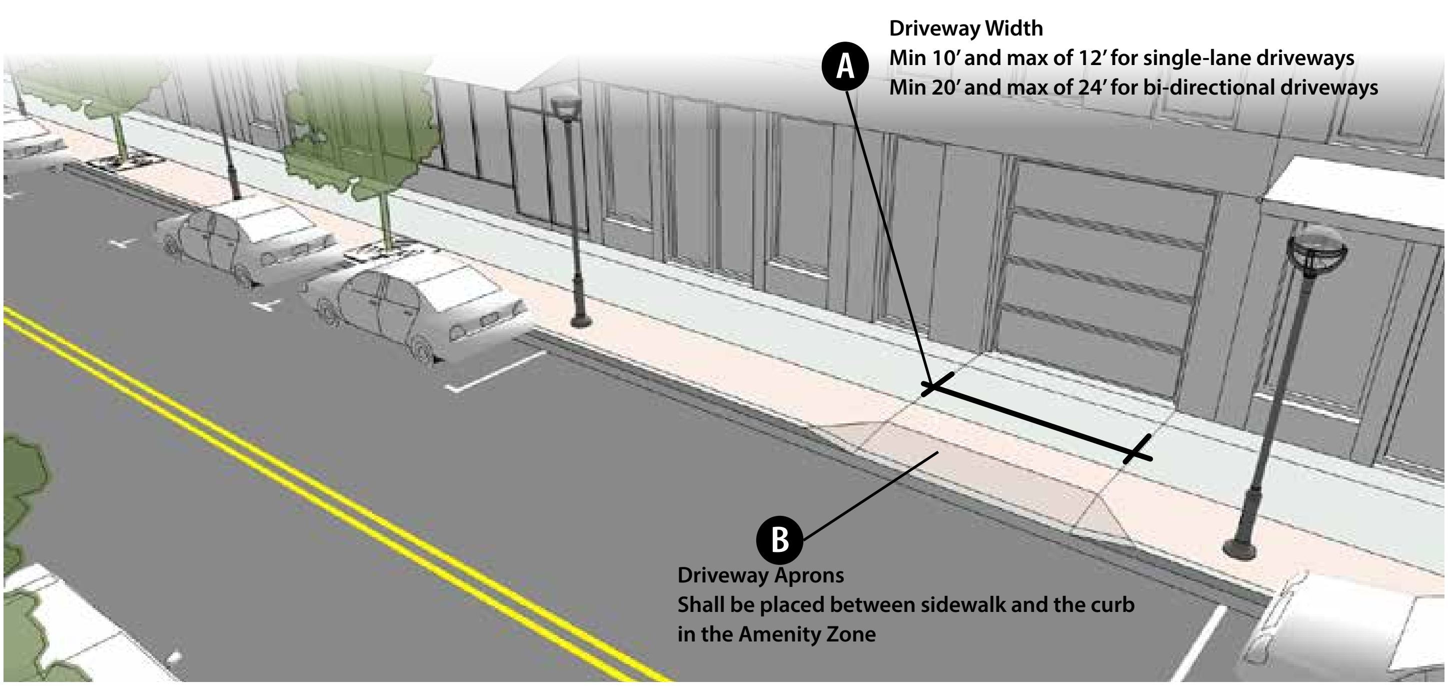
A **Driveway Width**:

» Single-lane driveways shall be at least 10 feet wide, but no wider than 12 feet.

» Bi-directional driveways shall be at least 20 feet wide and no wider than 24 feet.

- **Driveway aprons** shall be placed between the sidewalk and the curb in the Amenity Zone. The apron should not encroach on the clear sidewalk (walking zone). If there is a bumpout or parking lane planter, the apron should lie within the bumpout. Bumpouts should be used if the sidewalk is too narrow to accommodate a safe driveway intersection.

B **Sidewalk Interface**: Make driveways shall be flush with the sidewalk level to maintain a comfortable walking environment and reduce conflicts.



- **Sidewalk Materials**: Continue sidewalk paving material across the driveway to indicate that pedestrians will be crossing this space.
- **Visibility Sight Lines**: Curb cuts shall provide adequate visibility to and from the sidewalk and street. Ideally, vehicles should not need to block the sidewalk while gaining clear lines of sight, but this may be unavoidable.
    - » Where sight lines are limited, include appropriate signage indicating where the driver is to stop and wait.
    - » Mirrors, audible signals, or other devices to assist with visibility of pedestrians are encouraged.

Additional Design Considerations

- **Alley Access**: Curb cuts are not appropriate where alleys can provide rear access to residences and businesses. Where large new development occurs along a significant portion of a block face, provide a central alleys to reduce the need for multiple driveways and curb cuts.
- **Bike Lane Markings**: Where a driveway crosses a bike facility, paint bicycle markings on the pavement to indicate where there is a conflict.
- **Major Driveways**: Ensure driveways that function as an intersection, such as onto private alleys or drives, contain all of the features of a conventional intersection, including crosswalks, tight corner radii, and a signal, if deemed necessary.

Utility Considerations

- Design new curb cuts as to not impede drainage from the street.

Sustainability Considerations

- Consider using permeable materials for driveways, which can reduce stormwater runoff and improve water quality.

MAINTENANCE & MANAGEMENT

General Maintenance

- Driveway aprons with special paving materials may need additional maintenance from property owners.

Seasonal Use & Maintenance

- **Snow Removal:** Property owners in Ann Arbor are required to shovel their sidewalks, including where sidewalks cross a driveway, within 24 hours of a snow event.
    - » Snow from driveways should never be stored in the street and doing so is illegal in Michigan. While snow removal vehicles clearing the street may pile snow into a driveway apron during plowing operations, sidewalks crossing a driveway should never be used for snow storage.

Reviews & Approvals

- The Ann Arbor Planning and Development Services office is responsible for reviewing the creation of new driveways as part of the site plan review process.

ROADWAY ZONE

MEDIANS

Functional Emphasis / Frontage Context	Des. Comm.	Comm.	Mixed	Civic & Uni.	Near NBH
Pedestrian	✕	✕			
Transit		!	!	!	
Vehicle		!	!	!	
Bicycle		!	!		!
Balanced		!	!	!	!

DESCRIPTION & INTENT

A median divides lanes of traffic. In a downtown, medians are generally in the center of the right-of-way, dividing opposing directions of traffic. They may also be located on the side, separating local access or special purpose lanes such as dedicated travel ways.

Medians increase safety and enhance roadway operations by reducing vehicular movement conflicts, limiting turning movements, and providing a refuge for pedestrians crossing the street.

Medians take on many forms. They may be flush with the pavement and consist of painted markings, a space protected with bollards, or a raised curb. Striped or painted medians may precede more permanent improvements, providing localities an opportunity to test travel behaviors before making a significant capital investment. Raised medians within the travel zone provide opportunities for landscaping, street trees, and two-stage pedestrian crossings.

USE & APPLICATION

Location

- Given the relatively narrow dimensions of streets in downtown Ann Arbor, limited opportunities for the incorporation of medians into the street exist. Medians are generally applied to vehicle emphasis streets as a means to reduce conflicts and facilitate flow while providing an attractive streetscape environment.
- Medians are not well suited to pedestrian & access emphasis streets as they can impede visibility of businesses and make commercial support activities (e.g. deliveries) more challenging.
- Medians may be used as an access management tool, a means to limit vehicle conflicts on a corridor to facilitate traffic flow and safety. Medians may also be used as a traffic calming and beautification device.

Related Design Elements

- **Traffic Calming**: Used in isolation, roadway medians do not have a significant impact in reducing vehicle speeds. For the purpose of slowing traffic, medians are generally used in conjunction with other traffic calming measures, such as bumpouts or roadway lane narrowing.

- **Pedestrian Crossings**: Medians provide an important refuge, but do add to the overall width of the Roadway Zone. While providing a median can shorten each leg of a crossing, a wide median increases the total street crossing distance, which adds time to the signal sequence and causes traffic delay. Two-stage pedestrian crossings should be avoided whenever possible. Consider foregoing a median in order to narrow the pedestrian crossing width and enable safe single-stage crossing.
- **Sidewalks and Bicycle Lanes**: Do not remove or narrow sidewalks or bicycle facilities to provide medians or pedestrian refuges. Medians should not compromise the ability to accommodate other street uses. It may not be possible to add medians to streets with narrow driveways.

DESIGN & OPERATIONS

Design Requirements

A **Median Width**: Medians should be a minimum of 6 feet wide to provide adequate width for pedestrians crossing with strollers, bicycles or wheelchair devices.

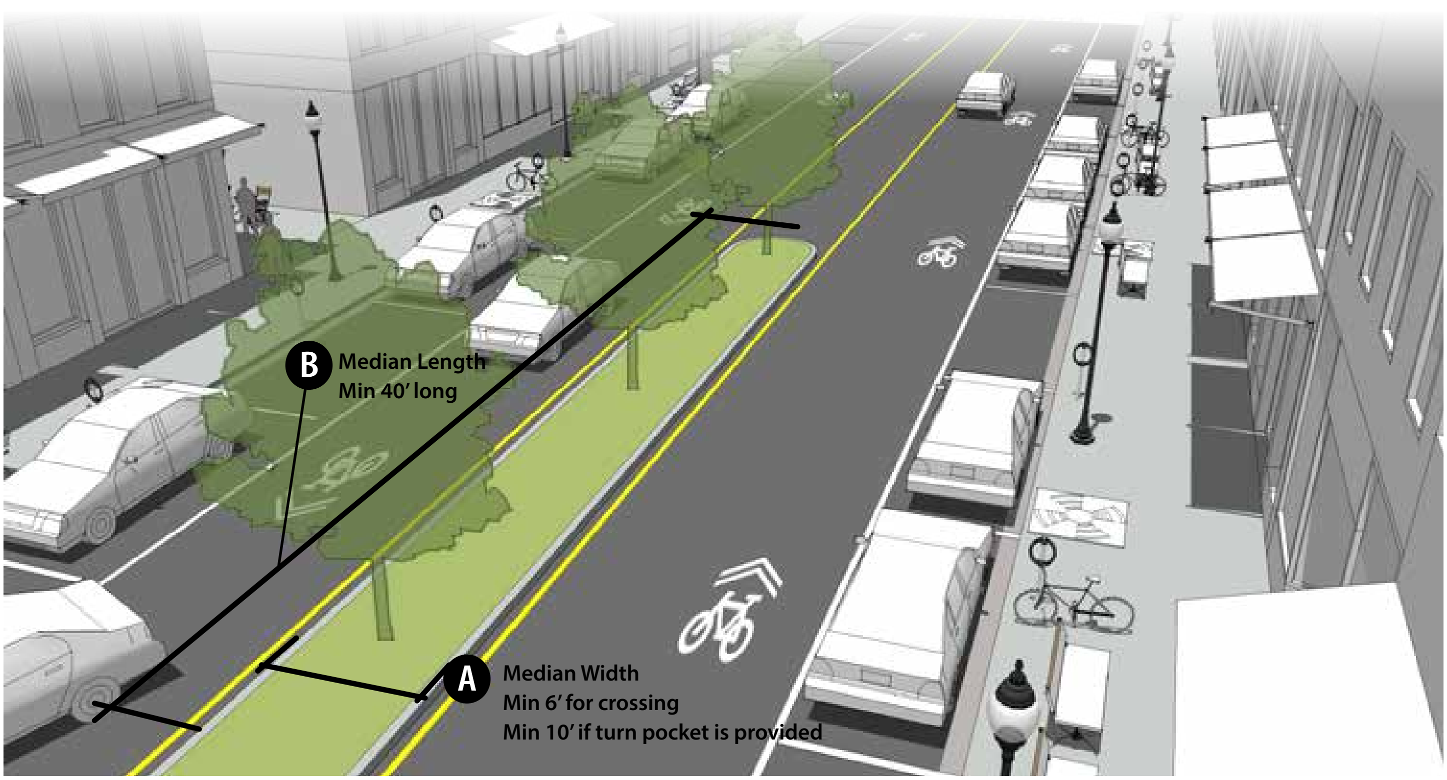
» Medians must be at least 10 feet wide if they are to provide turn pockets at intersections.

» Where a 6 foot median width cannot be provided, a narrower raised median can still improve crossing safety. In these instances, signals should be timed so that pedestrians can cross in one signal phase.

B **Median Length**: Medians should be a minimum of 40 feet long.

- **Crosswalks**: Crosswalks should cross medians at street level. The resulting cut-through should equal the width of the crosswalk and be wide enough to accommodate snow removal.

» Provide a median nub at crosswalks to buffer and protect pedestrians from traffic in the intersection. See Pedestrian Refuge Island for additional guidance.



- **Planting**: Design plantings to avoid blocking sight lines for pedestrian, cyclists, and motorists near intersections and crossings.

Utility Considerations

- Do not locate utilities below planted medians as plantings may impact utility lines and repair or replacement is challenging. Utilities under striped, painted or paved medians are easier to access with minimum disruption to roadway operations.

Sustainability Considerations

- Landscaping medians reduce the impervious surface area in the roadway, allowing stormwater infiltration or retention in the exposed soil. Curbed medians more than 4.5 feet wide, should be landscaped and used for stormwater management where possible. To support street trees, medians should be at least 6 feet in width and a minimum of 15 feet in length per tree. Refer to Street Tree design elements (Section 4.6) for additional information.
- Providing vegetation helps motorists identify medians. Varying the types of plantings or trees can give motorists a clue to the type of environment they are passing through, leading them to adjust their behavior and speed accordingly. Street trees located within the intersection should avoid blocking sight lines to ensure safety.

Design References

- The NACTO Urban Street Design Guide provides further information on the design of medians and pedestrian crossing islands in urban environments.
- The Institute of Transportation Engineers offers guidance on medians and other traffic calming devices.

MAINTENANCE & MANAGEMENT

General Maintenance

- **Landscape Care**: Planted medians will require landscape stewardship to ensure well maintain planting beds. Ann Arbor has an “Adopt-a-Median” program coordinated through the Adopt-a-Park program.
    - » In the early years, it may be necessary to irrigate or water by hand, any planting, especially trees, established in the median.

Seasonal Use & Maintenance

- **Snow Removal**: Medians should be designed with snow removal in mind. Medians can be used for snow storage when necessary, although this may negatively impact planted materials, can block sight lines along the roadway, and can trap pedestrians trying to cross at unmarked locations.
    - » Medians should allow adequate width in the adjacent travel lane to accommodate snow removal vehicles, as well as turn radii that facilitates snow clearing and removal.

INTERSECTION ZONE

MINI ROUNDABOUTS

Functional Emphasis \ Frontage Context	Des. Comm.	Comm.	Mixed	Civic& Uni.	Near NBH
Pedestrian	■	■			
Transit		■	■	■	
Vehicle		■	■	■	
Bicycle		■	■		■
Balanced		■	■	■	■

DESCRIPTION & INTENT

Mini roundabouts, also referred to as mini circles or neighborhood traffic circles, are small diameter traversable or protected islands[1] in the middle of an intersection. Mini roundabouts subtly deflect the path of traffic, slowing traffic speeds while maintaining vehicle progression. The slower speeds and angle of the vehicles provide greater visibility to pedestrians as well as a safer, easier crossing. Mini roundabouts have demonstrated significant safety benefits and reduction in the number and severity of crashes.

Mini roundabouts can be attractive focal points in a streetscape environment and some communities, like Seattle, WA, even have competitions between neighborhoods for the most attractive mini roundabout design and maintenance.

USE & APPLICATION

Location

- Mini roundabouts are appropriate in all Frontage Contexts, and pedestrian and bicycle emphasis streets, as well as balanced street types.
- Use mini roundabouts at the intersection of lower speed, bi-directional streets with only one lane of traffic per direction.
- Mini roundabouts may be used at physically-constrained locations as they can generally be accommodated in the existing bounds of most streets.
- Mini roundabouts are commonly used as an alternative to four-way stop signs but may also be used in lieu of two-way stop controls.
- Mini roundabouts may be used at isolated locations or may be applied in sequence along multiple intersections of a corridor.
- Mini roundabouts may be used to improve safety and flow at intersections like Fourth Avenue and Catherine Street where the mixing of drivers, pedestrians and cyclists cause confusion at the four-way stop.
- Mini roundabouts may be piloted and tested as temporary installations through the use of paint and/or temporary flexible curbing, sand bags, or other acceptable materials.[2]
- Mini roundabouts typically do not adversely affect bicycle facilities, emergency responders, or other special vehicles. Any unique challenges can typically be addressed through design adjustments.

[1] http://safety.fhwa.dot.gov/intersection/roundabouts/fhwasa10007/

[2] The "Living Preview" of the Yellow Brick Road project in Richmond, CA is a great example of a temporary and test installation of a mini roundabout. http://richmondconfidential.org/2014/10/24/residents-test-yellow-brick-road-and-proposed-walkable-streets-within-the-iron-triangle/ (Accessed January 2015)

Related Design Elements

- **Crosswalks**: Place crosswalks across all approaches so motorists know where to look for pedestrians and pedestrians know where to cross safely.
- Carefully design bicycle facility approach as entering the mini roundabout. A bicycle lane may be provided around the mini circle; however, it is more common that bicycles share the lane in a mini roundabout.
- Mini roundabouts on emergency vehicle framework streets or transit routes must be designed to accommodate the sweep of these vehicles.

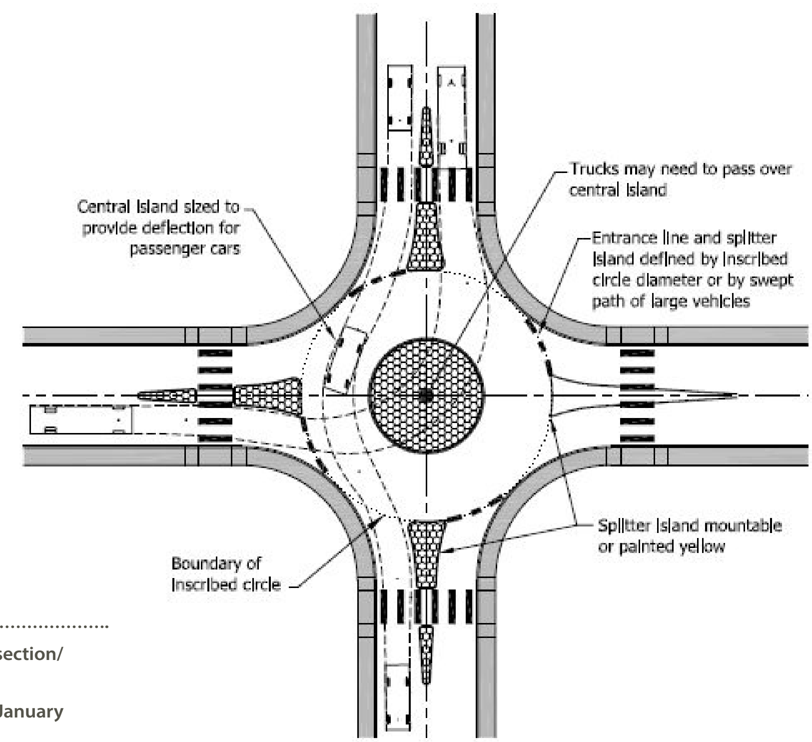
Policy References

- The FHWA, through its Office of Safety, has developed guidance for the design and use of mini roundabouts.[3]
- The Seattle Department of Transportation Neighborhood Traffic Control Program is one of the most extensive and mature in the nation providing robust resources for peer communities, including standard specifications for construction.[4]

DESIGN & OPERATIONS

Design Requirements

- **Geometry**: Make mini roundabouts as large as possible. Design the inscribed circle with radii large enough to deflect travel lanes, but small enough to stay within the existing curb lines. Properly designed, mini roundabouts should not require the realignment of existing street curbs.
- **Mountable Apron**: Create a protected area in the center surrounded by a mountable apron that accommodates the larger turning radii required by trucks, buses, and other larger vehicles.
  - » Design the mountable apron to accommodate and withstand snowplow blades. The City of Seattle standard is for a 2 foot wide concrete ring no more than 4 inches high.
- **Signage**: Use yield control on all entries.
- **Approaches**: Use raised channelization to guide approaching traffic into the circle. Pavement markings may be used as an alternative.
  - » Rumble strips should be used in advance of any integrated crosswalks to alert pedestrians of on-coming cars.



[3] Report number "FHWA-SA-10-007" http://safety.fhwa.dot.gov/intersection/roundabouts/fhwasa10007/ (Accessed January 2015)

[4] http://www.seattle.gov/transportation/trafficcircles.htm (Accessed January 2015)

Additional Design Considerations

- **Center Landscape Area**: The central island may be fully traversable (typically with a paved circle) or may permit landscaping inside of a wide apron.
- **Stop Controlled Entry**: Some communities use stop controlled entries which is then more appropriately called a neighborhood traffic circle, rather than mini roundabout.

Utility Considerations

- Ensure mini roundabouts do not conflict with sub-surface utilities, particularly if landscaping beds or curbs are provided as elements of the roundabout design.
- Do not locate utility vaults in mini roundabouts.

Sustainability Considerations

- Mini roundabouts can provide a unique opportunity for street greening and the removal of impervious surfaces. Place landscaping in the center portion of the mini roundabout. Ground cover should remain low, though trees may be used if the line of sight through the mini roundabout.

MAINTENANCE & MANAGEMENT

Special Maintenance

- Any landscaping in mini roundabouts should be regularly maintained and potentially irrigated. If community partners participate in landscape maintenance, clear safety protocols must be put in place and maintenance agreements should be adopted.
- Mini roundabouts may complicate street repaving projects.
- Roundabouts require both additional signage and pavement markings, which also must be maintained.

Seasonal Use & Maintenance

- If mini roundabouts are planted, seasonal landscape care is required.
- Mini roundabouts can introduce some challenges to snow removal. A mountable apron on the roundabout allows snowplows to maneuver around them. The center island of mini roundabouts may be used for temporary snow storage.

Reviews & Approvals

- The Ann Arbor Systems Planning and Engineering Units will review and approve mini roundabout applications in the city.

INTERSECTION ZONE

SIGNALS: NO TURN ON RED (LEFT AND/OR RIGHT)

Functional Emphasis / Frontage Context	Des. Comm.	Comm.	Mixed	Civic & Uni.	Near NBH
Pedestrian	⊗	■			
Transit		■	■	■	
Vehicle		■	■	■	
Bicycle		■	■		■
Balanced		■	■	■	■

DESCRIPTION & INTENT

“Right on Red” operations permit vehicles to complete a right-hand turn even when the signal governing their leg is displaying red. Vehicles may only proceed when the intersection is clear of on-coming vehicles and pedestrians in the crosswalk.

Conversely No Right on Red operations prohibit vehicles from making this turn. All vehicles must wait for the appropriate green signal.

In Michigan, vehicles are permitted to make a Left on Red, but only onto a one-way street.

Right on Red operations are generally used to aid in progressing vehicle traffic. The reduced idling time can have modest air quality benefits but, Right on Red may increase conflicts with and risk to pedestrians in a concentrated downtown area where pedestrians are common.

USE & APPLICATION

Location

- Unless specifically prohibited, Right on Red is permitted at all signalized intersections in Ann Arbor.
- No Right on Red is typically employed at locations with relatively high pedestrian volumes. This treatment is advised for intersections in Destination Commercial street types and should be considered at all other Commercial street types.
- Right on Red can be temporal, prohibiting right turns only during peak hours of pedestrian activity (for example 7AM to 7PM). Right on Red may be further qualified with signage that indicates “No Right on Red When Pedestrians Present.”

Policy References

- The MMUTCD is the definitive guide for all signal operations and design.[1]

INTERSECTION ZONE

SIGNALS: LEADING VS. LAGGING LEFTS

Functional Emphasis \ Frontage Context	Des. Comm.	Comm.	Mixed	Civic & Uni.	Near NBH
Pedestrian	■	■			
Transit		■	■	■	
Vehicle		■	■	■	
Bicycle		■	■		■
Balanced		■	■	■	■

DESCRIPTION & INTENT

Designated signal phases for left turns are common in many locations. Left turns may be accommodated through an exclusive signal phase, where only opposing left turns are permitted, or as an early or elongated period for the through green time for one approach of the intersection. These left turns are known as “leading lefts” if they occur at the beginning of the through vehicle phase or “lagging lefts” if they occur at the end of the phase.

Leading lefts tend to be less intuitive to pedestrians accustomed to being given a walk phase at the conclusion of the red phase for opposing traffic. Pedestrians may jump the signal and find themselves in direct conflict with left turning vehicles. Pedestrian/vehicle conflict have been found to be almost six times higher with leading lefts as compared to lagging left signal operations.[1]

USE & APPLICATION

Location

- Leading or lagging lefts allow time for turning vehicles to clear the intersection. They are generally used in locations that have a high volume of pedestrians or through traffic that inhibit the completion of the left-turn.
- Lagging lefts are generally preferred for pedestrian progression. Leading lefts are generally preferred for vehicle progression.

Policy References

- The MMUTCD is the definitive guide for all signal operations and design.[2]

DESIGN & OPERATIONS

Design Requirements

- Intersections with leading left phases should provide more generous sidewalk space to accommodate pedestrian queuing. Pedestrians are generally at their greatest concentration at the beginning of any signal cycle. Lagging lefts permit the majority of pedestrians to clear the intersection before left turns proceed.
- Leading Pedestrian Intervals (LPI) may not be used in conjunction with leading left signal operations, but may be combined with lagging left signals.

[1] Hummer, J. E., Montgomery, R. E., and Sinha, K. C. Guidelines for Use of Leading and Lagging Left-Turn Signal Phasing, Transportation Research Record, No. 1324, TRB, National Research Council, Washington, D.C., 1991.

[2] http://mutcd.fhwa.dot.gov/htm/2009/part4/part4e.htm

Functional Emphasis \ Frontage Context	Des. Comm.	Comm.	Mixed	Civic & Uni.	Near NBH
Pedestrian	!	!			
Transit		■	■	■	
Vehicle		■	■	■	
Bicycle		■	■		■
Balanced		!	■	!	■

INTERSECTION ZONE

SIGNALS: LEADING PEDESTRIAN INTERVAL

DESCRIPTION & INTENT

A leading pedestrian interval (LPI) is a brief time at the beginning of a signal phase that permits pedestrians to enter the crosswalk before any other traffic is permitted to advance. LPIs improve the visibility of pedestrians by putting them more clearly in the sight of right and left turning vehicles. Studies show that LPIs reduce pedestrian/vehicle collisions by up to 60%.[1]

USE & APPLICATION

Location

- LPIs are appropriate for use on any street type; however, are typically used at intersections with significant pedestrian volumes and high volumes of conflicting turning vehicles, such as Destination Commercial and other Commercial areas and areas of high student concentrations.
- LPIs may also be used on streets approaching vehicle flow corridors to improve the visibility of pedestrians crossing parallel to high volume, higher-speed streets.

Policy References

- The MMUTCD is the definitive guide for all signal operations and design."

DESIGN & OPERATIONS

Design Requirements

- Require the concurrent use of pedestrian signal heads.
- May not be used with leading left turns.
- Must be a minimum of three seconds in duration, but more commonly provide five or more seconds to permit pedestrians to cross at least one lane of vehicle traffic.
- Should be accompanied by audible and/or vibrotactile signals for visually impaired pedestrians.

Optional Design Considerations

- Eliminate Right on Red at locations were LPIs are used. Right on Red is generally undesirable at intersections with high and regular pedestrian volumes.
- At locations with extremely high pedestrian volumes, combine the LPI with signal timing that displays the "DON'T WALK" signal for pedestrians even while the green phase is still shown for parallel traveling vehicles. This brief period at the end of the cycle provides an opportunity for vehicles to complete turns after the majority of pedestrians have completed their crossing.
- Combine LPIs with bumpout to further increase pedestrian visibility and safety.
- Bicycles may also benefit from LPIs and clear an intersection to permit vehicle turns.

[1] A.C. Fayish and Frank Gross, "Safety effectiveness of leading pedestrian intervals evaluated by a before–after study with comparison groups," Transportation Research Record No. 2198 (2010): 15–22.

Functional Emphasis \ Frontage Context	Des. Comm.	Comm.	Mixed	Civic & Uni.	Near NBH
Pedestrian	■	■			
Transit		■	■	■	
Vehicle		■	■	■	
Bicycle		■	■		■
Balanced		■	■	■	■

SIGNALS: ALL-WALK SIGNAL PHASES

DESCRIPTION & INTENT

All-walk signal phases, also called pedestrian scramble lights, diagonal crossing or Barnes Dance, stop all vehicle movements on all legs of an intersection and permit pedestrians to cross in any direction – including diagonally across the intersection. Conceived by Flint, MI native Henry Barnes, the pedestrian scramble was first used in Denver, CO.[1]

All-walk signal phases may be the only opportunity in a signal cycle when pedestrians are permitted to cross since pedestrians are held during all other phases to remove their conflicts with turning vehicles. All-walk signal phases may also serve as an additional phase, with pedestrians still permitted to cross concurrent with parallel traffic during typical signal cycles.

- All-walk signal phases are generally unfamiliar operations to most pedestrians and may take some time for motorists and pedestrians to adapt.

USE & APPLICATION

Location

- All-walk signal phases should only be used where high volumes of pedestrians are expected on a routine basis.
- All-walk signal phases may also be used at locations where there are a high number of conflicting movements between crossing pedestrians and turning vehicles. In this case, the all-walk phase may be the only time when pedestrians are permitted to cross the intersection. Pedestrians are held on the sidewalk during vehicle phases. Although the all-walk phase permits movements in all directions and single-cycle crossings, it may also decrease pedestrian level of service as pedestrians must wait through two or more signal cycles before getting permission to cross.

Policy References

- The MMUTCD is the definitive guide for all signal operations and design.[2]

DESIGN & OPERATIONS

Design Requirements

- Instructive signage is generally necessary at all-walk signal phase locations, as this is a non-standard traffic operation.
- All-walk signal phases should be accompanied by audible and vibrotactile indicators for visually impaired pedestrians.
- Sidewalks should be large enough to comfortably provide space for queuing pedestrians waiting to cross.
- All-walk signal phases s should be routinely monitored and reassessed. Given the longer delays for both vehicles and pedestrians, there may be reductions in signal compliance.

[1] Jeremy Meyer, "Denver to eliminate diagonal crossings at intersections," The Denver Post. April 06, 2011 http://www.denverpost.com/ci_17780418 (Accessed January 2015)

[2] http://mutcd.fhwa.dot.gov/htm/2009/part4/part4e.htm

INTERSECTION ZONE

SIGNAL: TRAFFIC SIGNAL PRIORITY

Functional Emphasis \ Frontage Context	Des. Comm.	Comm.	Mixed	Civic & Uni.	Near NBH
Pedestrian	■	■			
Transit		■	■	■	
Vehicle		■	■	■	
Bicycle		■	■		■
Balanced		■	■	■	■

DESCRIPTION & INTENT

Traffic signal priority (TSP) prioritizes the progression of select vehicles, typically transit or emergency vehicles, over the standard progression of typical transit. TSP may be active or passive.

Passive TSP times traffic signals and corridor progression to the average bus speed rather than vehicle speed.

Active TSP is an Intelligent Transportation System (ITS) that enables an approaching bus to communicate with a traffic signal and alter the signal timing to improve transit progression. Active TSP may extend the signal green time, truncate the red phase, swap signal phases, insert a transit-only phase, or skip signal phases. The margin of signal time prioritized for transit is typically made up in modifications to the remaining signal phases with the overall signal cycle length remaining generally unchanged and fully recovered in the following cycle. TSP uses transponders on buses that communicate with traffic controllers. Prioritizing transit at intersections creates more reliable and efficient service. This makes transit a more attractive mode of transportation for users and reduces operating costs for the City and service area.

Ideally, TSP should be deployed in concert with, and as an integrated component of, an overall ITS Master Plan for the city as a whole.

USE & APPLICATION

Location

- TSP is generally used on high frequency, high ridership transit corridors, and transit emphasis streets.
- TSP should be installed only when there is documented schedule adherence issues.

Related Elements

- **Traffic:** Active TSP modifies pre-timed signals. Industry practice indicates that TSP generally has minimal disruption on vehicle traffic; however, may briefly interrupt traffic progression on intersecting corridors with synchronized lights. The benefits and potential effects of TSP should be examined and considered before deploying this technology.
- **Transit:** Active TSP requires that surface transit vehicles or emergency vehicles be equipped with signal communication devices.
- **Queue Jump Lanes:** TSP is often used in conjunction with bus queue jump lanes, though they are not a prerequisite for use.
- **Bus Stops:** Far-side bus stop locations tend to benefit the most from TSP systems, as they reduce delays from buses waiting at the near-side of the intersection for a green signal.

Policy References

- Transit Signal Priority: A Planning and Implementation Handbook (May 2005) funded by the U.S. Department of Transportation and published by ITS America provides comprehensive guidance on TSP for transit.
- The FHWA Traffic Signal Timing Manual (Publication Number: FHWA-HOP-08-024) includes a section on planning and implementing traffic signal priority.

DESIGN & OPERATIONS

Design Requirements

- TSP does not require any physical modifications to the intersection, but it is often utilized in conjunction with bus queue jump lanes.
- TSP may be implemented at individual intersections, along a continuous corridor or route, or throughout the signal system.
- TSP typically cannot be activated for more than two signal cycles in a row and then cannot be activated until two to three additional signal cycles have passed to enable overall intersection and network recovery.

Sustainability Considerations

- TSP does not introduce any unique opportunities for green infrastructure installation, although it can increase transit service and use and this minimize vehicle traffic and idling.

MAINTENANCE & MANAGEMENT

Special Maintenance

- TSP does require both on-board vehicle equipment and signal system components. ITS does not normally, introduce any additional maintenance burdens than standard signal maintenance. Typically the TSP will maintain on-board equipment while the city or state will maintain signal equipment, though both must work in concert.

Reviews & Approvals

- TSP systems would be deployed in collaboration between the AAATA and the City of Ann Arbor and/or MDOT.