chapter three

Design Elements

Introduction

While planning principles and design concepts provide a framework for the integration of land use and transportation planning, the application of principles and concepts is accomplished through specific, quantifiable design elements. The purpose of this chapter is to identify, describe and quantify the more significant design elements which need to be considered in the planning and design stages.

The design elements are arranged into the following categories:

- Bicycle/Pedestrian Circulation;
- Public Transportation;
- Infrastructure/Amenities; and,
- Vehicular Circulation.

The Chester County Planning Commission recommends that users of this handbook review in further detail the source documents associated with the recommended standards where applicable for better integration with the site specific conditions particular to the development being proposed. The design criteria and guidelines presented in this chapter generally represent minimum values that imply the lowest possible limit in design. However, it is the responsibility of each user to exercise and utilize values exceeding the minimum values wherever practical and within reasonable economic limitations and sound engineering judgment. Variations from what is presented in this chapter may be required for special or unusual conditions. In some cases, the additional resources listed outside of the recommendation may be more applicable pending on those unique site specific conditions.

BICYCLE/PEDESTRIAN

Bicycle Facilities

Bicycle facilities are vital components in a community's transportation system. An established bicycling network can reduce traffic congestion and pollution by providing alternate means to vehicular travel. They also provide recreational opportunities which encourage healthy lifestyles and thus enhance the quality of life within a community.

Bicycling is a very quick, convenient, and healthy way for adults and teenagers to make trips of up to 3-5 miles in reasonably good weather. Nationally, approximately 57% of all automobile trips are five miles or less in length and nearly 1/3 are two miles or less. Given these high percentages of short trips, bicycling should be a significant way to reduce dependence on the automobile for short commutes, errand running, social visits, etc. But today, bicycling accounts for a statistically insignificant percentage of transportation oriented trips in Chester County. Why is the bicycle not used for transportation in Chester County and what can be done to increase the number of people bicycling for transportation?

The AASHTO ***Guide for the Development of Bicycle Facilities*** states that "Bicycling is a healthy, low cost mode of travel that is available to nearly everyone. Bicycling is also one of the most energy-efficient forms of transportation available. Since bicycling emits no pollution, needs no external energy source, and uses land efficiently, it effectively moves people from one place to another without adverse environmental impacts."

"Bicycle facilities" can be located both within and outside of roadway right-of-ways. Within roadway rights-of-way, there are either bicycle lanes or cycle tracks that provide dedicated space for bicyclists, or there are 'share the road' routes that typically include improved shoulders, signage, and sometimes pavement markings. Outside the roadway, bicycle facilities are commonly referred to as "trails" and are typically "Shared Use" or "Multi-Use" facilities where cyclists share the facility with pedestrians and other non-motorized modes of travel, such as equestrians, cross country skiers, rollerbladers, skateboarders, baby strollers, and those using motorized scooters and wheelchairs. **See also the SHARED USE FACILITIES design element.**

Bicyclist User Groups

Defining the type of users and facilities is an important basis for bicycle and pedestrian planning. The following description of bicyclists and facilities is primarily based upon PennDOT's ***Design Manual 2 – Chapter 16: Bicycle Facilities*** and the AASHTO ***Guide for the Development of Bicycle Facilities***.

AASHTO categorizes bicyclists into the following categories relative to user skill and comfort level:

- **Experienced and Confident** – This group includes bicyclists who are comfortable riding on most types of bicycle facilities, including roads without any special treatments for bicyclists. This group also includes utilitarian and recreational riders of many ages who are confident enough to ride on busy roads and navigate in traffic to reach their destination. However, some may prefer to travel on low-traffic residential streets or shared use paths. Such bicyclists may deviate from the most direct route to travel in their preferred riding conditions. Experienced bicyclists may include commuters, long-distance road bicyclists, racers, and those who regularly participate in rides organized by bicycle dubs.
- **Casual and Less Confident** – This group includes a majority of the population, and includes a wide range of people: (1) those who ride frequently for multiple purposes; (2) those who enjoy bicycling occasionally but may only ride on paths or low-traffic and/or low-speed streets in favorable conditions; (3) those who ride for recreation, perhaps with children; and (4) those for whom the bicycle is a necessary mode of transportation. In order for this group to regularly choose bicycling as a mode of transportation, a physical network of visible, convenient, and well-designed bicycle facilities is needed. People in this category may move over time to the "experienced and confident" category.

Casual/Less Confident vs. Experienced/Confident Riders

Experienced/Confident Riders	Casual/Less Confident Riders
Most are comfortable riding with vehicles on streets, and are able to navigate streets like a motor vehicle, including using the full width of a narrow travel lane when appropriate and using left-turn lanes.	Prefer shared use paths, bicycle boulevards, or bike lanes along low-volume, low-speed streets.
While comfortable on most streets, some preferon-street bike lanes, paved shoulders, or shared use paths when available.	May have difficulty gauging traffic and may be unfamiliar wit rules of the road as they pertain to bicyclists; may walk bike across intersections.
Prefer a more direct route.	May use less direct route to avoid arterials with heavy traffic volumes.
Avoid riding on sidewalks. Ride with the flow of traffic on streets.	If no on-street facility is available, may ride on sidewalks.
May ride at speeds up to 25 mph on level grades, up to 45 mph on steep descents.	May ride at speeds around 8 to 12 mph.
May cycle longer distances.	Cycle shorter distances: 1 to 5 miles is a typical trip distance.

Source: AASHTO

Shared Roadway

A shared roadway (shown below) accommodates bicyclists and motorists in the same travel lane. Currently, this arrangement is the most prevalent bicycle facility in the Region.

A shared roadway example with limited shoulders: PA 162 in East Bradford Township

Wide outside travel lanes, with widths of 12’ to 15’ depending on the roadway context (e.g., rural or urban) are desired for shared lane facilities. A shared lane can be supplemented with “Share the Road” signage.

A paved shoulder or wide curb lanes provide accommodation for bicyclists adjacent to the vehicle travel lanes. Paved shoulders can be located on urban or rural roadways with moderate to high vehicular traffic volumes and moderate to high posted speeds. Paved shoulders for bicyclists range in width from 4’ to 6’+ depending on the available pavement width and can be supplemented with ‘Share the Road’ signage.

SHARED ROADWAY
(limited or no shoulder)
A street which accommodates bicyclists and motorists in the same travel lane. Typically the travel lanes are wider than what would be designed for automobile traffic only for the associated functional classification of the road and its context. Shared roadways may be a Signed Bike Route or include other indicators such as Share the Road Signs, Sharrows, or other pavement markers.

SHARED ROADWAY
(paved shoulder) - A street with a paved shoulder or wide curb lane that accommodates bicyclists adjacent to the vehicle travel lanes. A minimum four (4) foot shoulder is preferable, in conjunction with applicable municipal and PennDOT guidelines. Shared Roadways with paved shoulders may be a Signed Bike Route or include other indicators such as Share the Road Signs, Sharrows, or other pavement markers.

SHARE THE ROAD SIGNAGE
Supplemental signage added to a shared roadway to warn motorists of the increased likelihood of bicyclists.

Paved shoulders along US 322 in Guthriesville, East Brandywine Township

Paved shoulders are separated from travel lanes by the striping representing the outside edge of the outermost travel lane. The maintenance of paved shoulders via street sweeping is important for their success, as roadway debris, cinders, and tree limbs typically accumulate in this area of the cartway.

Shared Roadway Signage

Since 2005, PennDOT's Chester County Maintenance Office coordinated with the Chester County Planning Commission and Chester County Cycling Coalition on the most appropriate locations for Share the Road signage within Chester County along on-road bike routes.

A share the road sign along Strasburg Road in East Bradford Township.

Sharrow

The 2009 edition of the Manual on Uniform Traffic Control Devices (MUTCD) included a new pavement marking called a “sharrow”. Sharrows increase driver awareness of shared roadway arrangements, similar to the advisory treatment of Share the Road signage. PennDOT requires that municipalities are responsible for maintenance of 'sharrow' pavement markings.

Sharrow example in Washington, DC. Photo by Richard Layman.

The following resources provide general guidance regarding the placement of sharrows in the roadway:

- The Philadelphia Mayor’s Office of Transportation and Utilities (MOTU): ***New Sharrows in Philadelphia***.
- ***Chapter 9C*** of the Manual on Uniform Traffic Control Devices (MUTCD) regarding placement of markings.

Signed Bike Routes

Signed bicycle routes are treatments used to designate a preferential bicycle routing and provide wayfinding guidance to cyclists. AASHTO states that the “signing of shared roadways indicates to cyclists that there are particular advantages to using these routes compared to alternate routes”.

Route signs can provide directional, distance, and destination information to assist bicyclists in navigation. Signed routes can direct cyclists to corridors that have existing on-road facilities, or access locations for off road facilities.

Within the Region, the Bicycle PA Route L, which runs along Creek Road and US 322, is a type of signed bicycle route. The Bicycle Route L is a

SHARROW
A pavement marking that increases driver awareness of shared roadway arrangements. Typically, the use of sharrows has been approved by PennDOT; however, the approval of sharrows is presently evaluated on a case-by-case basis.

Bike route signage on the Chester Valley Trail.

SIGNED BIKE ROUTE
Way-finding treatment that indicates the facility has been designated for bicycle use.

long-distance, Class A-oriented bicycle route that runs 225 miles from Chester County to Susquehanna County. Bicycle PA Route S – the longest of Pennsylvania's cycling routes – traverses northern Chester County along PA Route 23, Pughtown Road, and other roadways before crossing into Montgomery County south of Phoenixville.

Bicycle Boulevard

Bicycle boulevards are not included in the PennDOT Design Manual; however, a ***Bicycle Boulevard Guidebook*** was recently released by the Initiative for Bicycle and Pedestrian Innovation at the Center for Transportation Studies. The guidebook provides direction on selecting routes and the application of design elements.

BICYCLE BOULEVARD
A street corridor treatment that prioritizes and enhances bicycle travel through the installation of traffic calming measures, signs, pavement markings, and crossing improvements. These facilities are typically located on roadways with low traffic volumes which are suitable for bicycle travel.

Bicycle boulevard in Berkeley, CA. Photo by Richard Layman. Used with permission.

Bicycle Lanes

Bike lanes are typically located on roadways in urban and suburban settings with moderate to high vehicular traffic volumes and moderate to high posted speeds. PennDOT's Design Manual requires a formal bike lane to be a minimum 5'width with application of pavement striping, markings, and regulatory signage.

Bicycle lane facilities should be oriented for one-way operation and carry bicycle traffic in the same direction as motor vehicles.

BICYCLE LANES
(a striped travel lane for bicycles) - Designated travel lanes within the cartway or along the road shoulder for exclusive use by bicyclists. Bike lanes typically involve a combination of supplemental indicators including but not limited to Share the Road Signs and other pavement markings.

A bike lane example in an urban setting: US Route 30 Business in Coatesville City.

Cycle Track

A cycle track facility is an exclusive facility for bicyclists that combines design aspects of bike lanes and shared use trails/sidepaths. See also the 'Multi-Use Trail' within the SHARED USE FACILITIES design element.

Cycle tracks are constructed within an existing cartway, but buffered from the vehicle lanes by curbing or on-street, parallel parking. Existing cycle track facilities have been designed for both one-way and two-way operations. For more information, see Alta Planning & Design's ***Cycle Tracks: Lessons Learned*** and the ***NACTO Urban Bikeway Design Guide***.

CYCLE TRACK Travel lane for non-motorized vehicles with a physical barrier to other traffic. These may be designed for one-way or two-way travel.

Two-way cycle track in Montreal. Photo by Richard Layman. Used with Permission.

Recommendations

- Follow the guidelines of the 'General Conditions for Selecting Different Bikeway Types' as published in AASHTO's Guide for the Development of Bicycle Facilities (2012, Fourth Edition, pages 2-17 to 2-20) to determine the most appropriate bicycle facility for implementation.

General Conditions for Selecting Different Bikeway Types

Type of Bikeway	Best Use	Motor Vehicle Design Speed	Traffic Volume	Classification or Intended Use	Other Considerations
Shared lanes (no special provisions)	Minor roads with low volumes, where bicyclists can share the road with no special provisions.	Speeds vary based on location (rural or urban).	Generally less than 1,000 vehicles per day.	Rural roads, or neighborhood or local streets.	Can provide an alternative to busier highways or street. May be circuitous, inconvenient, or discontinuous.
Shared Lanes (wide outside lanes)	Major roads where bike lanes are not selected due to space constraints or other limitations.	Variable. Use as the speed differential between bicyclists and motorists increase. Generally any road where the design speed is more than 25 mph.	Generally more than 3,000 vehicles per day.	Arterials and collectors intended for major motor vehicle traffic movements.	Explore opportunities to provide marked shared lanes, paved shoulder, or bike lanes for less confident bicyclists.
Marked shared lanes	Space-constrained roads with narrow travel lanes, or road segments upon which bike lanes are not selected due to space constraints or other limitations.	Variable. Use where the speed limit is 35 mph or less.	Variable. Useful where there is high turnover in on-street parking to prevent crashes with open car doors.	Collectors or minor arterials.	May be used in conjunction with wide outside lanes. Explore opportunities to provide parallel facilities for less confident bicyclists. Where motor vehicle allowed to park along shared lanes, place markings to reduce potential conflicts with opening car doors.

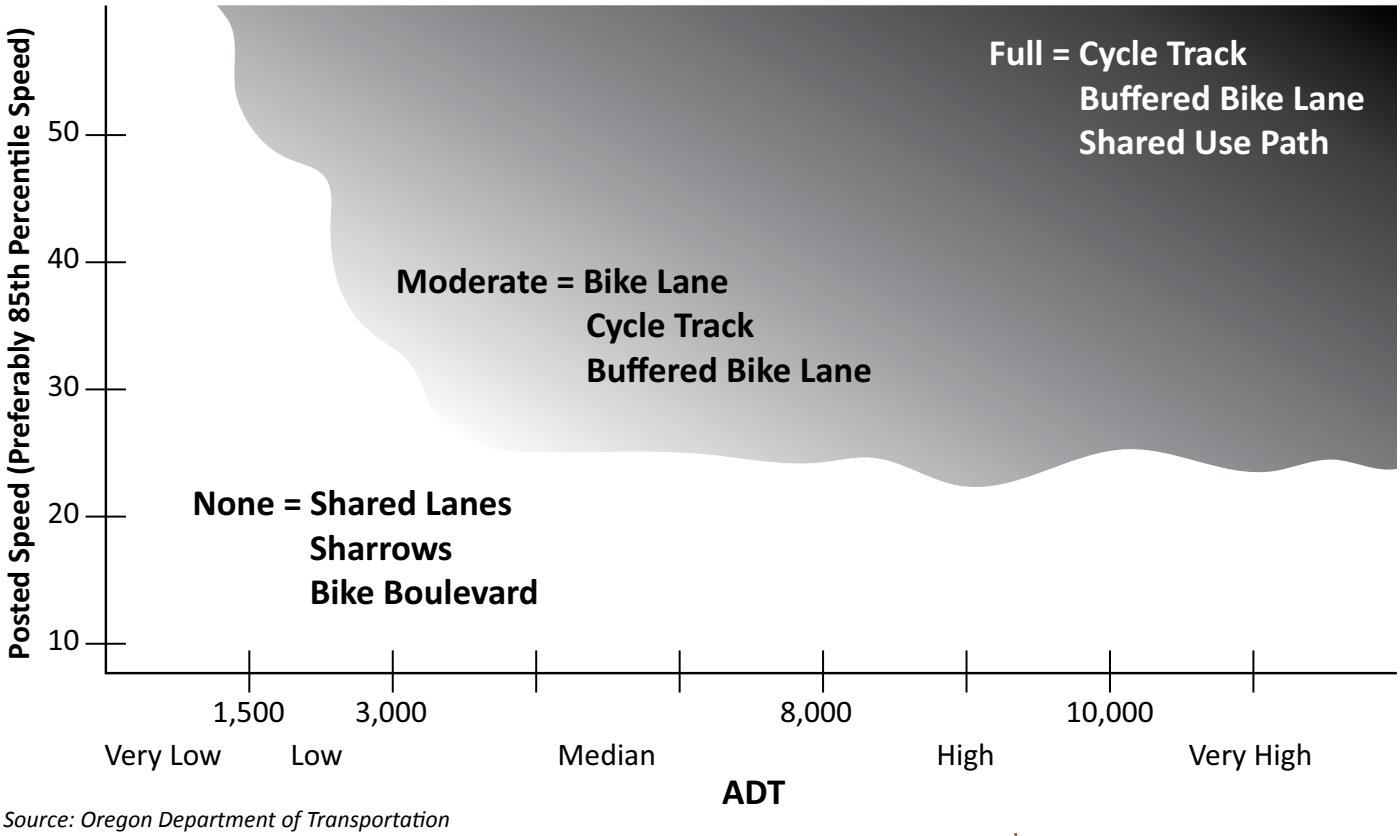
General Conditions for Selecting Different Bikeway Types (continued)

Type of Bikeway	Best Use	Motor Vehicle Design Speed	Traffic Volume	Classification or Intended Use	Other Considerations
Paved shoulders	Rural highways that connect town centers and other major attractors.	Variable. Typical posted rural highway speeds (generally 40-55 mph).	Variable.	Rural road-ways; inter-city highways.	Provides more shoulder width for roadway stability. Shoulder width should be dependent on characteristics of the adjacent motor vehicle traffic, i.e. wider shoulder on higher speed and/or higher-volume roads.
Bike lanes	Major roads that provide direct, convenient, quick access to major land uses. Also can be used on collector roads and busy urban streets with slower speeds.	Generally, any road where the design speed is more than 25 mph.	Variable. Speed differential is generally a more important factor in the decision to provide bike lanes than traffic volumes.	Arterials and collectors intended for major motor vehicle traffic movements.	Where motor vehicles are allowed to park adjacent to bike lanes, provide a bike lane of sufficient width to reduce probability of conflicts due to opening vehicle doors and objects in the road. Analyze intersections to reduce bicyclists/motor vehicle conflicts.
Bicycle boulevards	Local roads with low volumes and speeds, offering an alternative to, but running parallel to, major roads. Still should offer convenient access to land use destinations.	Use where the speed differential between motorists and bicyclists is typically 15 mph or less. Generally, posted limits of 25 mph or less.	Generally less than 3,000 vehicles per days.	Residential roadways.	Typically only an option for gridded street networks. Avoid making bicyclists stop frequently. Use signs, diverters, and other treatments so that motor vehicle traffic is not attracted from arterials to bicycle boulevards.

General Conditions for Selecting Different Bikeway Types (continued)

Type of Bikeway	Best Use	Motor Vehicle Design Speed	Traffic Volume	Classification or Intended Use	Other Considerations
Shared use path: independent right-of-way	Linear corridors in green-ways, or along waterways, freeways, active or abandoned rail lines, utility rights-of-way, unused rights-of-way. May be a short connection, such as a connector between two cul-de-sacs, or a longer connection between cities.	N/A	N/A	Provides a separated path for non-motorized users. Intended to supplement a network of on-road bike lanes, shared lanes, bicycle boulevards, and paved shoulders.	Analyze intersections to anticipate and mitigate conflicts between path and roadway users. Design path with all users in mind, wide enough to accommodate expected usage. On-road alternatives may be desired for advanced riders who desire a more direct facility that accommodates higher speeds and minimized conflicts with intersection and drive-way traffic, pedestrians, and young bicyclists.
Shared use path: adjacent to roadways (i.e., sidepath)	Adjacent to roadways with no or very few intersections. The path is used for a short distance to provide continuity between sections of path on independent rights-of-way.	The adjacent roadway has high-speed motor vehicle traffic such that bicyclists might be discouraged from riding on the roadway.	The adjacent roadway has very high motor vehicles traffic volumes such that bicyclists might be discouraged from riding on the roadway.	Provides a separated path for nonmotorized users. Intended to supplement a network of on-road bike lanes, shared lanes, bicycle boulevards, and paved shoulder. Not intended to substitute or replace on-road accommodations for bicyclists, unless bicycle use is prohibited.	Several serious operational issues are associated with this facilities type. See Section 5.2.2. and 5.3.4 of the Guide for additional details.

Urban/Suburban Recommended Separation Matrix



Source: Oregon Department of Transportation

Recommendations (continued)

- Follow the recommendations of PennDOT ***Design Manual 2 – Chapter 16: Bicycle Facilities*** and AASHTO's, ***Guide for the Development of Bicycle Facilities***. Another valuable resource is the ***NACTO Urban Bikeway Design Guide***.
- Dedicated bike lanes should be striped in such a way to address locations where buses may need to approach or leave a curb-side bus stop area that requires crossing the bike lane. This striping would help the bicyclist by indicating the potential presence of a bus at these locations. This striping concept does not appear to be specifically addressed in the Manual on Uniform Traffic Control Devices (MUTCD). This scenario could be addressed by applying dashed lane marking similar to those used to delineate bicycle lanes on the approach of motor vehicle right turn lanes.
- Road diets and the narrowing of vehicular travel lanes should be considered to create space for bicycle lanes and/or increased shoulder widths for share the road facilities.

- Municipalities should incorporate planning for bicycle/pedestrian facilities in comprehensive plan updates or amendments, special studies and/or Official Maps.
- Municipalities should consider amending their zoning and subdivision and land development ordinances to include definitions for bicycle facilities and clarify these terms across municipal borders. It may also be necessary to delete conflicting definitions and replace wording as appropriate throughout all municipal ordinances and policy documents when they are updated.
- Development Process -It is common for municipal officials to place conditions on the approval of subdivision and land development applications. Through negotiation, a municipality can request the installation of bicycle and pedestrian facilities. The Official Map, ordinance requirements, and other planning elements such as a Comprehensive Plan and/or other adopted plans such as a Bike/Ped Mobility Plan or Greenways Plan will identify the need for these facilities so that developers are aware that the municipality will require or would like to implement these facilities when land development applications are submitted.
- Municipalities should consider ways to incorporate bicycle parking into ordinances. Ordinances can require a certain amount of parking spaces be dedicated to bicycle parking though the installation of bike racks. **See also the BICYCLE PARKING design element.**

References

- PennDOT Design Manual 2 – Chapter 16: Bicycle Facilities
  http://www.dot.state.pa.us/public/Bureaus/design/PUB13M/Chapters/Chap16.pdf
- PennDOT Bicycle and Pedestrian Checklist – Design Process
  http://www.dot.state.pa.us/public/PubsForms/Forms/D-310.pdf
- PennDOT – Smart Transportation Guidebook
  http://www.state.nj.us/transportation/community/mobility/pdf/smarttransportationguidebook2008.pdf
- PennDOT – Bicycle and Pedestrian Information Page
  http://www.penndot.gov/ProjectAndPrograms/RoadDesignEnvironment/RoadDesign/Bike%20and%20Pedestrian/Pages/default.aspx#.VpfU-rYrJhE
- American Association of State Highway and Transportation Officials (AASHTO) – Guide for the Development of Bicycle Facilities
  https://bookstore.transportation.org/Item_details.aspx?id=1943

- U.S. DOT – Federal Highway Administration (FHWA): Bicycle and Pedestrian Design Guidance
  http://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design.cfm
- National Association of City Transportation Officials – Urban Bikeway Design Guide ***http://nacto.org/cities-for-cycling/design-guide/***
- FHWA Pedestrian and Bicycle Information Center
  http://www.pedbikeinfo.org/
- FHWA Guidance regarding Bicycle and Pedestrian Facility Design Flexibility
  http://www.chesco.org/DocumentCenter/View/33695
- Chester County Trail and Path Planning Guide
  http://www.chesco.org/DocumentCenter/View/415
- PennDOT Pedestrian Facilities Pocket Guide
  http://www.dot.state.pa.us/public/Bureaus/design/ADA/PocketGuide.pdf

(Page intentionally left blank)

Pedestrian Facilities

Pedestrian facilities serve as the very foundation of the multimodal transportation system. The AASHTO ***Guide for the Planning, Design, and Operation of Pedestrian Facilities*** states that "Walking is a fundamental form of transportation that is an integral part of the health and livability of our communities. All travelers are pedestrians at some point during their trip. Some travelers make their entire trip on foot, while others walk to catch the bus, or walk between their parking spaces and the front doors of their destinations. Many people also walk for recreation and exercise."

Pedestrian facilities reduce traffic congestion and pollution by providing alternate means to vehicular travel. They also provide recreational opportunities that encourage healthy lifestyles and enhance the quality of life within a community.

This "Pedestrian Facilities" design element refers to walkways, sidewalks, and crosswalks that are to be exclusively used by pedestrians.

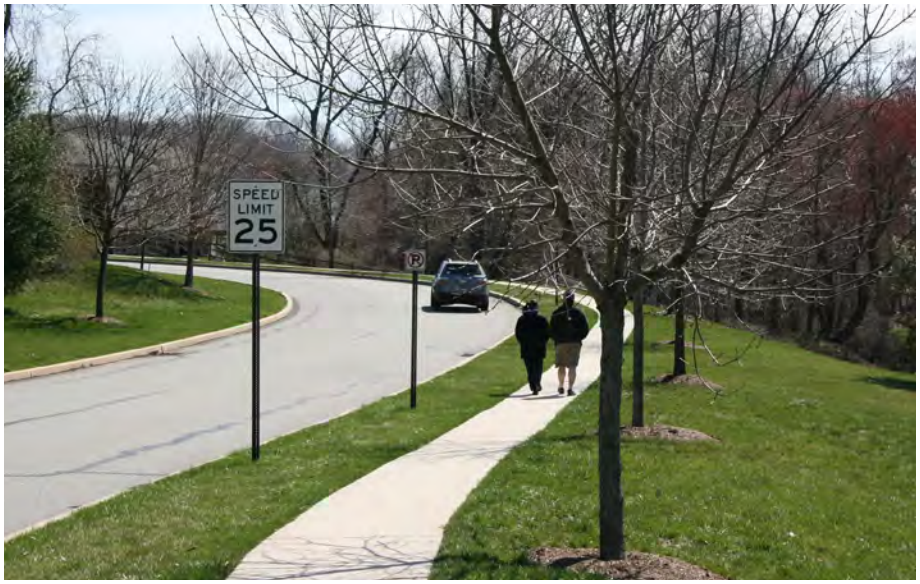
Sidewalks

PennDOT's Design Manual 2 – ***Chapter 6: Pedestrian Facilities and the Americans with Disabilities Act (ADA)*** requires sidewalks to be a minimum of 5 feet in width. This is to comply with the ADA requirement for periodic passing spaces of 5 feet in width thus allowing the entire length of the sidewalk to provide for these spaces.

Title 75 of Pennsylvania's Consolidated Statute prohibits bicycling on sidewalks within business districts, unless expressly permitted by regulatory signage. Planning guidance by PennDOT and AASHTO discourages bicycling on sidewalks, except in the case of young children or in unique circumstances, such as bridges with travel lanes too narrow to safely accommodate bicycle travel.

An active sidewalk/streetscape in West Chester Borough.

SIDEWALK
A pedestrian route, typically constructed of concrete and parallel to a street that provides a means for pedestrians to travel within the public right-of-way while physically-separated from vehicular traffic. Sidewalks are designed for pedestrian use only.



A sidewalk located along a residential roadway.

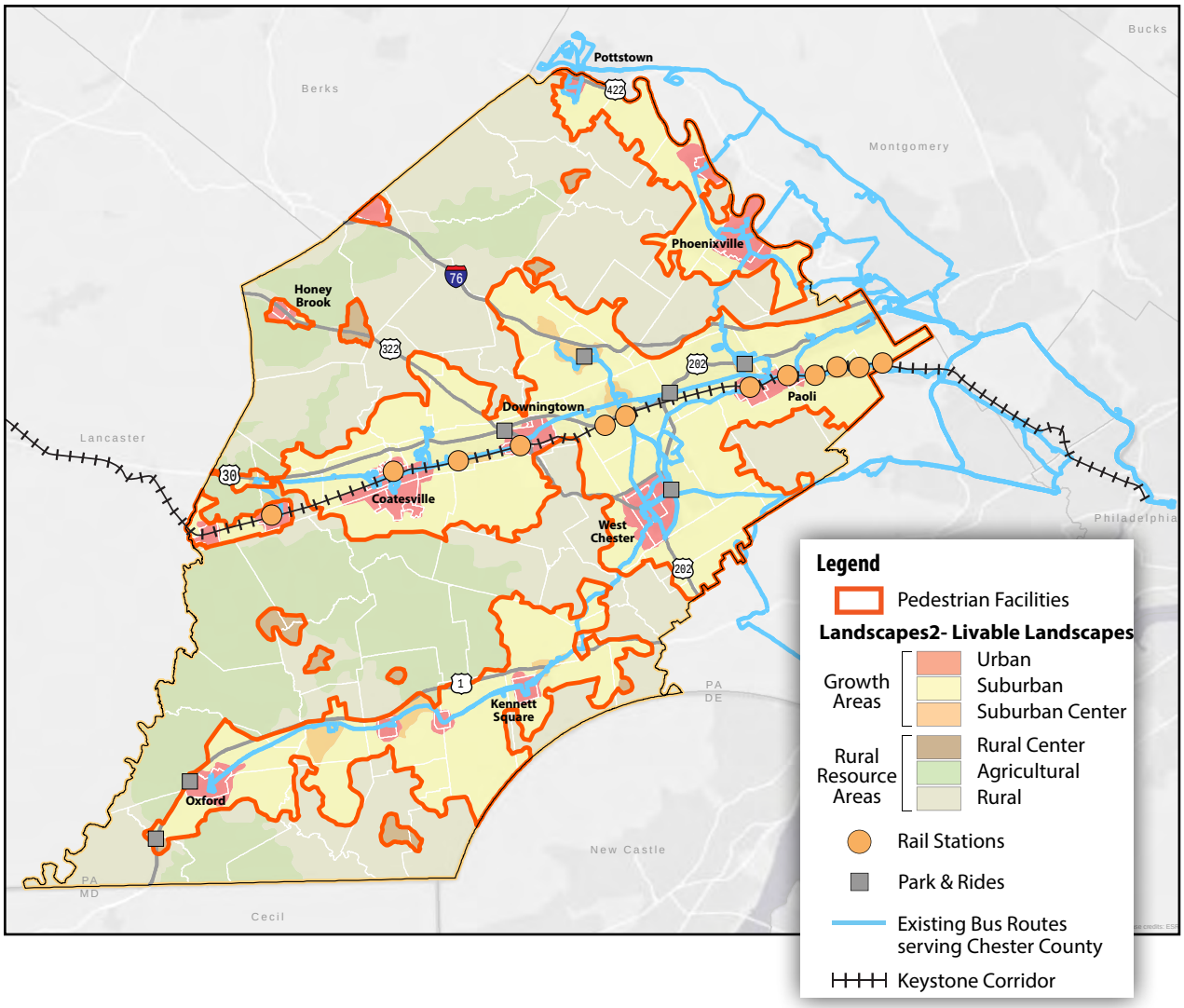
The Smart Transportation Guidebook states that "the most fundamental action that can be taken by any municipality to improve pedestrian facilities is to amend its land development ordinance to require the installation of sidewalks for new and redeveloped land uses." The Guidebook further states: "In suburban areas, developers have routinely requested waivers from sidewalk requirements, typically on the grounds that any anticipated pedestrian activity would be minimal. With few exceptions, this should not justify a waiver, given piecemeal suburban development patterns and the constant potential for redevelopment with more intensive uses.

Recommendations

Pedestrian facilities should be included as an integral part of the transportation system within the urban, suburban, suburban center, and rural center livable landscapes as defined by the County's comprehensive policy plan *Landscapes2*. Municipalities should ensure that subdivision & land development, zoning, comprehensive plans and traffic impact guidelines support the inclusion of pedestrian amenities as outlined herein.

This policy has been established through the adoption of the ***Public Transportation Plan***, an element to Landscapes2. Pedestrian facilities provide many more functions and advantages than just access to public transportation. They provide essential basic connectivity between local destinations as well as recreational opportunities that both contribute to healthy and vibrant communities and provide additional transportation options.

The following exhibit provides an overview of the livable landscapes location and applicability of the pedestrian facilities recommendation.



The following are recommended guidelines to be included in the establishment and/or revisions to any municipal sidewalk related ordinances:

- Sidewalks should have a minimum width of five (5) feet.
- Municipalities with Growth Areas (Urban, Suburban, and Suburban Center) and Rural Center livable landscapes should require by ordinance the installation and maintenance of sidewalks as an integral component of a community's pedestrian network.
- Outside of the Growth Area and Rural Center livable landscapes, sidewalks should be provided on both sides of all roadways in the following locations:
  1) in all commercial districts;
  2) where sidewalks and/or pedestrian circulation has been prioritized on any associated policy plan; and,
  3) within one thousand (1,000) feet of any school, office building, medical institution, commercial use, shopping center, community facility (such as a park or trail) or similar use identified by the governing body.
- The following is a chart of recommended sidewalk and buffer widths for the Landscapes2 growth areas. Buffers are the space between the roadway and sidewalk edges and often include landscape material and/or street furniture depending on their context. Shy distances are the spaces adjacent to fences, buildings, plantings, etc. that pedestrians typically avoid, and only applicable in urban contexts:

	CCPC Functional Class				
	Major Arterial	**Minor Arterial**	**Major Collector**	**Minor Collector**	**Local Road**
Clear Sidewalk Width	6'-12' urban; 5'-6' suburban	6'-14' urban; 5'-6' suburban	6'-10' urban; 5'-6' suburban	5'-8' urban; minimum 5' suburban	
Buffer	4'-6' urban; 5'-10' suburban			3'-6' urban; minimum 4' suburban	
Shy Distance	0'-2' urban; N/A suburban				

Source: Smart Transportation Guidebook

Walkways

Walkways (also known as internal walkways or pedestrian paths) are designed to ensure that pedestrians can avoid using parking aisles or travel lanes for access to building entrances. A walkway is generally used for pedestrian transportation between buildings and parking areas or sidewalks, within parking lots, between buildings on a parcel or within a development, or between adjacent uses, developments, or facilities as shown in the examples below.

An internal walkway in the parking lot of the Government Services Center in West Goshen Township.

A system of pedestrian walkways on the campus of West Chester University.

WALKWAY

A designated single use facility with an improved surface, primarily for use by pedestrians, typically located outside of the road right-of-way and/or not directly adjacent to a street.

Internal walkways within a parking lot, East Whiteland Twp., PA

Recommendations

Municipalities should consider requiring walkways within parking areas, and between parking areas and buildings. Where buildings are constructed with a setback or a development that occurs on a parcel where the buildings do not abut a public sidewalk, a requirement for a walkway from the building entrance to the public sidewalk should be required. This requirement may be linked to criteria such as parking lots over a certain size or where a parking lot does not directly abut a public sidewalk.

The following are recommended guidelines to be included in the establishment and/or revisions to any municipal walkway related ordinances:

- Require walkways between:
  - a) building entrances and sidewalks;
  - b) buildings and parking areas;
  - c) adjacent building entrances on the same lot;
  - d) multiple uses on the same lot;
  - e) transit stops and destinations (within ¼ mile): and/or
  - f) between developments on adjacent parcels.
- Require walkways in parking lots and located within a center island or along the lot's perimeter.
- Require walkways to have a minimum width of five (5) feet and otherwise constructed to meet PennDOT sidewalk standards, or in accordance with the requirements for a sidewalk within the applicable regulations of the municipal ordinances.

Crosswalks

Crosswalks and pedestrian signals with countdown timers are designed to facilitate safe crossing of roadways. These types of facilities are intended to limit the potential conflict between pedestrians and motorists.

Crosswalks may be either marked or unmarked: a marked crosswalk is any portion of the road outlined by painted markings or a different texture of concrete or pavers to slow and alert drivers, as shown in the following examples.

Signage plays a key role in regard to safety at crosswalks. Drivers must be alert for possible pedestrian activity and stop for pedestrians who are crossing a roadway in a marked or unmarked crosswalk.

Crosswalks are usually marked at intersections where there is a substantial amount of vehicular and pedestrian traffic, such as along school routes and at signalized and four-way stop intersections.

High visibility crosswalks are pavement markings that are installed to raise the awareness of motorists to the potential of pedestrians crossing the roadway. There are many different types of pavement markings for high visibility crossings. Zebra crossings (as shown in the photos) are considered to be the most visible crosswalk treatment for both pedestrians and motorists.

Countdown timers are installed in conjunction with walk signals and pavement markings at crossings. Timers warn pedestrians of the time remaining to completely cross the roadway safely before motor vehicles

A high-visibility crosswalk at the intersection of US Route 30 Business and PA Route 100 in West Whiteland Township.

CROSSWALK
A public right-of-way used for pedestrian travel across a roadway at an intersection or any portion of a block (mid-block crossing) to provide safe pedestrian access to adjacent roads, lots, or public use areas.

begin to move through the intersection. Timers can be paired with audible cues to benefit sight impaired pedestrians.

See also **MID-BLOCK CROSSINGS in the Shared Use Facilities design element**.

A high-visibility crosswalk in Downingtown Borough.

A countdown timer in West Chester Borough.

Recommendations

Municipalities should consider amending ordinances to include requirements for crosswalks. The following are recommended guidelines towards addressing crosswalks in a municipal ordinance:

- Crosswalks shall be installed and maintained as an integral component of the sidewalk network of the [zoning district/other designation] and shall be provided at all intersections of streets and driveways, and at all continuations of sidewalks and paths across streets and driveways.
- All crosswalks shall include signage and/or pavement markings to indicate a pedestrian crossing.
- Crosswalks shall be a minimum of six (6) feet wide defined through the use of interlocking unit pavers or striped in accordance with the Federal Highway Administration's ***Manual on Uniform Traffic Control Devices (MUTCD)***.

General Recommendations

- For facility design guidance, follow the recommendations of PennDOT Design Manual 2 – ***Chapter 6: Pedestrian Facilities and the Americans with Disabilities Act*** and AASHTO's G***uide for the Planning, Design, and Operation of Pedestrian Facilities***. Another valuable resource is the ITE publication ***Designing Walkable Urban Thoroughfares***.
- Municipalities should consider amending their zoning and subdivision and land development ordinances to include definitions for pedestrian facilities and clarify these terms across municipal borders. It may also be necessary to delete conflicting definitions and replace wording as appropriate throughout all municipal ordinances.
- Municipalities should incorporate planning for pedestrian facilities in comprehensive plan updates or amendments, special studies and/or official maps.
- Development Process – It is common for municipal officials to place conditions on the approval of subdivision and land development applications. Through negotiation, a municipality can request the installation of pedestrian facilities. The Official Map, ordinance requirements, and other planning elements such as a Comprehensive Plan and/or other adopted plans such as a Bike/Ped Mobility Plan or Greenways Plan will identify the need for these facilities so that developers are aware that the municipality will require or would like to implement these facilities when land development applications are made.

References

- PennDOT Design Manual 2 – Chapter 6: Pedestrian Facilities and the Americans with Disabilities Act *http://www.dot.state.pa.us/public/Bureaus/design/PUB13M/Chapters/Chap06.pdf*
- PennDOT Bicycle and Pedestrian Checklist – Design Process *http://www.dot.state.pa.us/public/PubsForms/Forms/D-310.pdf*
- PennDOT – Smart Transportation Guidebook *http://www.dvrpc.org/reports/08030A.pdf*
- PennDOT – Bicycle and Pedestrian Information Page *http://www.penndot.gov/ProjectAndPrograms/RoadDesignEnvironment/RoadDesign/Bike%20and%20Pedestrian/Pages/default.aspx#.VpfU-rYrJhE*
- American Association of State Highway and transportation Officials (AASHTO) – Guide for the Planning, Design, and Operation of Pedestrian Facilities *https://bookstore.transportation.org/item_details.aspx?id=119*
- U.S. DOT – Federal Highway Administration (FHWA): Bicycle and Pedestrian Design Guidance *http://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design.cfm*
- FHWA Pedestrian and Bicycle Information Center *http://www.pedbikeinfo.org/*
- Chester County Trail and Path Planning Guide *http://www.chesco.org/DocumentCenter/View/415*
- PennDOT Pedestrian Facilities Pocket Guide *http://www.dot.state.pa.us/public/Bureaus/design/ADA/PocketGuide.pdf*
- PennDOT, Pavement Markings and Signing Standards TC-8600 and TC-8700, Publication 111 *http://www.dot.state.pa.us/public/PubsForms/Publications/PUB%20111.pdf*

Shared Use Facilities

"Shared Use" or "Multi-Use" facilities are those where bicyclists share a facility with pedestrians and other non-motorized modes of travel such as equestrians, cross country skiers, in-line skaters, baby strollers, and those using motorized scooters and wheelchairs. These facilities are commonly referred to as 'trails' outside of a roadway right-of-way, and 'sidepaths' when located inside the road right-of-way.

Use restricted trails are commonly recreation related and located outside of the roadway right-of-way. The use restriction is generally created by the narrow width and steep grades of the path which limit the use to one user type (typically pedestrians within homeowner association maintained or hiking trails), but may also be limited to equestrians and/or mountain bikers to reduce potential user conflicts as determined by recreational programming.

Both of these facility types provide for a safe means of transport for both transportation and recreation purposes away from vehicular traffic and are valuable commodities contributing to the health and well-being of any community in which they are located.

This design element refers to both multi-use and use restricted paths applicable to both bicyclists and/or pedestrians.

Multi-Use Trails

Multi-Use trails typically have a hard surface (e.g., asphalt, concrete, compacted gravel, etc.) and have a recommended width per AASHTO of 10', although a minimum width of 8' may be used where space is constrained or in environmentally sensitive areas. Wider paths are also recommended if there is a high volume of existing or anticipated bicycle and pedestrian traffic.

The Chester Valley Trail in East Whiteland Township.

MULTI-USE TRAILS
(Off-road facilities, intended for multiple user modes) - A facility that is physically separated from the roadway and typically accommodates bi-directional travel by both bicyclists and pedestrians. The trail can be located within a publicly owned right-of-way, an exclusive right-of-way, or an easement. Shared use trails typically have an improved surface (e.g., asphalt, concrete, compacted gravel, etc.) and have a recommended width (per AASHTO) of 10 feet, although a minimum width of 8 feet may be used where space is constrained or when located in environmentally sensitive areas.

SIDEPATH
A multi-use trail that parallels a roadway.

USE-RESTRICTED TRAILS
(Off-road facilities, only certain modes are accepted) - Trails that are primarily used for one form of travel or by one type of user such as bicyclists or pedestrians. These trails are typically paved or have an improved surface.

Sidepaths

Sidepaths are a subset of shared use paths that denote paths that run adjacent to a parallel roadway and can provide bicycle connections between on- and off -road facilities. Due to being located either within or directly adjacent to the roadway right-of-way with the potential for multiple vehicular crossings, these facilities often require a more in-depth operational and safety analysis.

Use-Restricted Trails

Use-restricted trails are those that limit the allowable user groups based on one or more of the following factors: grades, surfacing, widths, potential user-conflict, ownership, and/or programming.

Steep grades of more than 8.33% limit universal (ADA) accessibility. Surfacing other than a smooth hard surface such as concrete or asphalt may not only limit ADA accessibility, but also certain bicyclists, in-line skaters,persons with baby strollers and those using other wheeled human-propelled transportation. Use-restricted trails can be narrower than the minimum standard for a multi-use trail (less than 8 feet wide). The width is a limiting factor towards the capacity of the trail to safely accommodate both pedestrians and bicyclists (or in-line skating, equestrians, and other uses) resulting in the potential for user conflict. This is why the most common restriction for these trails is for pedestrian use only. These trails can be hiking only, equestrian only, mountain biking only, or a combination thereof. Trails that may be used by potentially conflicting user groups may be managed through programming. For example, trails intended for both equestrian and mountain biking use may alternate days for when these user groups will have access to the trail system. Other programming limitations may be relative to ownership, such as trail systems that are privately developed and managed by homeowners association that may limit who and what user types will have access to their trails.

A use-restricted path in East Goshen Township

Use-restricted trails would be the most common trail standard to be developed as part of an internal trail system associated with a planned residential development. The minimum width for a multi-use trail (8 feet) may not be warranted or desired by the developer or residents of those communities. While the CCPC encourages the development of trails to the multi-use standard wherever possible, the minimum width for trails to be developed as part of a planned residential development should be 5 feet, the same standard as for internal walkways. **See also the PEDESTRIAN FACILITIES design element**.

Mid-Block Crossings

MID-BLOCK CROSSING

A designated space within a roadway that allows bicyclists and pedestrians to cross a road safely at a location other than an intersection.

A mid-block crossing permits pedestrians to cross a road at a location other than an intersection. These crossings require special engineering analysis to determine their appropriateness and effectiveness. Section 11.9 of the PennDOT Traffic Engineering Manual (Pub. 46) establishing criteria for mid-block crossings including roadway speed limit, traffic volume, sight distance, parking restrictions, proximity to other crossings, and pedestrian volume.

With some exceptions based on the specific conditions of any location, the following are PennDOT's general minimum requirements for the installation of a mid-block crossing:

- The posted speed limit is 35 mph or less.
- The nearest marked crosswalk on the same roadway is over 300 feet from the proposed crossing.
- The minimum number of pedestrians crossing the street within 150 feet of the proposed crossing during an average day should be 80 or more during any 1 hour, or 40 or more during each of any 4 hours.
- The maximum traffic volume on the roadway is 10,000 ADT (average daily traffic), except on two-lane roadways the maximum traffic volume may be 15,000 ADT.
- Parking is not permitted within 75 feet of the crosswalk, unless a curb extension is in place to improve pedestrian visibility.
- Must meet sight distance criteria based on existing grades.

A pedestrian uses the mid-block crossing feature on the Chester Valley Trail in West Whiteland Township.

PennDOT encourages these same criteria for locally owned roadways. For state-owned roads, a mid-block crosswalk engineering and traffic study is required to record the study's findings.

Recommendations

- Follow the recommendations of PennDOT Design Manual 2 – Chapter 16: Bicycle Facilities and AASHTO's Guide for the Development of Bicycle Facilities for bicycle only or multi-use/shared use facilities design.
- For pedestrian only facilities design, follow the recommendations of PennDOT Design Manual 2 – Chapter 6: Pedestrian Facilities and the Americans with Disabilities Act and AASHTO's Guide for the Planning, Design, and Operation of Pedestrian Facilities.
- For mid-block crossing, follow the requirements of Section 11.9 of the PennDOT Traffic Engineering Manual (Pub. 46)
- Municipalities should consider amending their zoning and subdivision and land development ordinances to include definitions for bicycle and pedestrian facilities and clarify these terms across municipal borders. It may also be necessary to delete conflicting definitions and replace wording as appropriate throughout all municipal ordinances.
- Municipalities should incorporate planning for bicycle/pedestrian facilities in comprehensive plan updates or amendments, special studies and/or official maps.

- Municipalities should require the identification and maintenance of existing trails (both shared and use restricted) and establishment of additional trails and connections in new development. There are a number of ways to protect existing trails and establish new trails through ordinances. The following are key points that should be included in ordinances for trail requirements:

    1. The standard width of any proposed multi-use trail should be 10 feet with a minimum width of 8 feet. Widths less than 8 feet should consider use restrictions based on projected users. The absolute minimum width for use-restricted trails should be 5 feet, the same as internal walkways.
    2. Subdivision and land development ordinances should require the identification of existing trails and/or recreational needs or impacts (preliminary plan requirements, impact assessments, conservation plan requirements) as part of the land development process.
    3. Logically continue, link or expand existing pedestrian facilities on, across and abutting the site consistent with the [Official Map, Improvements Plan Map, Comprehensive Plan, etc.]. The applicant may be requested to provide an easement dedicated to the municipality with connections to abutting properties that will enable the future continuation of the pedestrian network.
    4. Ordinance requirements should protect existing trails or allow for the realignment of existing trails on a site.
    5. There should be requirements for the identification and establishment of new trails as appropriate to connect to adjacent existing or planned facilities such as public bus or train stops or stations, public parks, community facilities, commercial areas, or higher density residential developments.
    6. Existing trails to be realigned, or new trail alignments should be installed prior to the construction of buildings or other structures on a site. Identification and establishment of trails may be required by either the zoning or subdivision and land development ordinance, or a combination of both.
    7. As appropriate, provide for the continued ownership and maintenance of trails and trail easements by having them dedicated to the public sector, donated to a private conservation organization, or placed under the care of a community association.

- Development Process – It is common for municipal officials to place conditions on the approval of subdivision and land development applications. Through negotiation, a municipality can request the installation of bicycle and pedestrian facilities. The Official Map, ordinance requirements, and other planning elements such as a Comprehensive Plan and/or other adopted plans such as a Bike/Ped Mobility Plan or Greenways Plan will identify the need for these facilities so that developers are aware that the municipality will require construction of these facilities when land development applications are made.

References

- PennDOT Design Manual 2 – Chapter 16: Bicycle Facilities ***http://www.dot.state.pa.us/public/Bureaus/design/PUB13M/Chapters/Chap16.pdf***
- PennDOT Design Manual 2 – Chapter 6: Pedestrian Facilities and the Americans with Disabilities Act ***http://www.dot.state.pa.us/public/Bureaus/design/PUB13M/Chapters/Chap06.pdf***
- PennDOT Bicycle and Pedestrian Checklist – Design Process ***http://www.dot.state.pa.us/public/PubsForms/Forms/D-310.pdf***
- PennDOT – Smart Transportation Guidebook ***http://www.dvrpc.org/reports/08030A.pdf***
- PennDOT – Bicycle and Pedestrian Information Page ***http://www.penndot.gov/ProjectAndPrograms/RoadDesignEnvironment/RoadDesign/Bike%20and%20Pedestrian/Pages/default.aspx#.VpfU-rYrJhE***
- American Association of State Highway and Transportation Officials (AASHTO) – Guide for the Development of Bicycle Facilities ***https://bookstore.transportation.org/Item_details.aspx?id=1943***
- American Association of State Highway and transportation Officials (AASHTO) – Guide for the Planning, Design, and Operation of Pedestrian Facilities ***https://bookstore.transportation.org/item_details.aspx?id=119***
- U.S. DOT – Federal Highway Administration (FHWA): Bicycle and Pedestrian Design Guidance ***http://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design.cfm***
- FHWA Pedestrian and Bicycle Information Center ***http://www.pedbikeinfo.org/***
- Chester County Trail and Path Planning Guide ***http://www.chesco.org/DocumentCenter/View/415***
- PennDOT Pedestrian Facilities Pocket Guide ***http://www.dot.state.pa.us/public/Bureaus/design/ADA/PocketGuide.pdf***

ADA Accessibility

Accessibility improvements provide mobility and safety benefits for everyone, not only for those with disabilities. All municipalities are required to follow the Americans with Disabilities Act (ADA) Accessibility Guidelines and ensure that developments within their municipalities follow the appropriate guidelines and standards most appropriate for the facility type as set forth by the US Access Board.

PennDOT has developed accessibility standards that are based upon and in some instances exceed the requirements established by the US Access Board. These standards are outlined in PennDOT Design Manual 2 – Chapter 6: ***Pedestrian Facilities and the Americans with Disabilities Act***.

The construction of all new facilities shall provide at least one accessible route within the boundary of the site from public transportation stops, accessible parking spaces, passenger loading zones if provided, and public streets or sidewalks, to an accessible building entrance. And, at least one accessible route shall connect accessible buildings, facilities, elements, and spaces that are on the same site.

The following links and info applicable to the design elements and related improvements described in this Multimodal Handbook were excerpted from the US Access Board Guidelines and Standards webpage: ***http://www.access-board.gov/guidelines-and-standards***

Buildings & Sites

Standards issued under the Americans with Disabilities Act (ADA) address access to buildings and sites nationwide in new construction and alterations. Similar standards apply to building and sites funded by the federal government under the Architectural Barriers Act (ABA).

- **ADA Standards**: ***http://www.access-board.gov/guidelines-and-standards/buildings-and-sites/about-the-ada-standards/ada-standards***
- **ABA Standards**: ***http://www.access-board.gov/guidelines-and-standards/buildings-and-sites/about-the-aba-standards/aba-standards***

Recreation Facilities

Access to recreation facilities, including play areas, swimming pools, sports facilities, fishing piers, boating facilities, golf courses, and amusement rides is addressed in the ADA and ABA standards. New provisions will cover access to trails, picnic and camping sites, and beach access routes.

- **Recreation Facilities** – ***http://www.access-board.gov/guidelines-and-standards/recreation-facilities/guides***

ADA ACCESSIBILITY
All or any portion of buildings, structures, site improvements, complexes, equipment, roads, walks, passageways, parking lots, transportation facilities, or other real or personal property that are readily accessible to and usable by individuals with disabilities to be expressed in terms of architecture and design, transportation and communication.

- **Outdoor Developed Areas** – *http://www.access-board.gov/guidelines-and-standards/recreation-facilities/outdoor-developed-areas/a-summary-of-accessibility-standards-for-federal-outdoor-developed-areas*

Streets and Sidewalks

New guidelines the US Access Board is developing will cover access to public rights-of-way, including sidewalks, intersections, street crossings, and on-street parking. The Board is also addressing access to shared use paths providing off-road means of transportation and recreation.

- **Public Rights-of-Way** – *http://www.access-board.gov/guidelines-and-standards/streets-sidewalks/public-rights-of-way/proposed-rights-of-way-guidelines*
- **Shared Use Paths** – *http://www.access-board.gov/guidelines-and-standards/streets-sidewalks/shared-use-paths/supplemental-notice*

Transportation

Board guidelines issued under the ADA address access to public transportation facilities and vehicles. New guidelines for passenger vessels are in development.

- **Transportation Facilities** – *http://www.access-board.gov/guidelines-and-standards/transportation/facilities/ada-standards-for-transportation-facilities*
- **Transportation Vehicles** – *http://www.access-board.gov/guidelines-and-standards/transportation/vehicles/adaag-for-transportation-vehicles*

Recommendations

- For all pedestrian improvements within a public right-of-way, follow PennDOT Design Manual 2 – Chapter 6: Pedestrian Facilities and the Americans with Disabilities Act ***http://www.dot.state.pa.us/public/Bureaus/design/PUB13M/Chapters/Chap06.pdf***

- For all other site related pedestrian improvements not covered by the PennDOT guidelines, follow the most appropriate guidelines as set forth by the US Access Board: ***http://www.access-board.gov/guidelines-and-standards***

A good example of an ADA parking installation.

Another good example of an ADA parking installation.

(Page intentionally left blank)

PUBLIC TRANSPORTATION

Bus Stops

The quality of a public transit ride is defined by all aspects of a rider's experience, from the time of departure to arrival at the destination. Beyond a rider's experience in the transit vehicle, there are two additional significant components to a "full" transit ride: the connection between a transit stop and one's origin/destination; and the experience waiting for the arrival of the transit vehicle. In this context, the provision of bus stop amenities such as a bus shelter and sidewalk connections have influential roles regarding the quality of public transit in Chester County.

> *"A high-quality transit stop is one that is well connected to the neighborhood or community it serves, accommodates the needs of all transit passengers safely and comfortably, and permits efficient and cost-effective transit operations."*
>
> *— SEPTA Bus Stop Design Guidelines*

Bus stops are located along the bus routes in the urban and suburban municipalities served by public transit. The primary service provider in Chester County is SEPTA, although additional bus routes are provided by the Transportation Management Association of Chester County (TMACC) including the Coatesville Link and SCCOOT (a partnership with the Southern Chester County Organization on Transportation); Krapf Transit Route A that connects Coatesville, Exton and West Chester; and the Pottstown Area Rapid Transit (PART) which provides bus service to the Coventry Mall and North Coventry Township emanating from Pottstown Borough.

This design element focuses on the development of bus stops, including bus shelters as amenities and the possible configurations for stop locations in line with the roadway.

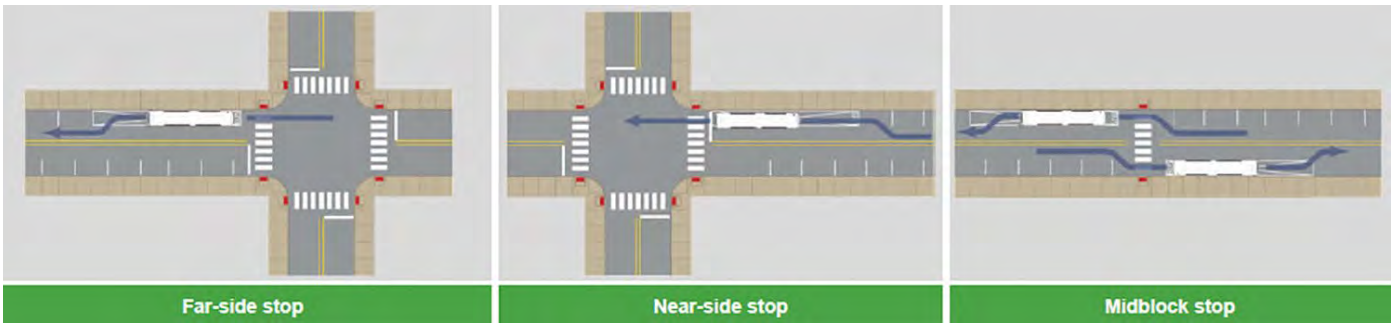
BUS STOP
A designated location - typically along a fixed bus route - where people gather to board and/or exit a bus.

Location

Proper site selection is critical for creating a safe and efficient bus stop. When planning for new or upgrading existing transit stops, municipal officials should reference the ***SEPTA Bus Stop Design Guidelines***, prepared for SEPTA by the Delaware Valley Regional Planning Commission (DVRPC) in October 2012. These guidelines would also apply to areas served by other transit operators.

PUBLIC TRANSPORTATION

Bus stops may be placed in one of three general locations relative to the roadway and intersections:



Source: SEPTA Bus Stop Design Guidelines

- Far-side stop
- Near-side stop; and,
- Midblock stop.

Placement at one of these three locations within the roadway must also consider in-street design alternatives relative to the flow of traffic. The SEPTA guidelines include guidance for the following in-street design alternatives illustrated on the following page:

- Curbside/Shoulder Stop
- Curb Extension
- Bus Bay/Turnout
- Open Bus Bay

Bus stops located outside of the roadway path are considered to be "off-line" stops and are commonly associated with transportation centers, railroad stations, office or medical centers, shopping centers, or park-and-ride facilities.

The SEPTA Bus Stop Design Guidelines also provide guidance towards the recommended dimensions for the standard elements of a bus stop in the chapter titled 'Curbside Design'. These elements include a loading pad, waiting area, stop area, pedestrian path, street furniture (if applicable), and a clear area for the following six bus stop types:

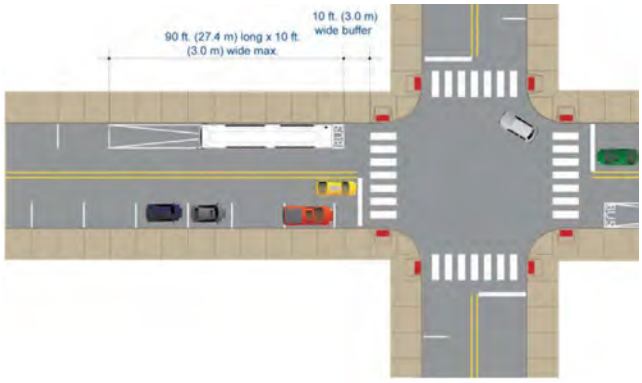
1. Minimum stop with recessed pedestrian path;
2. Minimum stop with curbside pedestrian path;
3. Narrow urban stop;
4. Urban stop with seating;
5. Stop with narrow shelter; and,
6. Stop with standard shelter.

Developers should determine which configuration and stop type may be most applicable to the proposed bus stop location based on existing roadway characteristics and site conditions, and refer to the SEPTA Bus Stop Design Guidelines for the most applicable guidelines towards its design. SEPTA staff can serve as a resource for site specific issues along its routes.

For additional stop types in a suburban setting, another point of reference to consider would be the ***Rethinking the Suburban Bus Stop*** and ***Safety & Security at Suburban Bus Stops*** publications prepared by the Airport Corridor Transportation Association (ACTA) in western Pennsylvania.

PUBLIC TRANSPORTATION

Curbside/Shoulder Stop

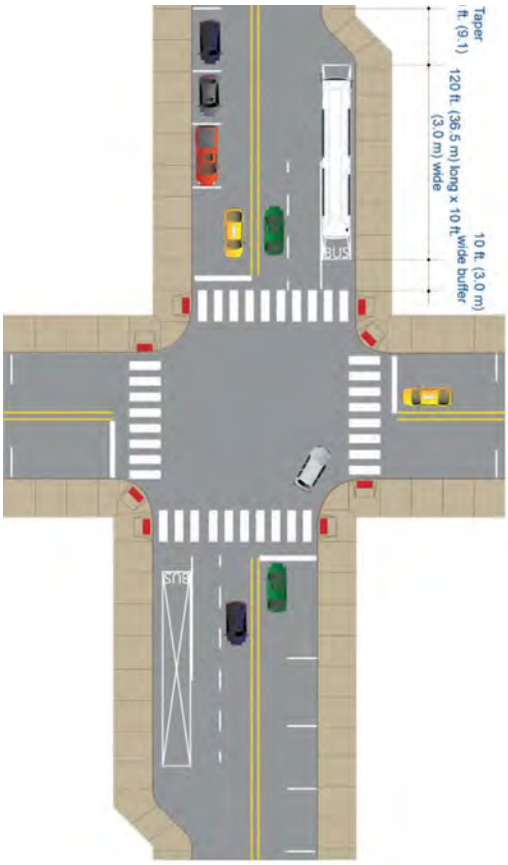


Source: DVRPC 2012

Curb Extension

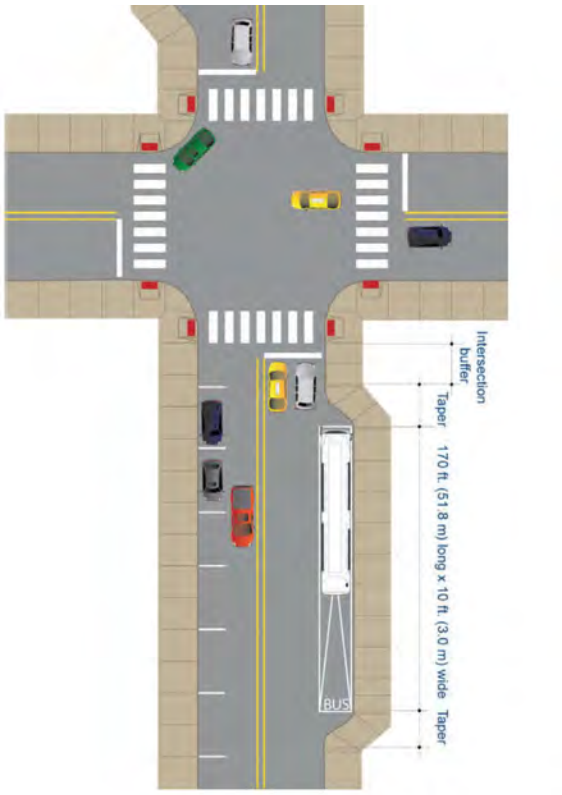
Source: DVRPC 2012

Open Bus Bay



Source: DVRPC 2012

Bus Bay/Turnout



Source: DVRPC 2012

Bus Shelters

Bus shelters can greatly improve the public transportation experience by providing riders with a safe waiting area, protection during inclement weather, and service information. Bus shelters are generally located in a roadway right-of-way unless private property owners have consented to the shelter being placed on their property. Shelters can be integrated into the building design, as shown in the Exton Mall image below, where a bus stop and shelter was implemented as part of the Mall's renovation several years ago.

A bus shelter in West Whiteland Township along U.S. Route 30 Business.

A bus stop and shelter at the Exton Square Mall in West Whiteland Township.

Municipalities should adopt requirements for the placement of bus stops with shelters in municipal ordinances when buildings, uses, or developments, that meet a minimum threshold, and occur along or within proximity of an existing or planned bus route. Pedestrian connections to the bus stop/transit shelter from parking lots and nearby development

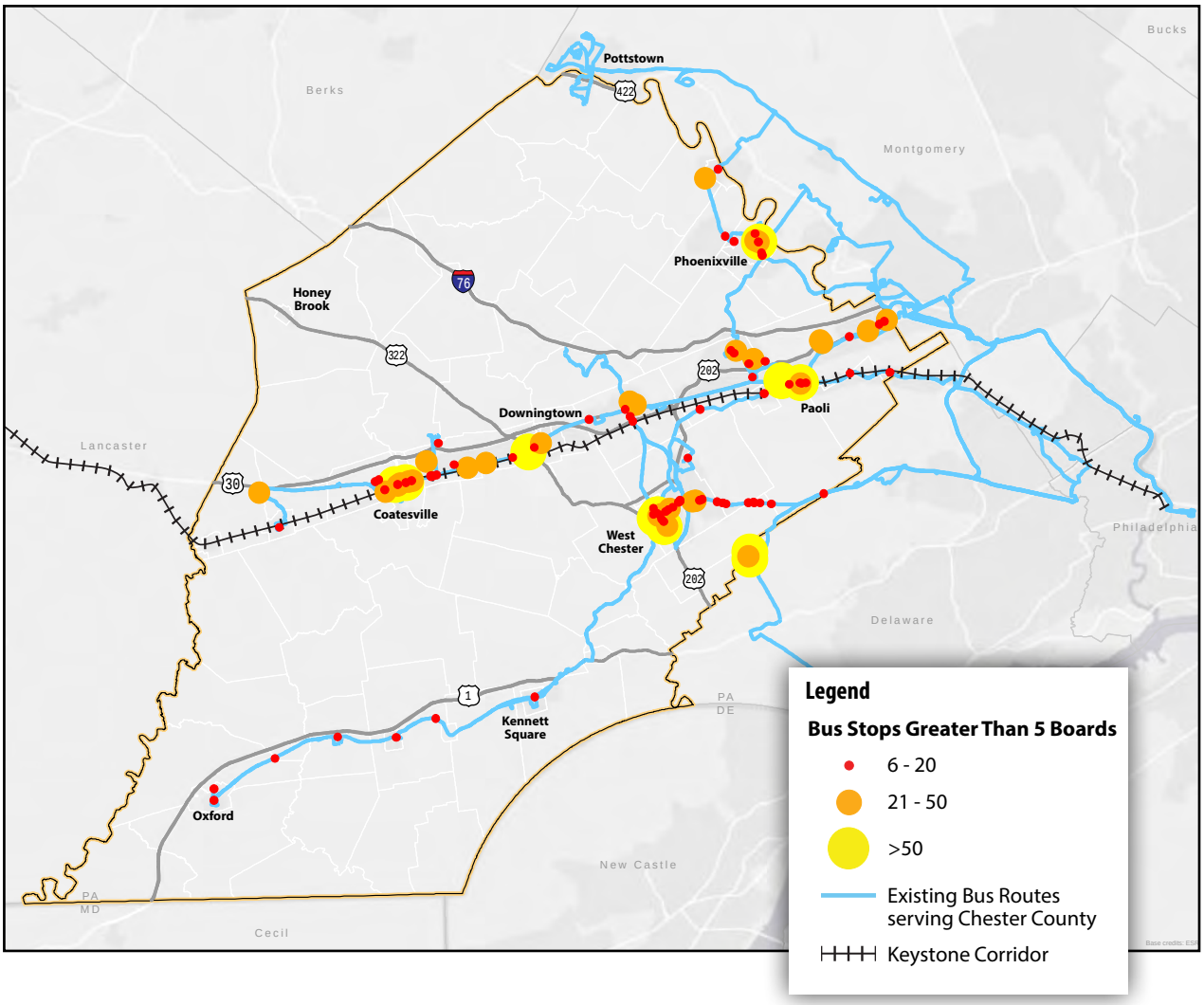
BUS SHELTER

A transit user amenity located at a bus stop to provide convenience, comfort, and shelter from the elements in the form of a structure such as a canopy.

should be required as referenced in the SEPTA Bus Stop Design Guidelines which recommends a pedestrian way connecting to every stop. Each municipality will need to determine the appropriate criteria for what type of development (size, number of units, density) should trigger the requirement for a bus stop with shelter. Each municipality should also determine criteria for maintenance and operational responsibilities for shelters.

Implementation of pedestrian connections and bus shelters will rely heavily upon the local land development process as well as targeted capital improvement projects at key locations where land development may not be imminent or where these facilities are identified to be most needed.

To direct improvements where they are most needed, the ***Public Transportation Plan*** recommends bus shelters at bus stops with greater than 5 daily boardings.



The 'Bus stops recommended for shelters in Chester County' exhibit above was generated based on the bus ridership data (daily boards) available at the time of the study. As the ridership continues to grow and evolve with varied degree of intensity, those ridership numbers will change. CCPC recommends the following three classifications of bus stops relative to the minimum curbside amenities to be provided at bus stops based on actual ridership data:

Basic Stop: daily boards of 5 or less

- Bus Stop sign printed on both sides to be visible from the roadway;
- ADA accessible loading pad; and,
- Paved pedestrian sidewalk/walkway connections (ADA accessible) leading to the nearest building entrance or connecting to an existing walkway system.

Collector Stop: daily boards from 6-20

Includes all Basic Stop amenities plus:

- Bus Shelter;
- System map indicating all transit routes serving the location;
- Bench and Trash Receptacle; and,
- Lighting.

Hub Stop: daily boards from 21-50

Includes all Collector Stop amenities plus:

Source: DVRPC 2010

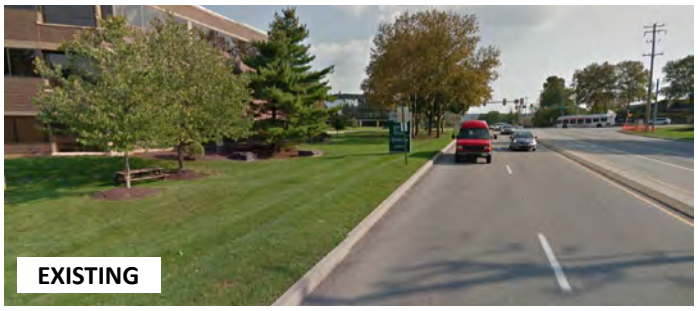
- Bus Shelters (minimum of 1, or a larger sized shelter);
- Benches and Trash Receptacles (minimum of 2 each);
- Bicycle Racks; and,
- Real time status info/kiosk.

Daily boards greater than 50:

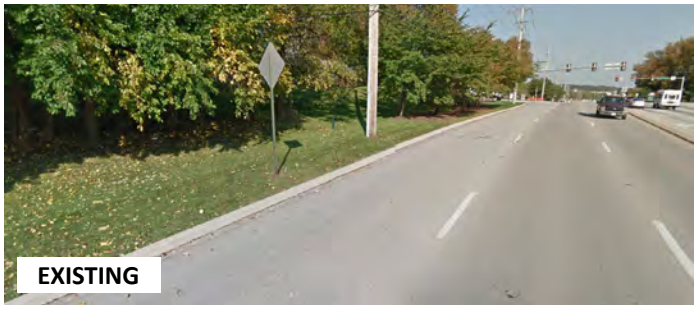
- See Transportation Centers.

PUBLIC TRANSPORTATION

The following are photo simulations illustrating how an existing bus stop may be developed using the SEPTA Bus Stop Design Guidelines. Site 1 is an example of a far-side stop with a bus bay/turnout, and site 2 is an example of another far-side stop with a curbside/shoulder boarding configuration.



Site 1: Example of a bus bay stop along Morehall Road north of the Great Valley Parkway.



Site 2: Example of a curb side stop along Morehall Road north of the Great Valley Parkway.

Graphics by CCPC

Collector and Hub stops may be placed off-line (outside the roadway) and within a site development to accommodate for the additional time required to load and unload what would be a higher volume of passengers and minimize any associated traffic impacts. These stops would be most applicable to commercial and employment centers and should be provided

in a central location relative to all sites that may be served and connected by pedestrian walkways.

Bus stop installations must consider both inbound/outbound directions for the associated transit route(s). Stops may be needed on either side of the roadway or intersection to provide for access to each direction.

An existing barrier to bus stop development is the reluctance of various agencies to assume the maintenance responsibilities of bus shelters. Many existing shelters are provided and maintained by advertising agencies that at the present time have no interest in expanding their footprint in Chester County.

Transit agencies are not responsible for the design or maintenance of transit stops in Chester County. Therefore, the provision of high-quality transit stops requires a partnership between transit agencies, Transportation Management Associations, municipalities, PennDOT, and property owners.

Recommendations

- Provide the recommended curbside amenities as per the Basic, Collector, and Hub stop classifications described herein based on the projected ridership (daily boards) associated with the proposed new development for new bus stop installations.
- Retrofit existing bus stops to provide for the curbside amenities as per the Basic, Collector, and Hub stop classifications described herein based on historically consistent existing actual ridership (daily boards).

	Amenities								
Stop Type	**Bus Stop Sign**	**ADA Loading Pad**	**Paved Walkway Connections**	**Bus Shelter**	**System Map**	**Bench/ Trash Can**	**Lighting**	**Bike Racks**	**Real Time Info**
Basic Stop (daily boards of 5 or less)	X	X	X						
Collector Stop (daily boards from 6-20)	X	X	X	X	X	X	X		
Hub Stop (daily boards from 21-50)	X	X	X	X*	X	X**	X	X	X

* = Minimum of 1, or a larger sized shelter.
** = Minimum of 2 each.

Recommendations (continued)

- Follow the recommendations of the ***SEPTA Bus Stop Design Guidelines*** towards the design and implementation of new and/or retrofit bus stop development.
- Provide bus shelters and pathways to and from transit shelters as part of high density land uses and major traffic generators near existing or future transit routes. Prioritizing the installation of these basic amenities at the more frequently used stops will create a safe and inviting point of access to the transit system and serve as an example for the implementation of improvements at other stop locations. Bus stop consolidation may be used to provide for more boardings at certain locations which would also contribute to increased route efficiency. Local ordinances may also need to be adjusted or revisited to allow for the placement of bus shelters, depending on the existing statutes.
- Consider including requirements for bus stops in zoning and/or subdivision/land development ordinances. The following are recommended guidelines towards the establishment of a bus stop with shelter ordinance:
    - Bus stops with shelters should be required along existing public transportation routes or key transportation corridors that have the potential for public transit service based on the density or intensity of proposed residential, institutional, commercial, or industrial uses. For example, a bus stop with shelter should be required where the gross leasable area for commercial, industrial, or institutional uses is fifty-thousand (50,000) square feet or more or where there is a residential development greater than one hundred (100) dwellings units. The municipality can adjust the "thresholds" to meet their community objectives or the intent of the associated zoning district.
    - Bus stops with or without shelters should be adequately lighted to provide safety and visibility for users. The source of light shall be shielded from all abutting properties and from traffic along any adjacent roadway.
    - Sidewalks and internal walkways should be provided to connect bus stops shelters to adjacent uses that generate significant pedestrian traffic.
    - Bus stops with shelters and their related facilities and amenities should be designed in accordance with the design standards of the SEPTA Bus Stop Design Guidelines as produced by the Delaware Valley Regional Planning Commission (DVRPC). Where

there are site-specific issues that are not explicitly covered by the SEPTA Bus Stop Design Guidelines, it is particularly important that they be vetted by the operating agency. This includes situations where a design exception or mitigation of conditions is required. In the case of SEPTA, both Service Planning and Transportation (operations) should be consulted to insure that there are no unintended operational issues that are generated by the bus stop design.

- The municipality shall have the final determination as to the location of bus stops with shelters. Area and bulk regulations of the associated zoning district shall not apply to the placement of bus stops with shelters.
- Bus shelters shall be placed on a concrete slab which should be constructed in accordance with municipal ordinances.
- Bus shelters should not exceed five (5) feet in width and ten (10) in length and shall be constructed of an aluminum frame with a minimum of two (2) sides enclosed with lexan, acrylic, Plexiglas, or safety glass and a roof. A bench should be provided in the shelter with a center divider/arm rest and a trash receptacle in a style approved by the municipality.
- Bus stops with shelters should be well-marked/identified with a double-sided sign, preferably on its own pole in accordance with current SEPTA sign standards.
- Bus stops with shelters should be maintained in a clean and neat condition and in good working order and repair and shall be inspected and cleaned at least once every seven (7) days.

- Develop a maintenance agreement model(s) for maintaining bus shelter facilities. Given that bus shelter maintenance is one of the existing barriers to implementing additional bus shelters in retrofit contexts, the public transportation agency providers, the TMAs, chambers of commerce, municipalities, and Chester County must identify at least one (preferably multiple) model for maintaining bus shelters that is agreeable and endorsed by all aforementioned parties. In the context of future land development projects, the maintenance of bus shelters should be codified as an obligation of the land developer/property owner.

References

- SEPTA Bus Stop Design Guidelines *http://septa.org/strategic-plan/reports/SEPTA-Bus-Stop-Design-Guidelines-2012.pdf*
- Safety & Security at Suburban Bus Stops *http://www.landscapes2.org/transportation/circulation/pdf/SafetySecurity-SuburbanBusStops.pdf*
- Rethinking the Suburban Bus Stop *http://www.landscapes2.org/transportation/circulation/pdf/Rethinking-TheSuburbanBusStop.pdf*
- APTA's Design of On-street Transit Stops and Access from Surrounding Areas *http://www.apta.com/resources/hottopics/sustainability/Documents/APTA%20SUDS-RP-UD-005-12%20On%20Street%20Transit%20Stops.pdf*

Park and Rides

A park and ride facility offers a safe, convenient location for commuters to leave their automobiles and travel to their destination in carpools, vanpools or buses. Park and ride facilities reduce the total number of vehicle miles of travel and improve air quality. A park and ride facility can offer a transit provider convenient access to a large number of patrons without going to the added operating expense and time of circulating buses through residential neighborhoods.

Park and ride lots can provide the following benefits:

- **Improves Energy Efficiency**: Park and ride lots can lead to reductions in vehicle miles of travel, energy consumption and vehicle emissions.
- **Encourages Public Transit Opportunities**: While many communities would like to establish some form of public transportation for their residents and commuters, few municipalities have the development density to financially support public transportation. A heavily used park and ride lot can create a critical mass that may lead to the development or extension of a bus route. Decisions about routes are made in the context of available funding and, in SEPTA's case, as part of its established Services Standards and Process and Annual Service Plan.
- **Reduces Congestion**: As major highways are reconstructed, congestion can be mitigated through the expansion of ridesharing, which is further enabled with the provision of Park and Ride lots.

Park and ride facilities may range in scope from several reserved parking spaces within a commercial or institutional parking lot to a facility of 500 or more parking spaces. The facilities may include:

- bus loading and unloading areas;
- taxi or kiss-and-ride areas;
- bicycle parking; and
- ADA compliant pedestrian access.

The size of the parking lot is dependent on the design volume, the available land area, and the size and number of other parking lots in the area.

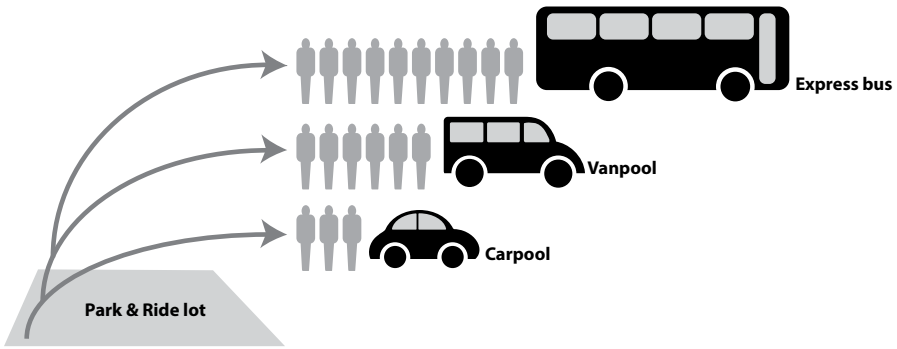
PARK AND RIDE
Parking lots designed to allow vehicle owners to park at a common site and maximize the use of public transit, vanpools and carpools.

Park & Ride at US 202 and Paoli Pike in West Goshen Township.

Park and ride lots come in different forms including:

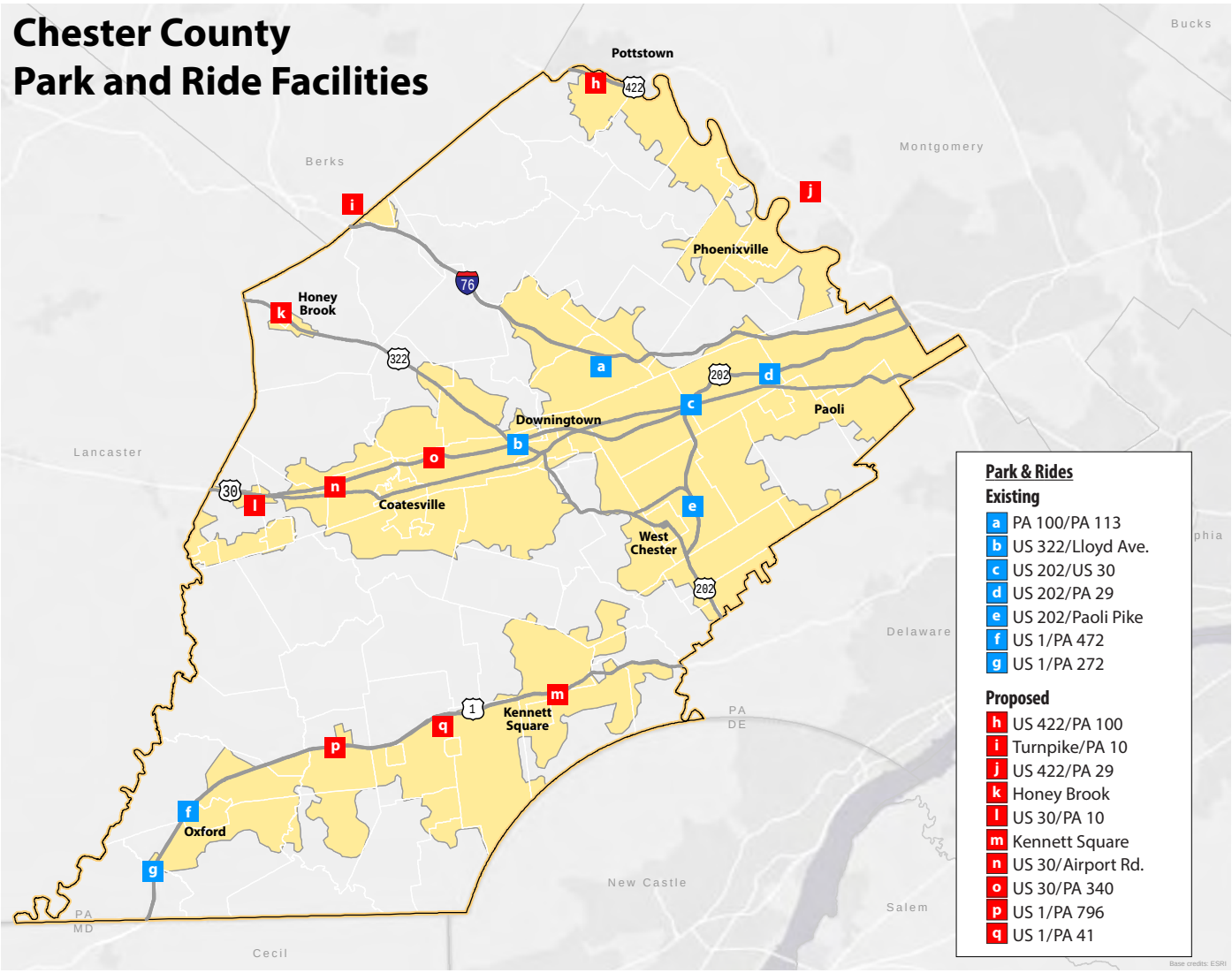
- A parking lot that was constructed for other uses such as a shopping mall but is being informally used for ride sharing.
- A parking lot at a shopping center or church which has been formally leased for use by commuters; or,
- A lot which has been constructed by a public agency exclusively for use by commuters.

Chester County's recently adopted ***Public Transportation Plan*** recommends implementation of the 'New Commuter Service Model' to address not only roadway congestion, but also service gaps and new service requests in the existing public transportation system. These new commuter services would begin as: a carpool originating from one of the park & ride locations; a group of people working at one of the county's major employment centers; or, any combination thereof. As the numbers of riders/participants increase, carpools would then evolve into a vanpool, and eventually into an express bus service.



Recommendations

- Develop additional park and rides within Chester County. There are seven existing park & ride facilities located near major interchanges throughout the county as represented by letters a-g on the exhibit below.



Proposed facilities (as indicated by letters h-q) in the exhibit above should be developed through the land development process and/or shared use arrangements with existing commercial centers.

Similar to bus shelters, the maintenance of park & ride lots is an existing barrier to the expansion of these facilities. Presently, PennDOT will develop park and ride lots but is reluctant to accept the maintenance responsibilities. Resolution of this issue is critical to the expansion of the park & ride network as envisioned by the ***Public Transportation Plan***.

Considerations for new park and rides include:

- Park and ride lots must be designed with safe access into and out of the lot.
- Locate park-and-ride lots adjacent to major highways interchanges and/or adjacent to existing or anticipated bus routes and visible to commuters whom they are intended to attract. In all cases, directional and informational signage should be provided. The parking areas should be located at points that precede bottlenecks or significant traffic congestion and close to residential areas to minimize single occupant vehicle traffic.
- Appropriate landscaping should be provided to mitigate the aesthetics associated with parking areas. The landscaping design should avoid unsightly expanses of pavement and should consider security as well as sight distance requirements. **See also the LANDSCAPE MATERIAL design element**.
- Street lighting should be included in the design of the project where security issues may be present. **See also the LIGHTING design element**.
- New facilities should provide adequate turning radii for both a standard 40 foot bus and a coach bus. **See also the VEHICLE CHARACTERISTICS design element**.
- Porous paving should be considered for lot surfacing to reduce stormwater runoff.
- Municipalities should consider encouraging the dedication of spaces for park and ride in commercial uses during the land development process. For example, a cinema complex may be an excellent opportunity for day use as a park and ride lot.
- A promotional program is needed periodically to inform the public of the availability of the lot.
- Park-and-ride facilities could be provided through lease arrangement with existing commercial properties, churches or fire halls. The reason for leasing space instead of building a new facility is to reduce the initial cost, assess the demand for such a facility and minimize the potential depletion of existing land.
- When demand at an existing, leased facility increases it may require leasing more parking spaces, making an addition to the existing facility or building an entirely new facility.
- Development of a park and ride facility should include a maintenance agreement that should be codified as an obligation of the land developer/property owner through the land development process.

References

- ***AASHTO Guide for Park-and-Ride Facilities***, 2nd Edition
- ***Park-and-Ride Planning and Design Guidelines***, Robert J. Spillar, P.E., Lead Transportation Engineer, Parsons Brinckerhoff Quade & Douglas, Inc., October 1997

Aerial photo of Quakertown Park and Ride located nearest the I-476 Northeast Extension/PA 663 intersection in Bucks County, PA.

(Page intentionally left blank)

Rail Stations & Transportation Centers

Rail stations and transportation centers serve as the intermodal hubs of the public transportation system in Chester County. They are the primary locations for where Chester County residents access either SEPTA or Amtrak services along the central commuter rail spine of the Keystone Corridor, or from where transit users may board one or more or transfer between the bus routes that serve the county and beyond.

This design element focuses on rail stations and transportation centers and the amenities they may provide to improve the built environment for transit users and their experience using the public transportation system.

The quality of a public transit ride is defined by all aspects of a rider's experience, from the time of departure to arrival at the destination. Beyond a rider's experience in the transit vehicle, there are two additional significant components to a "full" transit ride: the connection between a transit stop and one's origin/destination; and the experience waiting for the arrival of the transit vehicle. In this context, the amenities at rail stations and transportation centers have significant roles regarding the quality of public transit in Chester County.

Rail Stations

There are two passenger rail providers that serve Chester County. Amtrak provides regional and intercity service on the Keystone Corridor between Philadelphia and Harrisburg with additional intra- and interstate connections. SEPTA operates the Paoli/Thorndale commuter rail service on the same rail line extending between Philadelphia and Thorndale with regional connections in Philadelphia. This rail right-of-way is owned by Amtrak and extends on an east/west axis through the central portion of Chester County.

There are twelve existing passenger rail stations in Chester County (listed below from east to west). Two are served by Amtrak only, seven are served by SEPTA only, and three are served by both agencies:

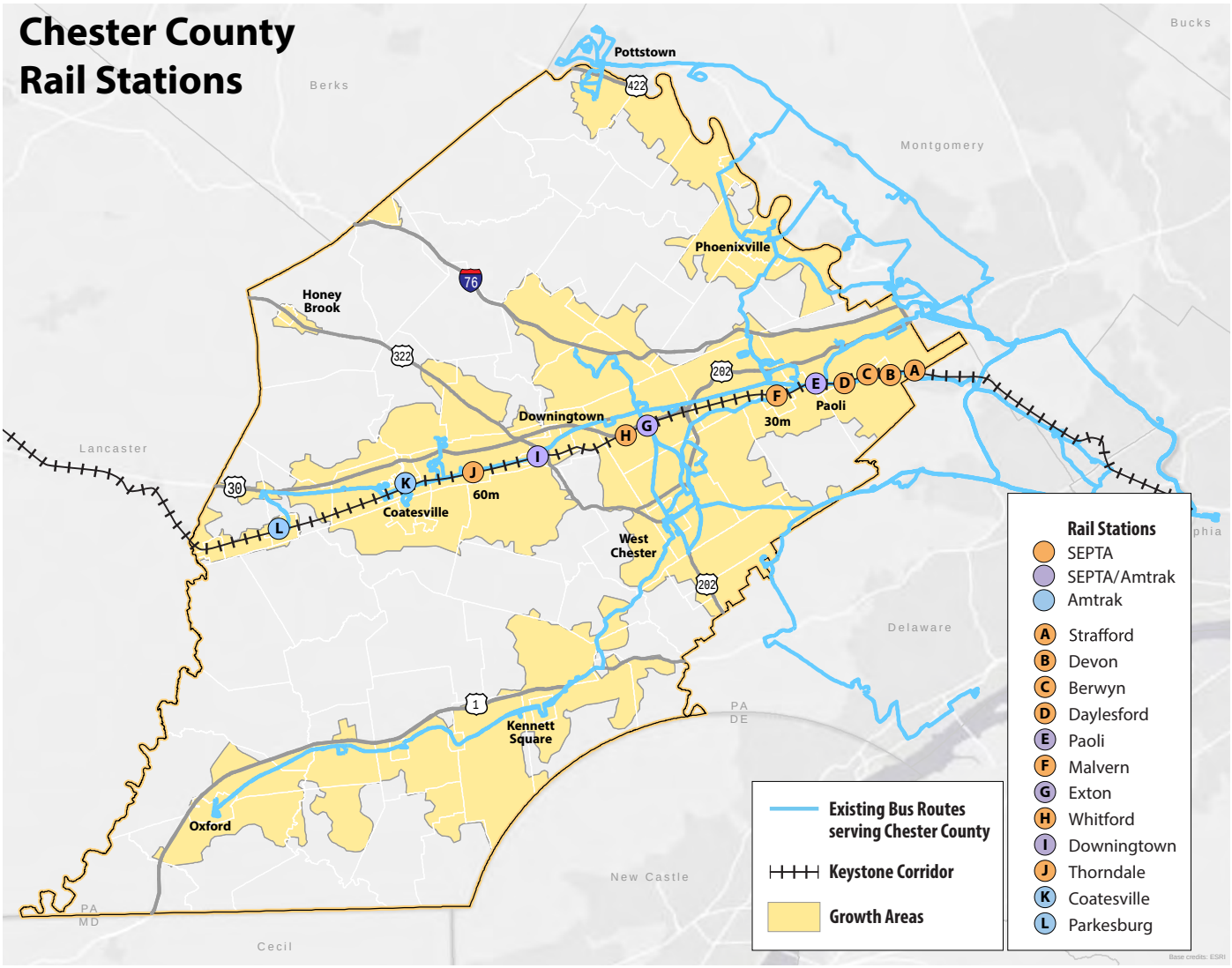
- **Strafford**: Old Eagle School & Crestline Roads
- **Devon**: Lancaster Ave. & Devon State Rd.
- **Berwyn**: Lancaster Ave. & Main Ave.
- **Daylesford**: Lancaster Ave. & Glenn Ave.
- **Paoli***: North Valley Rd. & Lancaster Ave.
- **Malvern**: Warren Ave near King St.
- **Exton***: Walkertown Rd. at PA 100

RAIL STATION
A stop along a commuter rail line where trains load or unload passengers.

PUBLIC TRANSPORTATION

- **Whitford**: Whitford & Spackman Roads
- **Downingtown***: Lancaster & Stuart Avenues
- **Thorndale**: Lincoln Highway & South Bailey Road
- **Coatesville****: North 3rd Ave. between Coates & Fleetwood Streets
- **Parkesburg****: West 1st & South Culvert Streets

* -serviced by both SEPTA and Amtrak
**-serviced by Amtrak only



The passenger rail service along the Philadelphia–Harrisburg line, particularly SEPTA's Paoli/Thorndale service, is the backbone of all public transportation in Chester County. The Paoli/Thorndale is the County's most heavily used public transportation service. The condition and accessibility of the stations along this rail line are key factors in drawing new riders and retaining existing riders.

Transportation Centers

There are three (3) transportation centers providing bus service connections located in Chester County:

- **West Chester Transportation Center** – This facility is located in the ground floor of the parking structure across from the Chester County Justice Center and provides connecting bus service for SEPTA Routes 92 and 104, Krapf Transit Route A and TMACC's SCCOOT route. Public parking is available in the garage, although space is limited.

TRANSPORTATION CENTER

A hub served by multiple transit routes that provides multimodal options and transfer opportunities for transit users.

West Chester Transportation Center.

Berwyn Train Station.

- **Exton Transportation Center (Exton Square Mall)** – This facility is located on the eastern side of the Exton Square Mall and provides connecting services for SEPTA Routes 92 and 204 and Krapf Transit Route A. Ample parking is available in the adjacent parking structure.

The Exton Transportation Center at the Exton Square Mall.

- **Paoli Intermodal Transportation Center (ITC)** – Once developed, the Paoli ITC will become Chester County's third transportation center. More information regarding the status of current planning and design efforts may be found at: ***www.paolitransportationcenter.com/***

The ***Public Transportation Plan*** identified a number of critical issues applicable to both rail stations and transportation centers. The most common issue to be addressed is parking availability. Limited parking at rail stations and to a lesser degree transportation centers limits the ability for people to access the public transit system. This limitation essentially places a cap on ridership. The majority of people that use public transit in Chester County typically drive from their homes to the rail stations so that they may use the commuter rail system. If no spaces can be found at the station of choice, potential transit users either choose to drive to another station, or in most cases decide to complete the trip in their automobile.

The lack of first mile (home to transit) and last mile (transit to destination) connections creates a significant barrier to public transportation use in Chester County. These first mile/last mile connections can be addressed through the provision of a drop-off (kiss n ride) loop and/or additional shuttle bus parking. Another potential solution is the installation of car shares and/or bike shares at or near the station sites.

Bicycle, pedestrian and/or shared use facilities described in this handbook should be improved within and around rail stations and transportation

centers to provide for better connectivity between adjacent neighborhoods and the public transportation system. Bicycle parking is an amenity that if securely provided may attract additional riders who would access the stations/centers via bicycle rather than by car.

Recommendations

- Provide for additional parking at rail stations with the following three-tiered approach:

    1. Expand surface parking at all stations where feasible. Surface parking should be developed to maximum capacity feasible at all station sites.
    2. Maximize shared use parking opportunities adjacent to rail stations. Arrangements with adjacent properties with existing lots or the space available to create additional parking should be explored to maximize parking if no additional space is available at existing stations.
    3. Develop structured parking where feasible. Once surface parking at the station sites is maximized, and all shared use opportunities with adjacent properties are exhausted, structured parking should be developed if feasible.

- Consider implementation of the recommended improvements for existing rail stations as outlined in the ***Passenger Rail Stations*** Technical Memorandum published by CCPC in January 2005.
- Recommended amenities for rail stations and transportation centers include:

    - ample vehicular parking;
    - bicycle parking;
    - kiss ‘n ride/drop-off/bus loop;
    - system/route mapping;
    - benches & trash receptacles;
    - real time status info;
    - heated shelter or waiting area; and,
    - restrooms.

- Bicycle parking should correlate to the percentage of ridership that access the stations via bicycle. With the implementation of better bicycle facilities in the vicinity of the stations, demand for bicycle parking will increase. **See also the BICYCLE PARKING Design element**.

- Provide car shares/bike shares at or near rail stations. Such facilities would require some form of public/private partnership and the ability for the share provider to establish a presence at or very near to the station site. The shares would also require reciprocal stations at or near the employment centers so that consumers would not be charged for the down time of having the vehicle while they are working. Feasibility studies will be required to further investigate car share/bike share opportunities associated with the rail stations.
- Municipalities should promote appropriate land uses and development densities in the vicinity of stations that enhance ridership potential and improve the interaction between the station and surrounding community. Examples of complementary land uses include convenience uses such as child care facilities, laundries/dry cleaners, and higher density residential development that would allow walk-up access to the station.
- SEPTA or Amtrak should expand its leasing of space in stations to businesses. The most popular offering at present is coffee shops, but there is additional potential. Niche markets should be identified that reflect undeserved needs around each station. These additional uses may require designated parking for vehicular-oriented traffic which may create an enforcement issue that should be considered by the municipality.

References

- SEPTA Bus Stop Design Guidelines ***http://septa.org/strategic-plan/reports/SEPTA-Bus-Stop-Design-Guidelines-2012.pdf***
- Chester County Public Transportation Plan, an element to the Landscapes2, the Chester County Comprehensive Policy Plan ***http://www.chesco.org/DocumentCenter/View/17264***
- Passenger Rail Stations Technical Memorandum published by CCPC in January 2005.***http://www.chesco.org/DocumentCenter/View/2586***

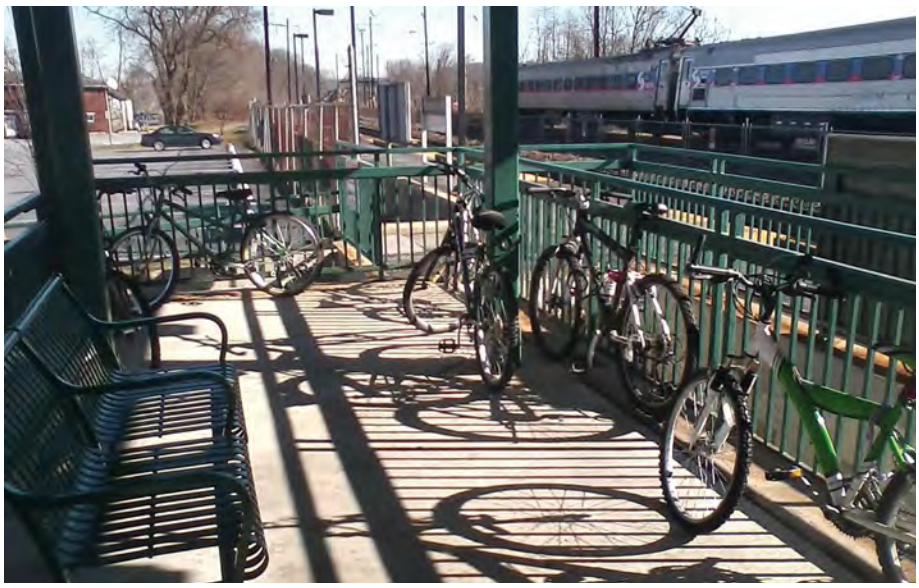
INFRASTRUCTURE & AMENITIES

Bicycle Parking

BICYCLE PARKING
A secure location on-site or within a facility for the temporary storage of bicycles.

Parking is an essential feature to the accessibility of all land use types. Just like parking a car, people need a safe, secure, and convenient location to store their bicycle once they get to their trip destination. The type of bicycle parking facility is dependent on the type of user and volume of bicyclists. For instance, commuters may prefer covered bicycle parking, such as a bike locker, for added security and to protect their bicycles from the elements for extended lengths of time. Alternatively, someone running errands may be more concerned with ease of access to quickly park and depart the location.

To accommodate recreational bicycling and bicycle mobility, it is essential that communities provide, or facilitate the provision of, secure bicycle parking and/or storage for a bicycle. The image below illustrates the need for bicycle parking at the Downingtown Train Station where bicycles are often locked to fences in a waiting/sitting area because no other option for bicycle parking is provided. There are several options for short-term and long-term bicycle parking and include, but are not limited to, bicycle racks, bicycle stations, and bicycle corrals.



This train platform at the Downingtown Train Station illustrates a need for dedicated bike parking.

Bikes locked to sign posts at the West Goshen Shopping Center.

Bicycle rack at Thorndale rail station.

BICYCLE RACKS
Stationary fixtures on which a bicycle is held upright and securely attached (typically using a bicycle lock) to prevent theft.

Bicycle Racks

Depending on the type of rack and space dedicated to the parking of bicycles, a bicycle rack can accommodate a few bicycles or a few dozen. Bicycle racks are available in many different designs and configurations that can be customized to any given installation. At a minimum, bicycle racks should be conveniently located, easy to use, and secure.

Bicycle Corrals

Corrals typically have 6 to 12 bicycle racks in a row and can park 10 to 20 bicycles using space otherwise occupied by one to two cars. Bike corrals remove the bicycle (and rider) from the sidewalk and away from potential conflicts with pedestrians using the sidewalk. Several bike corrals have been installed in the City of Philadelphia where the demand is high for bicycle parking as shown in the following image.

A bicycle corral at Walnut and South Sydenham Streets,Philadelphia.

BICYCLE CORRALS
On-street bicycle parking facilities that make efficient use of on-street automobile parking spaces for bicycle parking in areas with a high demand.

Bicycle Stations

Amenities can include changing facilities, day use lockers, parts and other gear available for purchase, repair services, air inflation stations, and information. Cyclists can purchase a membership to access their bicycles anytime, day or night. The bike station pictured below is located in Washington D.C. and the membership fee averages around $100 per year.

A bike station in Washington D.C. (Photo Courtesy of Mobis Transportation Alternatives)

BICYCLE STATIONS
Typically enclosed parking structures that securely house bicycles from theft and from the elements.

A bike station in Ottawa, Ontario, Canada. (Photo by John Calnan of SEPTA)

Recommendations

Municipalities should include requirements for bicycle parking in their zoning/subdivision & land development ordinances. Bicycle parking should be targeted to the following land uses:

- Institutional (libraries, schools, government offices)
- Retail centers
- Employment centers
- Recreational uses (parks and trails)
- Rail stations
- Transportation centers

There are a number of ways to incorporate bicycle parking into ordinances. Ordinances can require a certain amount of parking spaces be dedicated to bicycle parking though the installation of bike racks. Ordinance standards can also require or encourage the installation of bike racks near the entrance to a business or use on a public sidewalk where appropriate accommodations can be made. This can be accomplished through off street parking requirements, streetscape requirements, or incentives. The following are recommended guidelines towards the establishment of a bicycle parking ordinance:

- Bicycle racks should be required based on the density or intensity of a proposed residential, institutional, commercial, or industrial use. For example, one (1) bicycle rack that accommodates a minimum of ten (10) bicycles shall be required for every fifty-thousand (50,000)

square feet of gross leasable floor area or fifty (50) or more multi-family dwelling units. The municipality can adjust the "thresholds" to meet their community objectives or the intent of the associated zoning district.

Land Use	# of Bicycle Parking Spaces
Multi-family Residential	10 spaces for every 50 or more dwelling units
Institutional, Commercial or Industrial	10 spaces for every 50,000 SF Gross Floor Area

- Bicycle racks should be permanently anchored to promote stability and security, unless the racks are portable in which case they should be securely locked to a permanent structure.
- Bicycle racks should be located in visible areas near building entrances and/or areas of pedestrian activity such as: courtyards, bus shelters, etc.
- Bicycle racks should be located under a shelter or a building overhang or inset to provide shelter from the elements for bicycles and riders.
- Where no designated area for bicycle racks is feasible, perhaps in the case of a change in use, automobile parking space(s) can be dedicated to bicycle parking through the use of portable bicycle racks.

Other means by which to provide for more bicycle parking include:

- Encourage businesses to place bike racks at existing facilities; and,
- Ask businesses/business associations to donate money for bicycle parking or to sponsor bicycle parking for placement by the municipality.

(Page intentionally left blank)

Emergency Access

Chester County's Emergency Management Services provided the following general suggestions on providing emergency access to a property or development:

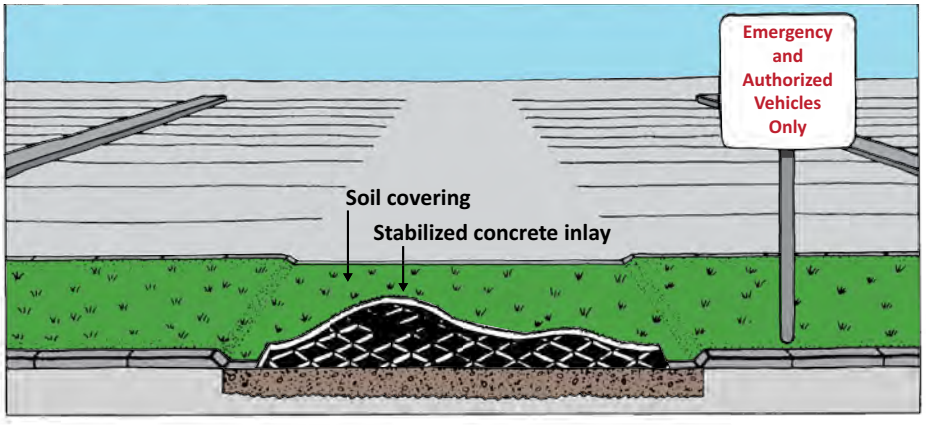
1. Provide more than one access point for subdivisions over 24 dwelling units.
2. Provide the proper turning radius and turnaround areas for emergency vehicles. **See also the VEHICLE CHARACTERISTICS design element**.
3. Reduce strings of flag lots to allow drivers the ability to find the correct parcel.
4. Make driveway grades no steeper than 12 percent.
5. Ensure proper pavement thickness for emergency access areas, especially at the rear of apartment buildings.
6. Provide emergency access routes, maintain them and make keys available if gates and locks are used.
7. Provide adequate distances between buildings and fire lanes for apartments, offices and commercial development.
8. Provide easy access to fire hydrant hook up locations.

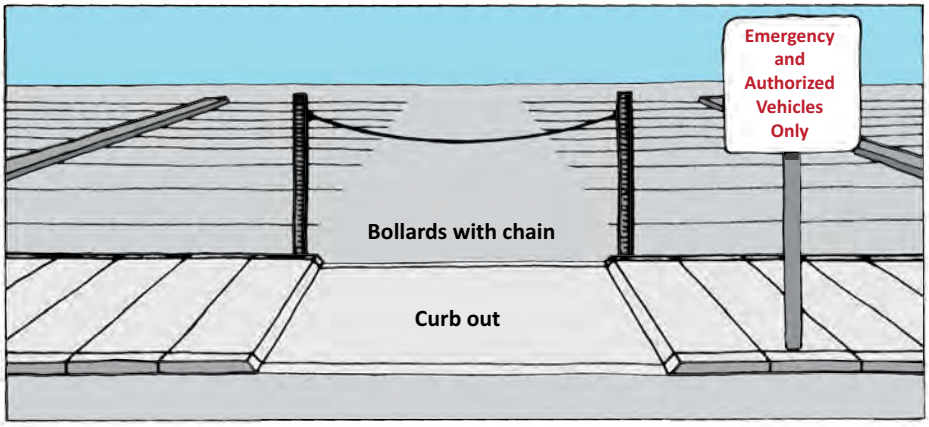
Emergency vehicle response is time-critical and vehicles are directly affected by poorly designed roadways. If roads are designed to facilitate emergency vehicle access, response time may be improved.

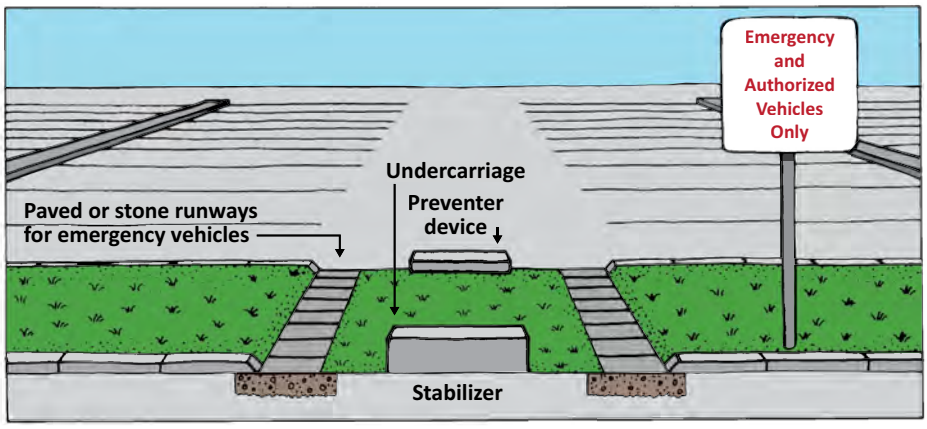
The following options as illustrated in the following Emergency Access Points exhibit (or combination of options) are some ways emergency vehicles can be accommodated when a development is unable to provide a second, fully improved access point:

1. stabilized grass paver and curb cut;
2. stabilized or paved surface with gate or chain and curb cut; and
3. undercarriage preventer device and curb cut.

EMERGENCY ACCESS
A feature, with a stabilized surface, that allows access for emergency vehicles to a particular property.







An efficient system that prevents misuse is the use of grass paver which provides a stabilized surface. This allows for grass to grow in the crevices and over the pavers so that they cannot be seen. In most cases they do not require a chain.

A gate or chain requires an emergency vehicle operator to dismount from the vehicle to open a gate or unlock or cut through a chain. They must also have the proper keys if it is locked. Gates are used more infrequently because of their susceptibility to violations and frequency of disrepair.

Undercarriage preventer devices are susceptible to violation by other motorists and may cause damage to the vehicle or pose a safety problem to the crew from the shock of crossing.

Where curbing exists, curb cuts should be provided to allow vehicular crossings without causing damage. Individual options should be evaluated based on specific site characteristics.

Recommendations

- Municipalities should require that all major developments have two, fully improved access points for the provision of emergency services. In the event that a second access point is not feasible then an emergency access point should be provided. If an emergency access point is used, an easement delineating maintenance and ownership responsibilities should be determined prior to plan approval.
- An emergency access point is only a temporary measure. It should only be kept in place until logical roadway extensions into future, adjacent developments can occur. If a road provides for an emergency access point at its terminus, then it should be designed according to its intended future use within the local road network.
- An emergency access route should be provided with no gates or chains that is traversable by emergency vehicles only or, if gates and locks are used, make keys available to emergency services. Use lightweight chains that are highly visible and can be easily broken by emergency vehicles. Provide a stabilized surface for use as a fire lane on all sides of apartment, commercial or industrial buildings.
- Municipalities should coordinate subdivision plan reviews with local emergency service providers.

Fire Lane

Residential, commercial or institutional buildings should be located within a reasonable distance of a dedicated, accessible and improved public street to ensure access to emergency fire vehicles. An emergency fire lane should be provided within the property lines to provide access to all buildings.

Minimum curb radii adequate for all emergency vehicles should be provided throughout the length of the fire lane. Fire lanes should also be designed to be continuous and not terminate in a dead-end.

FIRE LANE
(aka perimeter road)
A right-of-way for emergency vehicle access, within which no parking shall be permitted.

Recommendations

- Locate all commercial or institutional buildings within 150 feet of a dedicated, accessible and improved fire lane easement or no more than 600 feet from a dedicated, accessible and improved public street.
- Provide a minimum unobstructed right-of-way of 40 feet, with a 20-foot cartway width for fire lane easements.
- Provide a minimum of 55-foot radius on horizontal curves to accommodate emergency vehicles in the fire lane.
- Fire lanes should be designed to be continuous and not terminate in a dead-end.

Landscape Material

Definition

Trees, shrubs, and other plantings utilized in parking lots, streetscapes, and buffer areas.

Comments

Landscape material greatly enhances the attractiveness and appeal of commercial and residential developments, contributes to community character, and provides environmental benefits. Trees, shrubs and groundcovers provide many benefits, including:

- creation of a comfortable human scale environment;
- reduction of the urban heat island effect over large expanses of paving and thus extension of the paving lifespan;
- improved air and water quality;
- increased safety as a traffic calming element; and,
- reduced traffic noise.

When planning a streetscape, parking lot, or buffer area that is to include plant material, several factors should be considered when selecting plant species, including:

- the mature height and spread;
- the potential for root system damaging sidewalks and pavements;
- maintenance requirements such as the leaf and fruit litter; and,
- tolerance to pruning and adaptability to the street environment.

Plantings should always be located outside the clear sight triangle and should be several feet from the edge of the curb to allow for the openings of vehicle doors and free movement of passing vehicles. Drivers must be able to see between vegetation therefore plantings within or near the clear sight triangle should be trimmed to 2.5 feet high or should hang no lower than 8 feet. **See also the INTERSECTIONS design element**.

Requirements for street trees should be included in the subdivision and land development ordinance and be applied to all types of subdivisions and land developments. Requiring the right types of trees and appropriate spacing between trees during the plan review stage is important to avoid fixing costly mistakes at a later date. The use of native species (a species that occurs naturally within a region, either evolving there or arriving and becoming established without human assistance) should be encouraged, if not required.

STREET TREE

A tree that is currently located or proposed for planting along streets, highways, or parking lots. Such trees can be located on private property or on publicly-owned land.

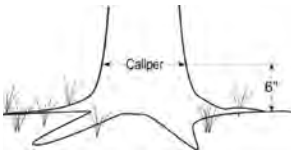
Street trees in West Chester,PA.

Recommendations

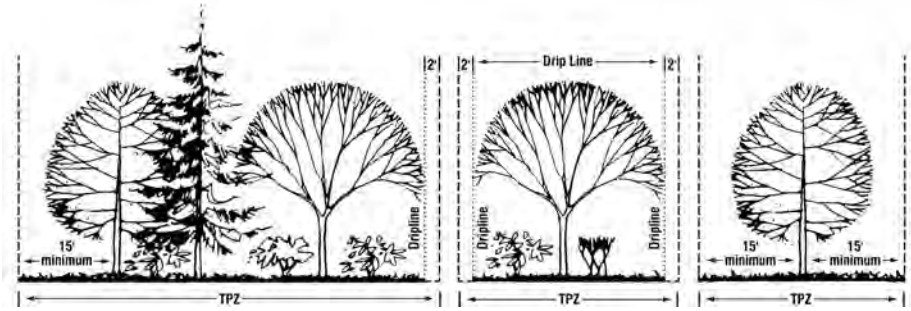
- Trees shall be located so as not to interfere with the installation and maintenance of sidewalks and utilities.
- Clear sight distances must be maintained at all intersections and driveway entrances. **See also INTERSECTIONS design element**.
- Trees to be installed should be a minimum three (3) inch caliper and a minimum of eight (8) feet in height at planting.
- Municipalities should include a street tree planting list that includes preferred species of plant materials with mature height and width. Trees placed in streetscapes, parking lots, or other urban environments in close proximity to paving shall be resistant to salt and de-icing compounds, not subject to disease or blight, able to withstand concentrated heat from large paved surfaces, and have deep root systems to prevent cracked pavements and sidewalks. One local resource listing such trees is the ***Philadelphia Parks & Recreation Recommended Street Tree List***.
- Municipalities should provide a list of preferred native species of plant materials as their use is strongly encouraged. Non-native species may be planted to serve specific purposes as long as they are not also invasive species. One local resource for native species information is the ***Brandywine Conservancy***.
- Trees with potential susceptibility to infectious disease or pathogens should be avoided, such as Ash trees (fraxinus species) due to the current spread of the Emerald Ash Borer.
- Trees with limited lifespans and structural issues should be limited to areas where their falling will not impact public safety or property. One such species is the 'Bradford' pear.

CALIPER

The diameter of a tree six (6) inches above ground level.



- Trees planted within urban environments should be planted within a space that allows for proper root growth. This may be accomplished through the use of continuous linear tree trenches, structural soil, silva cells or a combination thereof.
- Existing trees located between the cartway and right-of-way that meet the minimum caliper and height requirements may be used to satisfy the planting requirements if approved by the municipality. Existing trees to be preserved and used to satisfy street tree requirements shall be protected during construction phase through the use of a tree protection zone (TPZ) or similar tree protection standards.



Tree protection zones.

- Planting Plans should be prepared by a Registered Landscape Architect in the Commonwealth of Pennsylvania or equivalent professional. This is a requirement in many municipalities.
- All plant material should conform to the standards for nursery stock of the American Association of Nurserymen.

This is a good example of a parking lot landscape installation.

(Page intentionally left blank)

Lighting

Definition

The illumination of a roadway and/or parking facility by a fixed source.

Standards

Roadway:

- The Illuminating Engineering Society of North America (IESNA), ***Roadway Lighting***
- PennDOT Design Manual Part II: Highway Design: Chapter 5 – ***Lighting***

Parking and other site facilities:

- The Illuminating Engineering Society of North America (IESNA) ***Lighting Handbook***

Comments

Lighting may improve the safety of a highway or street and the ease and comfort of operation. Statistics indicate that the night time accident rate is higher than that during daylight hours, which to a large degree, may be attributed to impaired visibility. Evidence shows that in urban and suburban areas, where there are concentrations of pedestrians and roadside intersectional interferences, fixed source lighting tends to reduce accidents. The general consensus is that lighting of rural highways seldom is justified except on certain critical portions, such as intersections and interchanges, and areas where roadside interference is a factor. (AASHTO)

Warrants are factual evidence compiled for the purpose of justifying the installation of roadway lighting. Warrants should be based on conditions relating to the need for roadway lighting and the benefits it may provide. Factors such as traffic volume, speed, road use at night, night accident rate, road geometrics, and general night visibility are important considerations in determining the minimum conditions justifying lighting. (ITE)

Lighting that supports pedestrian access to and from bus stops, as well as visibility for waiting bus passengers is highly encouraged. When possible, SEPTA places bus stops in locations where lighting is provided. Lighting should be considered as part of implementing ***SEPTA's Bus Stop Design Guidelines***.

Attractive and appropriately sized street lighting fixtures are an important design element to consider during land development review. Where light pollution is a concern, the minimum amount of lighting needed for safety should be provided. In suburban areas with a higher density or level of traffic, an increased level of lighting may be appropriate for safety considerations.

More energy efficient light fixtures are being developed every day. LED lighting technologies have advanced considerably in recent years offering significant energy cost savings with the long term operation of these fixture types versus traditional bulbs.

Recommendations

- For roadway lighting, follow the recommendations of PennDOT Design Manual Part II: Highway Design: Chapter 5 – ***Lighting***; and, the Illuminating Engineering Society of North America (IESNA), ***Roadway Lighting***.
- For parking facility and other site lighting, follow the guidance contained in the Illuminating Engineering Society of North America (IESNA) ***Lighting Handbook***.
- Municipalities should ensure their lighting ordinance addresses the following criteria: illumination levels, lighting fixture design, control of nuisance and disabling glare, installation, energy efficiency, and light pollution/trespass.
- Site lighting should be directed inwardly from the periphery of a site to minimize the off-site impacts of lighting such as reducing glare and visual impacts on the adjacent roadways and adjoining land uses while providing for lighting that is sufficient for the safe use of a property. All lighting shall be aimed, located, designed, fitted and maintained so as not to present a hazard to drivers or pedestrians by impairing their ability to safely traverse and so as not to create a nuisance by projecting or reflecting objectionable light onto adjacent properties, past the object being illuminated, skyward, or onto a public roadway.
- Municipalities should require that a lighting plan be submitted with the preliminary development plan applications.
- The design of light fixtures should be consistent with the character of the area, the specific lighting application, and should otherwise comply with the Uniform Construction Code.
- Energy-efficient lighting design and operation should be used wherever possible.
- All exterior lighting shall meet IESNA full-cutoff criteria.

For more information regarding the effects of light pollution, please refer to the International Dark-Sky Association website at ***www.darksky.org***.

Noise Control

Also known as: Sound walls or vegetated buffers

Definition

The control of unwanted sound coming from the roadway.

Standards

AASHTO (A Policy of Geometric Design of Highways and Streets) – Efforts should be made to minimize the radiation of noise into noise-sensitive areas along the highway. Reducing noise can be accomplished by building an earthen or concrete barrier between the noise source and the receiver. Shrubs, trees, or ground covers are not very efficient in shielding sound because of their permeability to air flow. However, almost all buffer plantings offer some noise reduction, and exceptionally wide and dense plantings may result in substantial noise reductions. Noise reduction should be considered in the early design stages and the terrain should be taken into advantage in forming a natural barrier so that the appearance is aesthetically pleasing.

PennDOT: Use AASHTO Standards for earthen berms/landscape screens. For sound wall/noise barriers, see PennDOT Publication 24: ***Project Level Highway Traffic Noise Handbook***

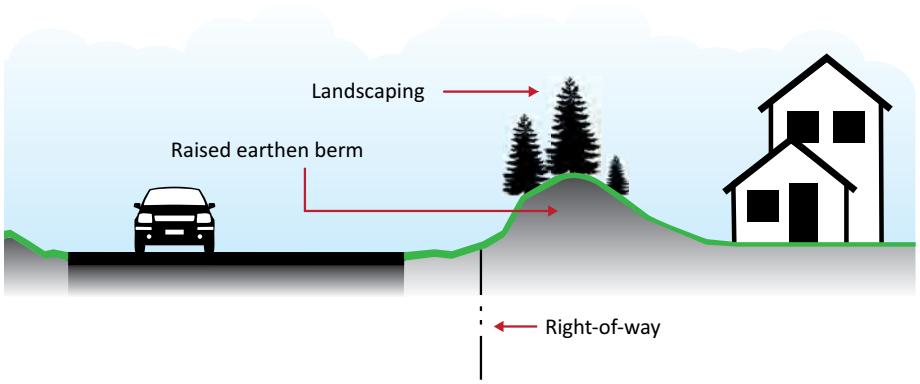
Comments

Screening and buffering devices such as raised earthen berms with landscaping, staggered landscaping within a designated buffer area and fence or wall structures, are effective for many uses. They are predominantly used to:

- reduce noise;
- provide privacy for dwelling units;
- separate incompatible land uses;
- shield unattractive structures from view;
- reduce light infiltration and glare; and,
- create visually appealing views, vistas and space.

When considering noise abatement measures it is important to recognize that it is more cost-effective to include them in the original design plan than to add them afterwards. Also, the use of existing, mature vegetation can properly enhance screened and buffered areas.

Earthen berm with landscaping



The installation of sound walls along a highway are determined by PennDOT's Noise Abatement Process, as outlined in their ***Project Level Highway Traffic Noise Handbook***. The following are excerpts from the PennDOT brochure ***"Sound Decisions About Highway Noise Abatement"***:

What Projects Are Eligible?

Only certain highway improvement projects are eligible for noise mitigation in Pennsylvania. These projects have the potential to alter the acoustical environment and are analyzed for noise impacts and abatement is considered. The scope of these types of projects include highways on new locations, substantial alteration of either the vertical and/or horizontal alignment on existing highways, and various other improvement projects, including certain auxiliary lanes, weigh stations, rest areas, etc.

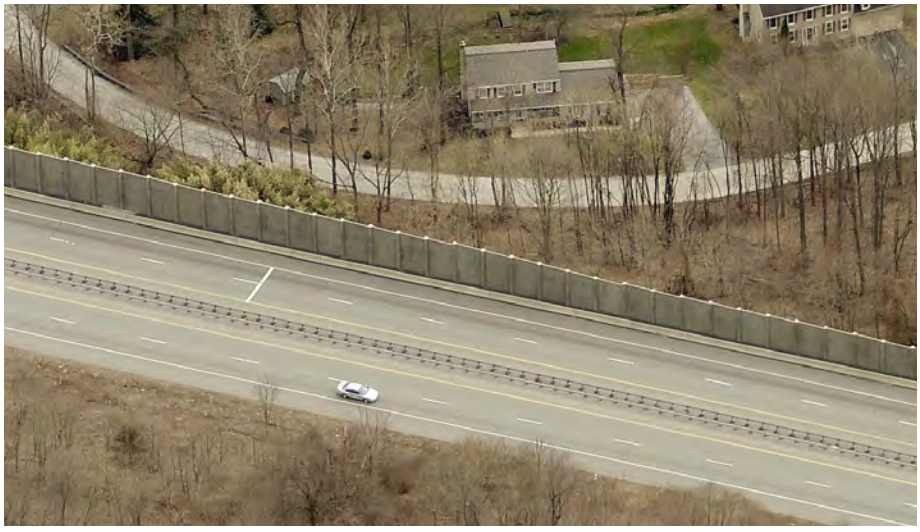
For eligible projects, there is a specific process that PennDOT uses to identify communities that will be considered for noise abatement and to determine whether noise abatement measures can be implemented within state or federal guidelines. This process includes the following steps:

1. **Determine which land-uses in the project could be affected by the project** – The Federal Highway Administration (FHWA) has established noise abatement criteria for various land uses which PennDOT uses to determine impacts and where abatement consideration is warranted. Locations such as residences, libraries, houses of worship, hospitals, schools and parks are often the most common land uses that receive abatement consideration.
2. **Monitor Noise Levels** – After noise-sensitive locations that may be affected by the proposed highway project have been identified, existing traffic noise levels are monitored at locations that are representative of affected neighborhoods. The results of the monitoring sessions are used to ensure that the noise prediction model will provide accurate results.

3. **Noise Modeling** – Computer modeling is performed with the FHWA TNM Model to assess future conditions in light of the proposed improvements. Noise projections are made for the worst-case future build condition using forecasted traffic information 20 years in future when the highway is at its maximum capacity.
4. **Noise Abatement Consideration** – PennDOT must determine that noise abatement measures are warranted, feasible, and reasonable at noise-sensitive areas.
    - To determine whether abatement consideration is warranted, the noise modeling projections are compared to noise impact criteria for the land use. Using criteria based on FHWA guidelines, abatement is warranted if the future noise levels approach or exceed the noise abatement criteria or are elevated by 10 decibels [dB(A)]above the existing conditions.
    - Feasible noise barriers are those that provide at least 5 dB(A) of noise reduction to noise sensitive locations and pose no safety, engineering, or access restrictions.
    - For a barrier to be reasonable it must be cost effective and maintenance, constructability, drainage and utility impacts, as well as the desires of the affected residents, must be considered.

Recommendations

- Consider the unique characteristics of a site when conducting the site analysis and design.
- Provide an adequate right-of-way for the screening and buffering of incompatible land uses, reverse frontage lots and residential areas along highways.
- Incorporate existing, mature vegetation into the design. Transplant existing trees whenever possible rather than destroy them
- For sound walls, follow the guidance of PennDOT Publication 24: ***Project Level Highway Traffic Noise Handbook***.
- Provide some form of a vegetative treatment to soften the appearance of concrete barriers if they are used.



Noise wall between PA 100 and adjacent neighborhood.

(Page intentionally left blank)

Parking

Parking lots are critical linkages between the transportation system and destinations. A poorly designed parking lot that does not accommodate all modes can single handedly discourage alternative modes. A well designed parking lot can transform a development into a vibrant welcoming space.

Excess parking has many direct and indirect costs. Direct costs for developers include the purchase of additional land, improvement and added maintenance costs, and property taxes. Indirect costs to a developer, but more direct costs to the environment include heat island generation and the excess stormwater runoff and loss of ground water recharge areas created by the added impervious surfaces.

Parking availability can affect not only the destination, but also the means people will use to reach a destination. The more difficult it is to find available parking, the less likely people will drive their automobiles to a destination. Lack of available parking also makes it more likely that people will utilize public transit, if it is available and relatively convenient. If there is a consistent abundance of available parking, it may indicate the parking lot is too large.

Many off-street parking lots for commercial areas have traditionally been designed to accommodate the maximum parking loads and predominant use of single occupancy vehicles. Balancing the demands of the private sector to provide sufficient parking with the municipality's desire to reduce the harmful impacts of excess parking is an issue many municipalities must contend with in new developments.

Determining the proper size, location, and layout of parking facilities are important decisions that municipalities must make to provide the most appropriate level of parking within a municipality. Facility types generally include off-street surface parking, on-street parking, and structured parking (parking garages).

Walkways are an integral part of parking lot design.

Comments

Parking facility design must reflect many factors including the amount of space available for the facility, the number of parking spaces required by the destination's land use, environmental and site specific conditions. The following provides general design principles and guidance regarding the physical elements to be addressed when developing parking facilities.

Site Work – Basic design principles to consider when deciding where parking facilities should be located include:

- Locate parking areas convenient to building entrances;
- Minimize extensive grading operations by designing with the topography;
- Slope parking areas between a minimum of 1% and a maximum of 5%, with an ideal slope of 2%;
- Create multiple smaller parking areas rather than one large mass;
- Integrate planted islands to increase aesthetics and improve runoff collection opportunities;
- Use topography and trees to mitigate negative visual impacts;
- Minimize negative impacts on the natural environment such as the unnecessary removal of mature vegetation or compromising soil stability; and,
- Utilize rectangular parking area configurations to minimize land area requirements.

Number of Spaces – The Delaware Valley Regional Planning Commission (DVRPC) developed the publication ***The Automobile at Rest: Toward Better Parking Policies in the Delaware Valley***, which inventories the parking standards of all Chester County municipalities and offers the following policy recommendations towards establishing a proper amount of parking spaces:

- Conduct an inventory of parking usage at various locations, times, and days to gauge whether excess parking is supplied for certain uses;
- Revisit number of parking space requirements in ordinances to ensure that required parking supply does not exceed demand and is sensitive to the local context. The following table – excerpted from ***SmartCode (Version 9.2)***, a new urbanist model transect-based unified development ordinance – suggests parking requirements for different use types across the transect of land use types ranging from rural to urban core:

Smart Code Parking Requirements

Land Use	Number of Spaces		
	T2 Rural T3 Suburban	T4 General Urban	T5 Urban Center T6 Urban Core
Residential	2.0/dwelling	1.5/dwelling	2.0/dwelling
Lodging	1.0/bedroom	1.0/bedroom	1.0/bedroom
Office	3.0/1,000 sq. ft.	3.0/1,000 sq. ft.	2.0/1,000 sq. ft.
Retail	4.0/1,000 sq. ft.	4.0/1,000 sq. ft.	3.0/1,000 sq. ft.

Source: Table 11 – SmartCode Version 9.2

- Provide alternatives to conventional parking standards by allowing by-right, flexible parking provisions such as shared parking, reserve parking, and fee-in-lieu parking; and,
- Identify areas where a unique context, such as proximity to transit or an historic village setting, indicates the need for specialized standards such as parking

Pedestrian and Vehicular Circulation – The orientation and configuration of parking spaces must be considered early in the development process to create a safe and convenient facility:

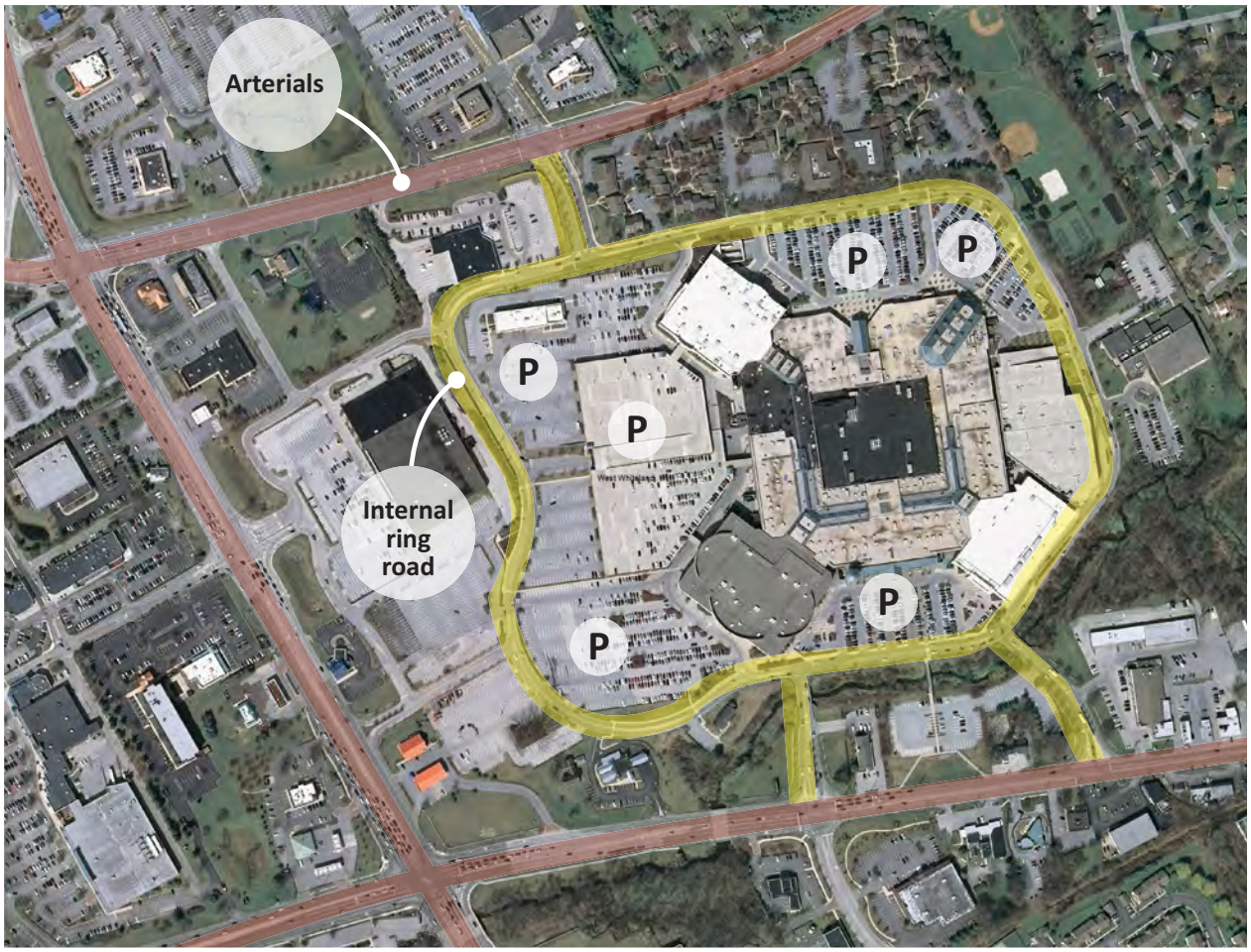
- Circulation systems should be designed to minimize the number of conflicts between vehicular, bicycle, and pedestrian traffic;
- Pedestrian circulation should always have a higher priority than vehicular circulation;
- Rows of parking spaces should be aligned perpendicular to the facility it serves to minimize the number of pedestrian crossings of driveway aisles;
- All off-street parking facilities should be accessible without backing into or otherwise re-entering a public right-of-way;
- Customer and employee parking areas should be separated when applicable to allow for better turnover nearest the main facility entrance;
- Turning radii should be provided to accommodate the largest vehicles that will utilize the facility, such as refuse haulers, buses, and tractor trailers; **See also VEHICLE CHARACTERISTICS design element**.
- Parking rows should be located on each side of a driveway aisle for paving efficiency;
- End islands, whether painted or curbed, are useful in several respects. An important one is to delineate the circulation road edge. Of equal importance is providing adequate sight distance for vehicles leaving the parking aisles;

- Dead end parking areas should be avoided whenever possible; and,
- Transit stops should be sited at a central location with walkways leading to all facility entrances to achieve a balance between multimodal accessibility and transit route efficiency.

Distributor Roads – In larger commercial and office developments there should be a hierarchy of travel lanes ranging from a ring road, or distributor road to parking aisles. Providing for different types of traffic improves circulation and reduces the potential for accidents.

The distributor road which is intended to carry higher speed and higher volumes of traffic throughout the development should have wider lanes, no parking, and should directly link the parking area to the public street. Distributor roads carry traffic at speeds of 10 to 20 MPH while parking aisles function at speeds of less than 10 MPH.

The intended function of the roadway immediately adjacent to a building is to be the fire lane and pick-up/drop-off area. It should not be used as a distributor road for through traffic.



Example of an internal distributor road.

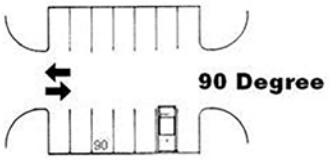
Off-Street Parking

OFF STREET PARKING
(On-lot parking) - A space located off the public right-of-way for parking a motor vehicle.

Off-street parking is the most common type of parking facility. These facilities have traditionally been developed as one large paved area resulting in expanses of asphalt. Most of these traditional lots were developed prior to the passage of modern stormwater regulations. Parking lot designers should limit the places where pedestrians are forced to cross vehicular traffic, and reduce redundant driveways, inefficient single stacked parking bays, locations where cars need to back into intersections, limit vehicular stops and turning movements, as well as consider appropriate locations for trash enclosure pads with regard for trash vehicle turning radii.

One of the first decisions to make when designing a parking facility is to determine the safest and most efficient configuration of the available space to meet the parking requirements. There are a number of different parking angle configurations to be considered, including perpendicular (or 90 degree) and other angled (60, 45, 30 degrees) options. The following provides basic descriptions and dimensions including the advantages and disadvantages for each configuration type:

Perpendicular (90 degree) – This is the most efficient and economical parking configuration because it accommodates the most vehicles per square foot of available parking area. Perpendicular configurations work best with two-directional driveway aisles; one way drive aisle configurations have almost the same space requirements and offer little advantage in circulation. Standard dimensions for this configuration are 9 foot wide by 18 foot deep spaces with a 24 foot wide (two-directional) driveway aisle for a total 60 foot wide cross section.

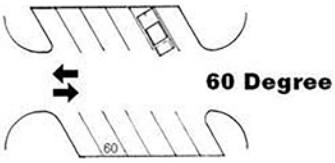


Advantages:

- Handles the most vehicles per square foot of available space
- Handles most vehicles per linear foot along a driveway

Disadvantages:

- Requires the widest dimension (60 ft) for a double bay
- Difficult maneuvering for some drivers compared to other angled options



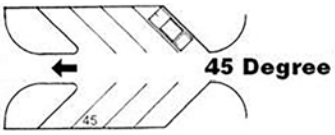
Angled—60 Degree – The primary advantage with any angled parking is the ability to provide more spaces or better circulation patterns when the space available for parking is dimensionally constrained. The 60 degree angled parking configuration is ideal for a fast turnover rate or predominantly short term use and may be preferred over 90 degree parking in some situations due to ease of navigation, even though it may be a less efficient use of the available space. Standard dimensions for this configuration are 9 foot wide by 20 foot deep spaces with a 24 foot wide (two-directional) driveway aisle for a total 64 foot wide cross section, or 16 foot wide (one-directional) driveway aisle for a total 56 foot wide cross section.

Advantages:

- Easy maneuvering in and out of parking spaces due to better visibility
- Lends itself to either one-or two-way aisles
- Works best with short term and high turnover situations

Disadvantages:

- Requires more pavement per vehicle than perpendicular configurations
- Handles fewer vehicles per linear foot



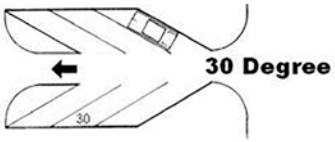
Angled—45 Degree – The 45 degree angled parking configuration displays similar benefits and limitations as the 60 degree configuration. Standard dimensions for this configuration are 9 foot wide by 19 foot deep spaces with a 14 foot wide (one-directional) driveway aisle for a total 52 foot wide cross section. Two-directional driveway aisle dimensions are not provided since two-directional 45 degree parking requires almost the same amount of cross section width as 90 degree configurations while providing significantly fewer spaces.

Advantages:

- Reduced width requirements
- Easy maneuvering in and out of parking spaces
- Good rear visibility

Disadvantages:

- Does not work well with two-way aisles
- Requires more pavement per vehicle than both 90 and 60 degree parking configurations



Angled—30 Degree – Similar to 45 degree configurations, this configuration progressively increases the amount of pavement required per space while narrowing the double bay cross section. Standard dimensions for this configuration are 9 foot wide by 16.5 foot deep spaces with a 12 foot wide (one-directional) driveway aisle for a total 45 foot wide cross section.

Advantages:

- Easiest spaces to back out from a visibility standpoint
- Least required width for double bay cross section

Disadvantages:

- Requires the most pavement per vehicle parking space
- Does not work well with two-way aisles

Landscaping – The most attractive,most functional, and most sustainable parking areas are those that are well landscaped. Trees provide valuable additions to parking areas, whether planted in curbed islands or located on the parking area perimeters. Trees provide shade, visually reduce the mass of open pavement, and mitigate heat gain. Landscaped areas may be used to collect runoff for stormwater management. The following are some general considerations for how plant materials can be used to improve parking facilities:

- Provide internal parking islands to break up large expanses of paving and reduce the heat island effect;
- Provide appropriately-scaled, well-graded and planted earthen berms or mounds around parking area perimeters to screen the parking area from streets and other facilities; and,
- Minimize the use of medium to tall shrubs on internal curbed parking islands to allow for greater visibility within a parking area

Other factors to consider:

- Parking areas are not conducive to healthy plant growth due to reflected sunlight, heat gain, and exhaust fumes. Only plant species that are tolerant of these extreme conditions should be used.
- Non-porous pavement limits the oxygen and water exchange between plant roots and the atmosphere. Soil compaction resulting from construction amplifies these conditions for existing trees. Consider the use of porous pavements and existing tree protections during construction of these facilities to promote plant health.
- Curbing should be used for planted islands where appropriate to protect against trunk damage created by vehicles.
- In addition to providing curbing and/or bumper blocks, ensure that parking spaces provide sufficient separation from trees and shrubs to avoid damage.
- Native plant species should be selected whenever possible.
- Clear sight distance should be provided at all intersections/driveway entrances. Low level plantings in parking islands should remain low and not destract sight lines within a parking lot.

Avoid the following with respect to tree plantings:

- trees with messy fruits or berries;
- brittle-limbed species;
- spreading root systems;
- large leafed deciduous trees that can clog drains and make walking hazardous; and,
- trees susceptible to insects and diseases.

Trees that should be selected include those that:

- cast medium to dense shade in summer;
- have normal life spans over 60 years;
- thrive in pollution and in the heat of a typical urban environment;
- demonstrate salt and de-icing compound tolerance;
- require little pruning and are structurally sound; and
- are resistant to insects and diseases.

See also LANDSCAPE MATERIAL design element.

A good example of trees and planted islands within a commercial parking lot.

Lighting – Lighting is an important component of parking lot safety, especially for a facility that has early morning, late afternoon, or night time use. The Illuminating Engineering Society (IES) recommended minimum average illumination level for a surface parking lot is 0.5 footcandles. The IES also recommends that all pedestrian routes and entrances/exits should be well lit with a minimum average of 1.0 footcandles. Lighting poles are typically 20-25 feet in height, and should be located in islands or in parking perimeters and protected from potential vehicular damage.

Other lighting factors to consider include:

- Lights should be pointed downward to minimize light pollution and excess glare. Cutoff fixtures should be used to avoid light spilling onto neighboring properties.
- Bulb selection will affect the color of light projected. High pressure sodium bulbs are relatively inexpensive, yet cast an orange hue while more expensive metal halide bulbs cast more of a white light.
- LED fixtures are now becoming more widely used as the technology for these fixtures has advanced to provide much brighter fixtures. The energy required to power LED fixtures is considerably less than standard bulbs resulting in significant cost savings.

See also LIGHTING design element.

Stormwater Management – Surface parking lots have traditionally been developed with large expanses of asphalt resulting in a significant increase in stormwater runoff. The stormwater was then collected by a drainage system where runoff from large storm events would be temporarily stored in a retention basin then slowly released through control structures into the natural drainage systems. This general concept has been revised and reflected in Pennsylvania through the State's adopted erosion and sediment control regulations where the focus is to infiltrate or recharge a much larger portion of this runoff into the ground. As part of this shift, the National Pollutant Discharge Elimination System (NPDES)—as authorized by the federal Clean Water Act—now requires a permit for any earth disturbance exceeding 1 acre, where the threshold was previously 5 acres. These permit applications are reviewed by the local Conservation District as part of the land development process.

To help facilitate these new regulations, the state has published the Pennsylvania Stormwater Best Management Practices Manual. Some examples of Best Management Practices (or BMPs) applicable to surface parking include:

- Pervious Pavement with Infiltration Bed
- Infiltration Basin
- Subsurface Infiltration Bed
- Infiltration Trenches
- Rain Garden/Bioretention Areas
- Vegetated Swales and Filter Strips

Example of vegetated bioswales within parking islands at Riverfront Park, Pottstown, PA.

Shared Use Parking – 'Shared Use' parking is the approved use of the same off-street parking spaces for two (2) or more uses where peak parking demand of the different uses occurs at different times of the day, or, where various uses are visited without moving the automobile; and, where the division of parking spaces is a net decrease from the combined total of individual off-street parking requirements for each use.

Municipalities should consider possibilities for shared parking facilities based on operating hours and peak parking times for adjacent or nearby uses. Through the use of shared parking facilities, a lower overall number of parking spaces may be justified. Municipalities should be assured that adequate parking facilities for all uses will continue in the long-term and be available regardless of individual land use changes.

Areas where excess parking is provided should be considered for use as a park and ride facility for public transportation. **See also the PARK-AND-RIDE design element.**

Parking lot with a large expanse of uninterrupted paving.

On-Street Parking

Standards

AASHTO: The minimum width of a parking lane is 8 feet. The desirable width is 10 to 12 feet.

PennDOT:

- Arterial: Ten foot minimum, 12 feet desirable, 9 feet if used as a turning storage lane and average running speed is less than 40 MPH. Eight feet is acceptable if that lane will not be used as a traffic lane in the foreseeable future.
- Collector: Seven to 10 feet on both sides with two 11-foot travel lanes. Eight to 10 feet in commercial and industrial areas.
- Local: Seven to 10 feet on both sides with one 10-foot travel lane, depending on lot size and intensity of development. The desirable minimum is 8 feet.

Standard dimensions for on-street parallel parking spaces are 8 feet wide by 22 feet long and placed at least 50 feet from any intersection.

See also the LANE DESIGN design element

Comments

It can generally be stated that on-street parking decreases through capacity, impedes traffic flow and increases accident potential (AASHTO). From a comprehensive review of accident data, curb parking is directly or indirectly responsible for at least one out of every five accidents that occur on surface streets in our cities each year (ITE). While this applies to the nation's urban centers it must be taken into account when designing on-street parking anywhere.

The type of on-street parking selected should depend on the specific function and width of the street, the adjacent land use and existing and anticipated traffic volumes.

On-street parking is most commonly associated with urban or village landscapes and is often metered as a revenue generator as part of a community's parking management program. On-street parking spaces are typically included in the design of the roadway within which they are located and also referred to as 'parallel' parking.

On-street angled parking is less common and often associated with historic or central business districts with lesser traffic volumes where it also serves as a traffic calming effect. These installations require much more space within the road right-of-way than parallel parking but offer the opportunity to create more stalls within the same length.

Back-in angled on-street parking has recently been installed in the Borough of Pottstown, Montgomery County, PA. This installation on East High Street converted two westbound travel lanes and on-street parallel parking into one westbound lane, one bike lane and back-in angled parking within the same available space. Installed in 2003, this concept "has helped revitalize the downtown by slowing traffic, providing more parking spaces adjacent to stores, encouraging bicycling, and making it easier for pedestrians to cross the street."

ADA ACCESSIBILITY & PARKING REQUIREMENTS
(aka handicapped parking and access) - All or any portion of buildings, structures, site improvements, complexes, equipment, roads, walks, passageways, parking lots, transportation facilities, or other real or personal property that are readily accessible to and usable by individuals with disabilities in terms of architecture and design, transportation and communication.

ADA Accessibility & Parking Requirements

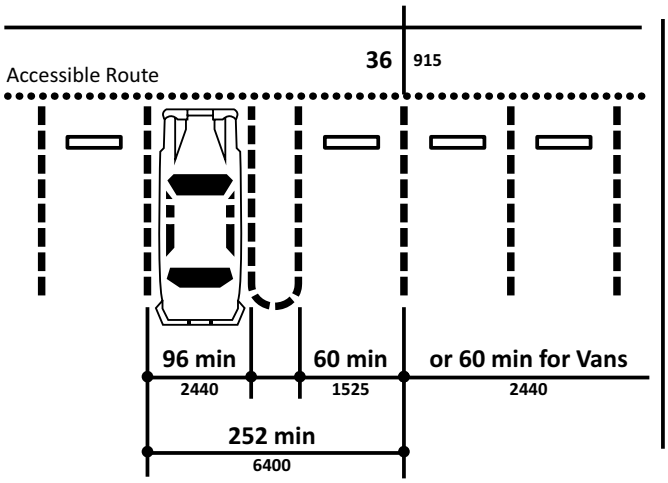
The Americans with Disabilities Act (ADA) ***Accessibility Guidelines for Buildings and Facilities*** requires that the construction of all new facilities shall provide at least one accessible route within the boundary of the site from public transportation stops, accessible parking spaces, passenger loading zones if provided, and public streets or sidewalks, to an accessible building entrance. And, at least one accessible route shall connect accessible buildings, facilities, elements, and spaces that are on the same site. The accessible route shall be a minimum of 36 inches wide. The routes should be as close to the designated handicapped parking spaces as possible. **See also the ADA ACCESSIBILTY design element.**

The minimum number of accessible parking spaces to be provided is based on the total number of spaces included:

Total Parking Spaces in Parking Lot	Minimum Handicapped Spaces Required
Less than 26	1
26-50	2
51-75	3
76-100	4
101-150	5
151-200	6
201-300	7
301-400	8
401-500	9
501-1,000	2% of total
Over 1,000	20+1 for each 100 over 1,000

Accessible parking spaces serving a specific facility should be located closest to an accessible entrance. If facilities have multiple accessible entrances, accessible parking spaces should be dispersed and located closest to the accessible entrances.

Accessible parking spaces should be at least 8 feet (96 inches) wide. Parking access aisles should be part of an accessible route to the facility entrance. Two accessible parking spaces may share a common access aisle at least 5 feet wide, with the potential for the aisle to be 8 feet minimum width if shared with accessible van parking. Parked vehicle overhangs should not reduce the clear width of an accessible route. Parking spaces and access aisles should be level with surface slopes not exceeding 1:50 or 2% in all directions. Signing for parking spaces should be placed on the paving surface and meet the requirements of the law.



Source: ADA Accessibility Guidelines for Buildings and Facilities

ADA accessible parking.

STRUCTURED PARKING
(Parking garage) - A building constructed primarily to provide for many levels of off-street parking to meet high parking demands.

Structured Parking

Parking garages are most commonly associated with densely developed urban centers and represent a significant investment in providing for a parking facility. They may also be developed at locations that have a significant draw with little or no additional space available to provide for more surface parking to meet the parking demands. Examples of such locations include transportation centers, rail stations, shopping malls & centers, and significant employment centers.

There are many design factors to consider for structured parking, including:

- The size and shape of the lot where the structure will be developed.
- Who the primary users of the facility will be.
- Connections to the adjacent street network.
- The architectural style of the structure's facades and how they may relate to existing adjacent structures.
- A municipality may also look for shared use opportunities—SEPTA's West Chester Transportation Center was incorporated into the newly constructed parking garage developed by Chester County across from the Justice Center on Market Street.

West Chester Borough's Chestnut Street parking structure with solar array.

Recommendations

- Recommend use of ITE's, ***Parking Generation and Guidelines for Parking Facility Location and Design: A Recommended Practice*** as a starting point to establish parking requirements. Requirements of adjoining uses should be considered for possible sharing.
- Follow the recommendations of the DVRPC publication ***The Automobile at Rest: Toward Better Parking Policies in the Delaware Valley***, to further refine the actual parking demand and number of spaces to be provided for the proposed use.
- Trees and other landscape materials should be provided for all off-street parking lots. A good ratio for determining the appropriate number of trees would be one tree for every 3-5 parking spaces required. Landscape materials should be planted so as to not interfere with required clear sight distances at plant maturity.
- Adequate lighting should be provided in parking lots for facilities with night time uses to ensure safety and security. Cutoff fixtures should be used to avoid light pollution and spillage onto adjacent uses. Energy efficient bulbs should be considered for long term cost savings.
- Developers and municipalities should utilize stormwater BMPs such as porous pavement, planted islands, rain gardens, and others whenever possible to reduce and infiltrate stormwater runoff.
- Permit shared use parking facilities which may reduce the number of required parking spaces and associated impervious coverage. Shared parking is particularly useful when two land uses have different peak parking demands.
- Residential parking should be off-street whenever possible. Streets bordering large lots do not require on-street parking because vehicles are accommodated on the property while streets bordering smaller lots usually require some form of on-street parking.
- Follow the regulations of the Americans with Disabilities Act Accessibility Guidelines for ***Buildings and Facilities*** (Chapter 2, section 208); and, ***Transportation Facilities*** (Chapter 5, section 502)
- Municipalities that need to provide structured parking should consider not only the development costs but also the long term operation and management of such a facility.

(Page intentionally left blank)

Setbacks & Building Placement

This design element addresses how the factors of setbacks and building placement affect the size and placement of multimodal transportation infrastructure and create a comfortable human environment within a site development.

Setbacks

A setback is used to create a buffer area which protects buildings or structures from the road by mitigating noise levels, by providing a safety zone and by improving aesthetics through landscaping or screening. Setbacks are a function of the area type, land use and the functional classification of the road.

SETBACKS
The minimum distance from the street right-of-way line to the lot line that establishes the area within which no structure can be erected.

The setback area and the right-of-way buffer area do not serve the same function. Setbacks are not intended to accommodate the future widening of the road therefore they should be measured from the ultimate right -of-way. See **RIGHT-OF-WAY ULTIMATE** design element. If no ultimate right-of-way exists, then setbacks should be measured from the existing right-of-way. The use of a setback measured from the ultimate right -of-way allows for the future expansion of a road while preserving the property and the building values when the road is widened.

Recommendations

- On roads of similar classification, there should be consistent setback in all adjacent zoning districts.
- Setback values should be determined according to the functional classification of the roadway.
- The following chart is suggested as a reference in determining setbacks. The process of determining setbacks is complex. This chart should only be used as a guide:

	Growth Area				Rural Areas			
	RES	COM	IND	OFF	RES	COM	IND	OFF
Arterial	15	15	10	15	150	150	125	150
Collector	15	15	10	15	100	100	50	100
Local	10	10	10	10	25	25	50	50

RES: Residential COM: Commercial IND: Industrial OFF: Office

Good setback example.

Poor setback example.

BUILDING PLACEMENT
The relative location of a building or buildings and other site elements on a lot or property.

Building Placement

How a building looks, its placement on a site and its relationship to adjacent structures and the immediate surroundings are some of the most significant influences on the character of any community or development (Pennsylvania Standards for Residential Site Development, Pennsylvania Housing Research/ Resource Center, 2007).

According to the PHRC, the following factors should be considered when placing buildings on a site:

- Setbacks
- Orientation
- Building Design
- Lot Size

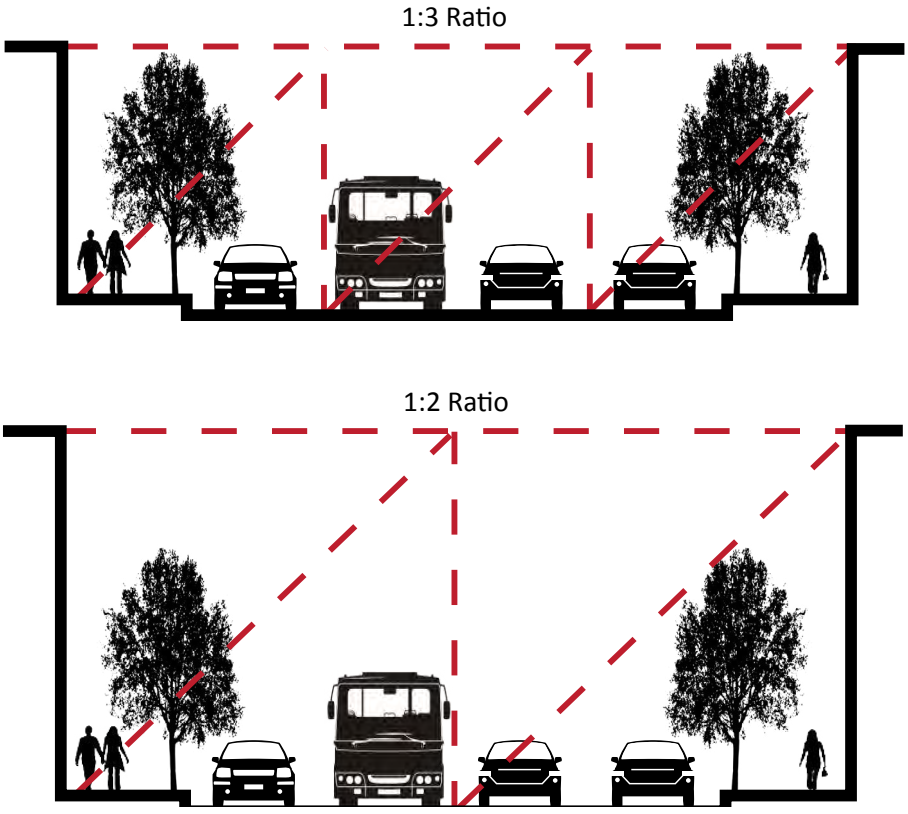
While these may be the primary factors for determining where buildings are placed, the relationship between the buildings and the circulation system utilized to access the building(s) is another factor that should be considered towards the creation of outdoor 'spaces' and a comfortable human scale environment. Parking lots, driveways, walkways, trails, etc. not only provide access to, but also limit where people may congregate in the outdoor environment.

For example, a design principle of many corporate parks constructed in the 1980's era placed the parking, main building entrances, and any pedestrian walkways on the opposite side of the buildings from the primary road frontage. While the design intent may have been to create the look of a green campus-like environment, the lack of pedestrian facilities on the frontage side results in a relatively sterile exterior due to a lack of apparent

human activity. There is simply no way to tell if these developments are full of life or if they are completely empty since the frontage always has the same appearance. This appearance has a direct effect on the marketability of the space within those buildings.

Successful developments achieve a balance between the functionality of the vehicular circulation system and the comfort and safety of the pedestrian environment, including minimizing conflict points. The sooner one may enter a comfortable pedestrian environment connecting to a building from the time they exit their car, the better the human experience will be for that development.

Building heights are another factor affecting the pedestrian experience. According to ITE's ***Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*** "Buildings are the primary feature of urban contexts that create a sense of definition and enclosure on a thoroughfare—an important urban design element that helps create the experience of being in a city and in a place that is comfortable for pedestrians. The threshold when pedestrians first perceive enclosure is a 1:4 ratio of building height to thoroughfare width—typical of low density environments. In denser urban contexts, height-to-width ratios between 1:3 and 1:2 create an appropriate enclosure on a thoroughfare.



Source: CCPC, 2015

Illustration of height to width ratios that create a scale on thoroughfares that is comfortable to people and encourages walking (human scale). Human scale ratios fall between 1:3 and 1:2 as measured from the building fronts.

While building heights and the inter-relationship of multiple buildings plays a significant role in creating outdoor spaces, pedestrian environments require the combination of subtle yet effective barriers such as curbing, fences, railings, bollards, planting beds and/or trees to provide the necessary separation from vehicular circulation to create a safe and comfortable space.

Recommendations

- Always consider the relationship between building placement and both pedestrian and vehicular site circulation and how it will impact not only safety but also the pedestrian friendly experience of the development.
- Provide for outdoor gathering spaces where appropriate, particularly in commercial and employment centers, urban centers, and suburban centers. These spaces help to create the appearance of vitality within a development.

Commercial development incorporating outdoor gathering spaces.

Ground level view of commercial development above.

Employment center with rear entrances and parking, no pedestrian facilities along frontage.

Ground level view of the employment center.

(Page intentionally left blank)

Signage (Non-Traffic Related)

Also known as: Advertising signs.

Definition

An outdoor sign, display, light, figure, painting, drawing, message, plaque, billboard or other thing which is designed, intended or used to advertise or inform.

Standards

PennDOT: Recommended use of the Pennsylvania Code, Title 67, Chapter 445, "***Outdoor Advertising Devices***," for properties adjacent to the right-of-way of the interstate and Federal aid primary system

Comments

The location of signs should never present unnecessary hazards for pedestrians or vehicular traffic. When possible gather signs together into a unified system. Signs should always be placed to allow for the maximum amount of sight distance. They should not be located directly in the driver's line of sight, especially at intersections. The scale and placement of the sign should also be sensitive to the context of its location.

Recommendations

- Follow the recommendations of the Pennsylvania Code, Title 67, Chapter 445, ***Outdoor Advertising Devices*** for properties adjacent to the right-of-way of the interstate and Federal aid primary system.
- Prohibit signs within clear sight triangles, except for traffic signs.
- Limit the number of signs to one per property. Any joint use properties with more than one principal use should use a freestanding sign to consolidate all the individual signs. The height of free-standing signs should not exceed the distance from the base of the sign to the cartway or to buildings.
- Consolidate signs on adjoining properties where practical.
- No advertising signs should have blinking lights or lights that simulate a traffic signal nor should they use the words "stop," "look," or "danger" or any other word which attempts to direct traffic within 500 feet of an intersection.
- Municipalities should regularly review and consider amending their sign ordinance(s) to address changing issues.

INFRASTRUCTURE & AMENITIES

Examples of non-traffic related signage adjacent to the roadway.

VEHICULAR CIRCULATION

Boulevard

Definition

A type of street having the opposing travel lanes separated by a landscaped median. Also known as a divided street or highway.

Comments

Boulevards provide a method of separating opposing traffic flows for residential areas, commercial, institutional, and industrial developments. They should extend as far as the first intersection within the development. A boulevard median should not be included in the calculation of the cartway width, but should be included in the calculation of the right-of-way width.

The provision of separated, two-lane cartways allows for access to a development if one of the cartways is closed due to an emergency. The unobstructed lanes can be used for two directional travel. Often, an entrance to a development is designed with a boulevard treatment that is not functional because it only separates the cartway for a short distance. If the cartway is obstructed beyond the separated boulevard and no other access point exists, then all access to the development is cut off.

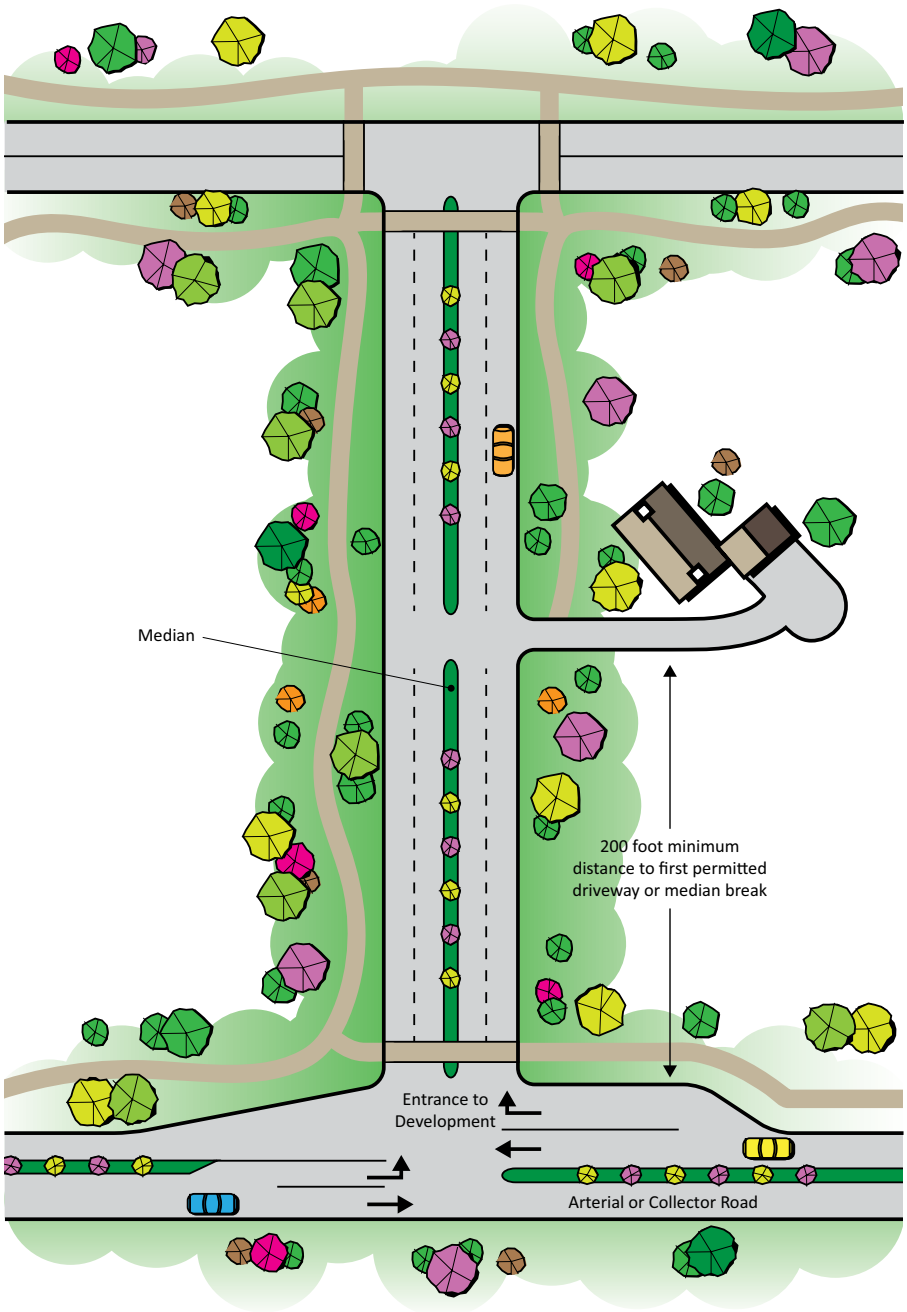
An entrance road designed as a landscaped boulevard is an attractive feature found in many of the successful cluster subdivisions. While this might not be appropriate in rural areas where the location and entrance to the subdivision should be more subtle, it works well in suburban or transitional areas.

Recommendations

- A boulevard design should be utilized in cases where a second access or emergency access cannot be provided to a development.
- A recommended minimum width, preferably 6-8 feet, should be established for a boulevard median.
- A recommended minimum single lane width of 11 feet (uncurbed) or 13 feet (curbed) for each cartway in residential areas and 15 feet (uncurbed) or 16-18 feet (curbed) for each cartway in commercial areas, should be established..
- Extend a boulevard to the first intersection within the development. Median breaks may be permitted 200 feet from the beginning of the boulevard. This restriction exists due to minimum values for sight distance, vehicle stacking and corner clearance.
- Limit the number of cross-overs to avoid potential conflicts.

- Choose a landscaping treatment in the median that avoids sight distance problems. PennDOT typically does not permit trees to be planted within medians in PennDOT rights-of-way.
- Determine median maintenance responsibilities prior to plan approval.
- No parking should be permitted along boulevards.

Boulevard



Boulevard entrance in Kennett Township.

Boulevard entrance in Upper Uwchlan Township.

(Page intentionally left blank)

Cul-de-sac & Spur Roads

Cul-de-sac

Standards

AASHTO: A 30-foot minimum radius. Use mountable curbs in residential areas if the cul-de-sac has less than a 47-foot radius with a central island. A 45-foot minimum radius should be used in commercial and industrial areas.

PennDOT: Recommended use of AASHTO standards. A cul-de-sac must have a 40-foot radius to qualify for Liquid Fuels Fund.

Comments

When properly designed, a cul-de-sac can be a useful technique for dealing with certain site configurations. When improperly designed, the cul-de-sac turnaround can create huge expanses of paved area requiring additional maintenance and generating excessive stormwater runoff. Cul-de-sac turnarounds should be required to include landscaped islands in the center to reduce impervious surface and provide a more attractive view both for homes facing the cul-de-sac and for residents of the subdivision in general.

The commonly used symmetrical design operates satisfactorily and is aesthetically pleasing, but better operation is obtained if the design is off-set so that the entrance-half of the pavement is in line with the approach-half of the street. One steering reversal is avoided in this design.

The radius of a cul-de-sac should be no larger than necessary to permit free turning of the largest service vehicles regularly accessing the neighborhood. The minor inconvenience experienced by some drivers in reversing direction may not be an important consideration. If a school bus must access the cul-de-sac, larger radii should be provided. If a school bus does not have to access the cul-de-sac, smaller radii are acceptable as long as pedestrian access is provided. A smaller cul-de-sac radius minimizes impervious surfaces, decreases installation and maintenance costs, and decreases stormwater runoff. A right-of-way should be provided that is larger than the cartway radius.

A Y- or T-shaped turnaround for dead -end streets and short cul-de-sacs servicing up to 10 homes conserves land, reduces construction and maintenance costs, and permits flexibility in land planning and the siting of homes.

Using a central island minimizes impervious surfaces, provides visual relief from the pavement,provides a recharge basin for stormwater and can be used for storage of plowed snow in the winter. Mountable curbs bordering the island allow oversized vehicles to maneuver within the cul-de-sac.

CUL-DE-SAC
(Y or T-shaped or circular turnarounds or dead-end streets) A local road connected to the existing road network at only one end with a special provision for turning around at the closed end.

Homes at the far end of a long cul-de-sac become more isolated and difficult to reach. Therefore, the anticipated traffic volumes and the number of housing units should be considered when determining cul-de-sac length. The minimum length of a cul-de-sac must be 250 feet to qualify for funding through the Liquid Fuels Tax Fund. In some cases there are access management benefits to allowing a cul-de-sac to be less than 250 feet.

Recommendations

The following recommendations apply to cul-de-sacs which are never intended to connect with adjoining, developable properties. If a cul-de-sac is intended to connect with future developments then it should be designed to accommodate its future function.

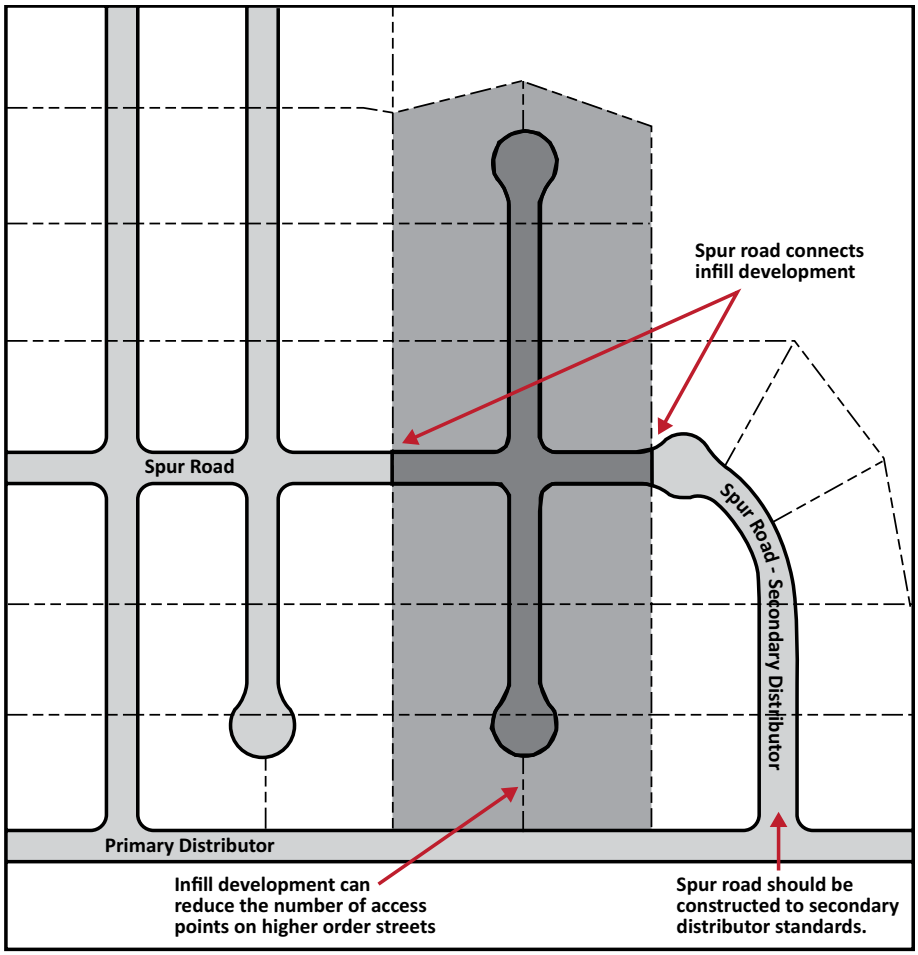
- Recommend use of an off-set cul-de-sac to create visual variety and improve the turning ease for drivers.
- The minimum radius of a residential cul-de-sac should be 40 feet with a 50-foot minimum right-of-way. If larger vehicles access the cul-de-sac, a radius greater than 40 feet may be needed. Excessive paving should be discouraged.
- Discourage the use of cul-de-sacs in commercial and industrial developments because they become idle space that may eventually be used as a storage area.
- Use central islands within a cul-de-sac. Provide a minimum radius of 45 feet for the cul-de-sac where parking demand is minimal. Where there is a demand for parking the minimum radius should be 52 feet with a 62-foot minimum right-of way. The central island should have mountable curbs for the occasional vehicle backup. The maintenance responsibilities of islands should be determined prior to construction.
- Generally, the minimum length of a cul-de-sac should be 250 feet. In some cases, a cul-de-sac less than 250 feet may be necessary for access management. Liquid Fuels Tax Fund regulations should be changed to allow this. The maximum length should be 1000 feet or a total of 25 single family or 50 multifamily residential units, whichever is more restrictive. This limits the number of vehicles using a single access point.
- A cul-de-sac turnaround should have a maximum grade of 4 percent. The grade of the cartway may be higher. The preferred drainage pattern is to allow stormwater runoff to go towards an intersection where the terrain permits. Central islands may be used as a place to store plowed snow.

Spur Roads

Spur roads provide for the future extension of roads into adjacent properties. They also provide better pedestrian circulation by linking neighborhoods, trails, bikeways or sidewalks and providing access from other subdivisions to commercial centers, schools or parks. Spur roads can reduce the impact of development on arterial roads by eliminating the need for new access points and by decreasing the amount of trips generated from subdivisions. Pedestrian safety is increased by separating users from unsafe roads with no shoulders or sidewalks and from high-speed arterials.

Recommendation

- A spur road should be built to complement its intended function. If it eventually serves a distribution function, it should be designed accordingly. This precludes the need for the municipality to acquire additional right-of-way in the future. It also protects the existing structures and property values.



SPUR ROADS

(Stub street, access spur, partial street) - An improved, dedicated right-of-way adjacent to a tract for future access which can be utilized to create a local access network, including additional access for the original subdivision.

VEHICULAR CIRCULATION

A landscaped cul-de-sac turnaround can significantly reduce impervious coverage and enhance a community's appearance.

Example of a cul-de-sac and a spur road in Caln Township.

Driveways

This design element pertains to multiple factors concerning driveways, including: classification, angle, grades, radii and width, setback from intersection, shared, sight distance, and spacing and number.

Classification

Standards

	High Volume	Medium Volume	Low Volume	Minimum Use
Average Daily Traffic (ADT)	1,500+	1,500-750	750-25	Less Than 25

See Pennsylvania Code, Title 67, Transportation, Chapter 441, "Access To and Occupancy of Highways by Driveways and Local Roads."

Comments

High-volume driveways (1500+ ADT) often require signalization for large shopping centers, multi-family residential buildings and office complexes. Medium-volume driveways (1500-750 ADT)usually do not require signalization. Typical medium-volume driveways are used in motels, fast food restaurants, service stations and small shopping centers. Examples of low-volume driveways (750-25 ADT) are small office buildings, elementary or junior high schools and car washes. Minimum use driveways (less than 25 ADT) are associated with single family residential, multi-family residential with less than five units, and duplex housing.

Recommendation

- Follow the recommendations of the Pennsylvania Code, Title 67, Transportation, Chapter 441, ***Access To and Occupancy of Highways by Driveways and Local Roads***.

DRIVEWAY CLASSIFICATION

Every entrance or exit used by vehicular traffic to or from properties which are adjacent to rights-of-way and are expected to be used by more than a certain number of vehicles.

Angle

Standards

PennDOT: Ninety degrees preferred, 60° minimum, unless otherwise specified as is the case with a filling station or when site conditions dictate otherwise. When two access driveways are on the same property and used for one way operation, each driveway may be between 45° and 90°; and 30° exit driveways may be used where no median opening exists.

Comments

The angle between the driveway centerline and the roadway edge should be based primarily on safety requirements. The speed at which a vehicle can enter or leave a public roadway is affected by the angle of approach or

DRIVEWAY ANGLE

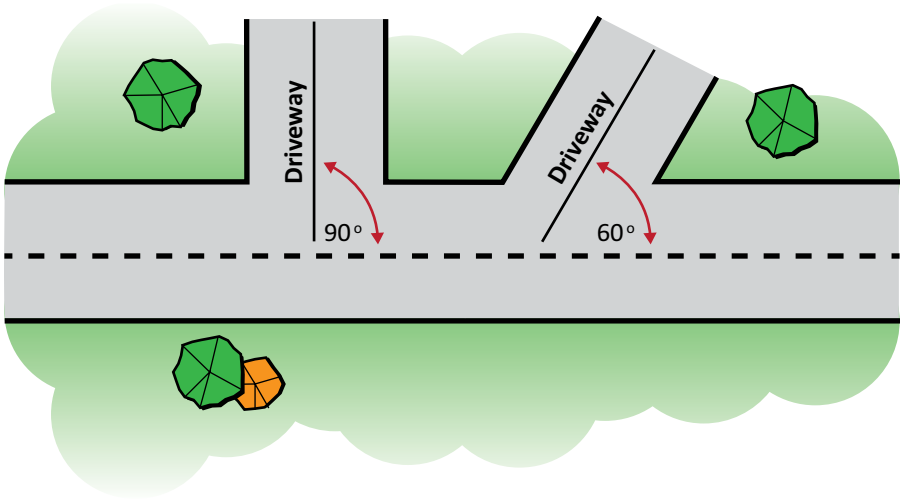
The horizontal angle at which a driveway joins the roadway, as measured from the centerline of the roadway to the centerline of the driveway.

departure. Alternative designs are often used for relatively high entering and exiting speeds.

Recommendation

- Follow the recommendations of the Pennsylvania Code, Title 67, Transportation, Chapter 441, ***Access To and Occupancy of Highways by Driveways and Local Roads***.

Angle of Driveway



The angle of a driveway is measured from the centerline of the roadway to the centerline of the driveway.

DRIVEWAY GRADES
The vertical slope of a driveway.

Grades

Standards

PennDOT: Please refer to the driveway design requirements, section 441.8, page 441-25 of the Pennsylvania Code, Title 67, Transportation, Chapter 441, ***Access To and Occupancy of Highways by Driveways and Local Roads***.

Comments

Vehicles entering and leaving driveways which have abrupt changes in grade must travel at extremely low speeds. For those entering, the possibility of rear end collisions on the public street is greatly increased. The driveway profile is also important with respect to how it affects potential damage to the underside of vehicles. Driveways should be 1.5 inches above the grade of the pavement to maintain proper drainage and prevent ponding.

When residential driveway grades exceed ± 10% consideration should be given to a paved parking area outside the street right-of-way. This improves snow removal operations by removing vehicles from the street.

Recommendation

- The grade of a driveway should be as close to 0.5 percent as possible. Where 0.5 percent grade is not feasible, follow PennDOT maximum grade values listed in the Pennsylvania Code, Title 67, Transportation, Chapter 441, ***Access To and Occupancy of Highways by Driveways and Local Roads***.

Radii and Width

Standards

High Volume Driveway

See PA Code, Title 67, Transportation, Chapter 441

Medium Volume Driveway

	Single Unit Trucks and Passenger Vehicles				Buses and Combination Trucks			
	Speed				Speed			
	<45 MPH		>45 MPH		<45 MPH		>45 MPH	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Width	14	28	14	28	14	28	12	28
Radius	15	30	15	50	45	55	50	55

Low Volume Driveway

	Single Unit Trucks and Passenger Vehicles				Buses and Combination Trucks			
	Speed				Speed			
	<45 MPH		>45 MPH		<45 MPH		>45 MPH	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Width*	10	20	12	20	12	15	12	20
Width**	20	24	20	24	22	24	22	24
Radius	10	15	15	25	35	50	45	55

Minimum Volume Driveway

	Single Unit Trucks and Passenger Vehicles				Buses and Combination Trucks			
	Speed				Speed			
	<45 MPH		>45 MPH		<45 MPH		>45 MPH	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Width	10	20	10	20	12	15	12	20
Radius	5	15	10	25	35	50	40	55

DRIVEWAY RADII
A measure of the sharpness of the corner formed by an intersecting driveway and road, independent of the angle at which the driveway intersects the road.

DRIVEWAY WIDTH
The narrowest dimension of a driveway measured perpendicular to the centerline of the driveway.

Comments

The preceding charts are recommended values. PennDOT may change the values based on site specific conditions, proposed uses, or a variety of reasons towards sound engineering judgment.

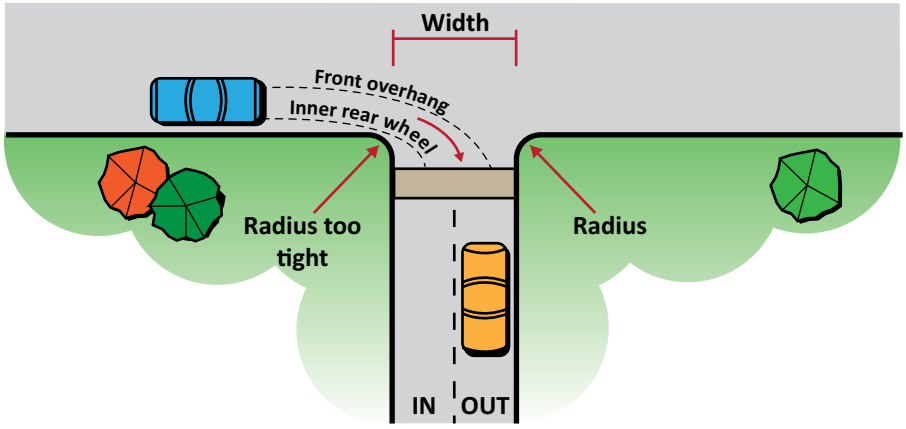
The radius should be related to the actual path of a vehicle making a right turn in or out considering the width of the adjacent street and the width of the driveway. The vehicle path should not encroach on the opposing lane during entering or exiting movements.

A larger turning radius will prevent vehicular conflicts. A radius of 75 feet could be considered on higher volume driveways where a deceleration lane cannot be constructed.

Recommendation

- Follow the recommendations of the Pennsylvania Code, Title 67, Transportation, Chapter 441, ***Access To and Occupancy of Highways by Driveways and Local Roads***.
- Use a 5-foot radius on minimum use driveways within villages and on local access streets in subdivisions.

Poorly Designed Driveway



Setback from Intersection

Standards

PennDOT:
General location restrictions. Access driveways shall be permitted at locations which:

1. Sight distance is adequate to safely allow each permitted movement to be made into or out of the access driveway;
2. The free movement of normal highway traffic is not impaired;
3. The driveway will not create a hazard; and
4. The driveway will not create an area of undue traffic congestion on the highway.

Driveways adjacent to intersections. Driveways serving properties located adjacent to a highway intersection shall be subject to the following:

1. There shall be a minimum 10-foot tangent distance between the intersecting highway radius and the radius of the first permitted driveway.
2. The distance from the edge of the pavement of the intersecting highway to the radius of the first permitted driveway shall be a minimum of 20 feet on curbed highways and 30 feet on uncurbed highways.
3. Paragraphs (1) and (2) of this subsection may be waived only if the intersecting highway radius extends along the property frontage to the extent that compliance is physically impossible.
4. Access to corner lots may be restricted to only that roadway which can more safely accommodate its traffic.

Comments

All driveways shall be located, designed, constructed, and maintained in such a manner as not to interfere or be inconsistent with the design, maintenance and drainage of the highway. (PennDOT)

A deep setback between an intersection and a driveway is desirable as a safety factor to avoid traffic conflicts at intersections.

Recommendations

- General location restrictions are found in the Pennsylvania Code, Title 67, Transportation, Chapter 441, ***Access To and Occupancy of Highways by Driveways and Local Roads***.

DRIVEWAY SETBACK FROM INTERSECTION
(aka driveway distance from intersection or corner distance) - The distance from the edge of the pavement of the intersecting roadway to the tangent of the radius of the first driveway.

- Follow the recommendations of the Institute of Transportation Engineers (ITE) for specific dimensions.
- Access to corner lots should be to the lesser order street and located at the property line most distant from the intersection.

See also **DRIVEWAY SPACING AND NUMBER**

DRIVEWAY SHARED
(aka joint use driveway) - A driveway constructed to provide access to multiple properties.

Shared Driveway

Standards

AASHTO & PennDOT: 2-3 dwelling units per shared driveway

Comments

An economical and attractive method of serving a few homes while minimizing the number of driveways is through a shared or joint-use driveway. This is a privately owned and maintained, paved access which terminates at the last home. The width of the driveway should be wide enough for two cars to pass. PennDOT requires that a shared driveway be built to public road standards when it accesses a state highway and serves more than three dwelling units.

Recommendations

- Create shared or joint-use driveways to reduce the number of access points along a roadway.
- Follow the recommendations of the Pennsylvania Code, Title 67, Transportation, Chapter 441, ***Access To and Occupancy of Highways by Driveways and Local Roads***, with some adjustments.
- A shared driveway serving only two dwelling units should be a minimum of 10 feet wide as long as a paved pullover area is provided. The location of the pullover area should be based on reasonable sight distance.
- Allow no more than three dwelling units to gain access to a private driveway.
- When more than three dwelling units access a single driveway, it should be built to public road standards.
- Resolve maintenance responsibilities through easements, deeds or letters of agreement.

Sight Distance

Standards

For Passenger Cars and Single Unit Trucks Exiting from a Driveway onto Two-Lane Roads

Posted Speed	Safe Sight Distance – Left*	Safe Sight Distance – Right*
25 mph	250	195
35 mph	440	350
45 mph	635	570
55 mph	845	875

For Buses And Combination Trucks Exiting from a Driveway onto Two-Lane Roads

Posted Speed	Safe Sight Distance – Left*	Safe Sight Distance – Right*
25 mph	400	300
35 mph	675	625
45 mph	1,225	1,225
55 mph	2,050	2,050

** Measured from a vehicle setback 10 feet from the pavement edge.*

For Passenger Cars and Single Unit Trucks Exiting from a Driveway Onto Four and Six-Lane Roads

Posted Speed	Safe Sight Distance – Left*	Safe Sight Distance – Right*
25 mph	175	195
35 mph	300	350
45 mph	500	570
55 mph	785	875

DRIVEWAY SIGHT DISTANCE

(aka Clear sight distance) The minimum distance that a driver of a vehicle, situated at eye level, 3.5 feet high, and 10 feet back from the pavement edge, can continuously see along the road to another vehicle, at 3.5 feet high, approaching on the roadway.

For Buses and Combination Trucks Exiting from a Driveway onto Four and Six-Lane Roads

Posted Speed	Safe Sight Distance – Left*	Safe Sight Distance – Right*
25 mph	300	300
35 mph	625	625
45 mph	1,225	1,225
55 mph	2,050	2,050

** *Measured from a vehicle setback 10 feet from the pavement edge to a vehicle approaching in the outside lane.*
*** *Measured from a vehicle setback 10 feet from the pavement edge to a vehicle approaching in the median lane.*

For Passenger Cars and Single Unit Trucks Entering Driveways by Left Turns

Posted Speed	Safe Sight Distance****		
	Two-Lane	Four-Lane	Six-Lane
25 mph	190	205	220
35 mph	300	320	345
45 mph	445	470	500
55 mph	610	645	680

For Buses and Combination Trucks Entering Driveways by Left Turns

Posted Speed	Safe Sight Distance****		
	Two-Lane	Four-Lane	Six-Lane
25 mph	330	360	390
35 mph	485	530	575
45 mph	690	750	810
55 mph	905	990	1,075

**** *Measured from the point where a left-turning vehicle stops to a vehicle in the outside lane.*

Note:
The previous tables should be used only as a general guide. At the time of this document's publication, PennDOT is in process of updating their Publication 282: Highway Occupancy Permit (HOP) Guidelines. DRAFT information for the Pub. 282 revision refers to Chapter 2 of Design Manual 2 (Pub 13M) and the AASHTO Green Book regarding sight distance values.

Comments

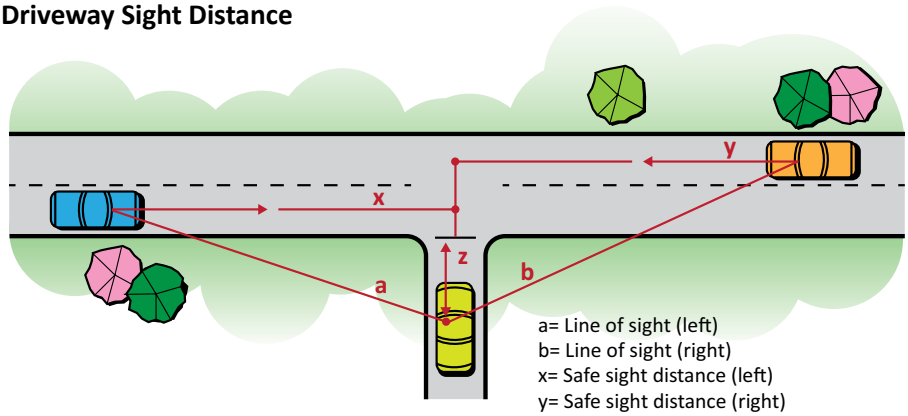
It is important to have adequate sight distance for all driveways to provide the best possible visibility thereby reducing points of conflict. Ordinances should allow municipalities to control vertical elements that obstruct

essential sight distances. High-volume driveways at the crest of hills may require a left-turn lane to reduce accident potential and provide adequate sight distances.

Recommendations

- Follow the recommendations of the updated Publication 282: Highway Occupancy Permit (HOP) Guidelines regarding sight distance values.
- See also the PennDOT Driveway Sight Distance Measurements Form M-950S *http://www.dot.state.pa.us/public/PubsForms/Forms/M-950S.pdf*

Driveway Sight Distance



a= Line of sight (left)
b= Line of sight (right)
x= Safe sight distance (left)
y= Safe sight distance (right)
z= 14.5' standard driveway
10' minimum use driveway only

Spacing and Number of Driveways

Standards

PennDOT

Number of driveways. The number and location of entrances which may be granted will be based on usage, interior and exterior traffic patterns, and the current design policies of PennDOT.

1. Normally, only one driveway will be permitted for a residential property and not more than two driveways will be permitted for a non-residential property.
2. If the property frontage exceeds 600 feet, the permit may authorize an additional driveway.
3. Regardless of frontage, a development may be restricted to a single entrance/exit driveway, served by an internal collector road separated from the traveled way.

Multiple driveways serving the same property must be separated by a minimum distance of 15 feet measured along the right-of-way line and 20 feet measured along the shoulder, ditch line, or curb. When the distance between the multiple driveways is 50 feet or less measured along

DRIVEWAY SPACING AND NUMBER
(aka distance between driveways) - The amount and location of driveways in relation to other driveways. The distance is measured between curbline openings.

the shoulder or ditch line, the area between shall be clearly defined by permanent curbing. This curb shall be placed in line with the existing curb or two feet back of the shoulder or ditch line on uncurbed highways. It shall be extended around the driveway radii to the right-of-way line.

PennDOT does not provide specific standards for spacing between driveways on individual properties.

Comments

The greater the number of driveways that are intersecting the street, the greater the number of potential conflict points and accidents. Additional driveways also reduce street capacity and street speed.

Access management is particularly important on corridors served by transit bus routes. In the case of driveways adjacent to intersections, they should be placed, when possible, in such a way that does not unduly restrict the transit agency from placing a bus stop adjacent to the sidewalks and crosswalks that serve that intersection.

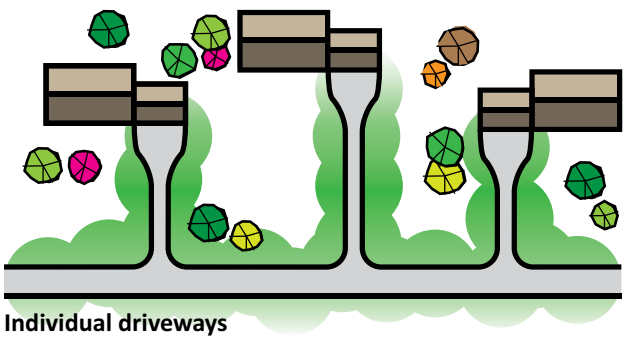
Many existing sites, particularly serving automobile-oriented uses, preclude bus stop placements because of uncontrolled or limited control access points or driveways placed in close proximity to the intersection. This may force the transit provider to create a mid-block stop, whereby the passengers either cross the arterial or collector in an uncontrolled location or they have to cross the aforementioned access points to reach a controlled crossing point.

Effective methods of eliminating excessive driveways are to integrate access points and eliminate unnecessary access points. These methods are especially useful when building on environmentally constrained lands.

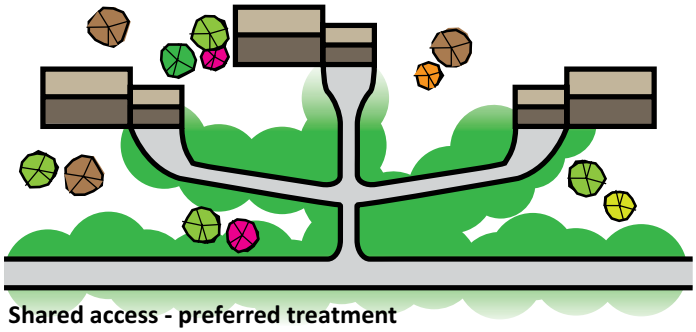
Recommendations

- Recommendations for the number of driveways are found in the Pennsylvania Code, Title 67, Transportation, Chapter 441, ***Access To and Occupancy of Highways by Driveways and Local Roads***.
- On arterial and collector roads align opposing driveways to avoid jogs or off-sets.

Shared Access



Individual driveways



Shared access - preferred treatment

Intersections

'Intersections' pertains to multiple design elements concerning intersections, including: alignment, channelization, grades, off set, radii, sight distance, signalization, spacing, and traffic control devices:

Alignment

Standards

AASHTO & PennDOT: As close to 90º as possible, but a minimum of 60º.

Comments

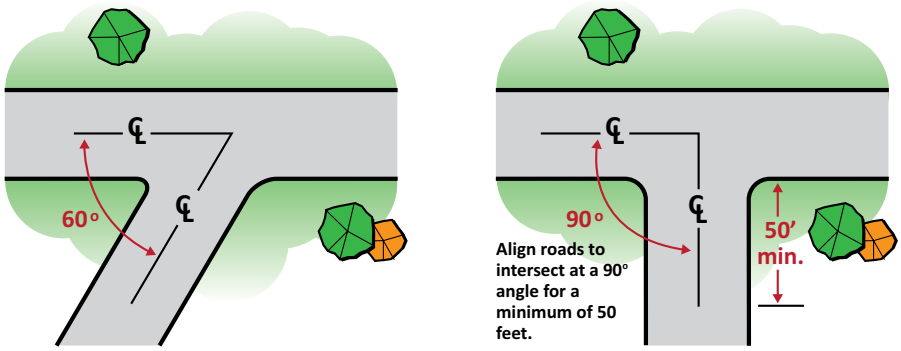
Since intersections represent points of conflict and are potentially hazardous, the alignment should provide adequate sight distance and allow users to maneuver safely with minimum interference. Roads intersecting at acute angles require extensive turning roadway areas and tend to limit visibility, particularly for truck drivers. When a truck turns on an obtuse angle, the driver has blind areas on the right of the vehicle. Acute-angle intersections increase the exposure time of the vehicles crossing the main traffic flow and may increase the accident potential.

According to PennDOT, realigning roadways that intersect at acute angles may prove beneficial. But angles above 60° do not warrant realignment closer to 90° since it produces a small increase in visibility.

Recommendation

- As close to 90° as possible, but a minimum of 60°.

Intersection alignment



Align roads to intersect at a 90 degree angle for a minimum of 50 feet.

INTERSECTION ALIGNMENT

(Angle of intersection) - A measure of the horizontal alignment where two or more roadways join or cross, measured at the intersecting centerlines.

INTERSECTION CHANNELIZATION
(Islands or pavement markings) - The islands or pavement markings that delineate the travel lanes and turning lanes.

Channelization

Standards

Manual on Uniform Traffic Control Devices (MUTCD)

Comments

Channelized islands should be placed so that the proper course of travel is immediately obvious, easy to follow, and of unquestionable continuity. Properly placed islands are advantageous where through and turning movements are heavy. The use of curbed islands generally should be reserved for multi-lane highways or streets and for more important intersections on two-lane highways. In or near urban areas where speeds are low and drivers are accustomed to confined facilities, channelization can be expected to work well.

Painted or striped channelization can be made to increase efficiency and safety and has the advantage of easy modification when warranted by driver behavior (ITE). This type of channelization may be used initially to establish the best layout arrangement before the permanent construction of islands, if necessary.

Islands serve several purposes including:

- separation of conflicts;
- control of angle of conflict;
- reduction in excessive pavement areas;
- regulation of traffic and indication of proper use of intersection;
- arrangements to favor a predominant turning movement;
- protection of pedestrians;
- protection and storage of turning and crossing vehicles; and,
- location of traffic control devices.

Recommendation

- Follow the guidelines of the Federal Highway Administration's, ***Manual on Uniform Traffic Control Devices*** (MUTCD).

Aerial image of the US Business 30 and PA 100 intersection in West Whiteland Township, PA.

Grades

Standards

AASHTO: Grades in excess of 3 percent should be avoided. Where conditions make designs unduly expensive, grades should not exceed 6 percent. Storage areas should be flat or 0.5 percent minimum to 2 percent maximum.

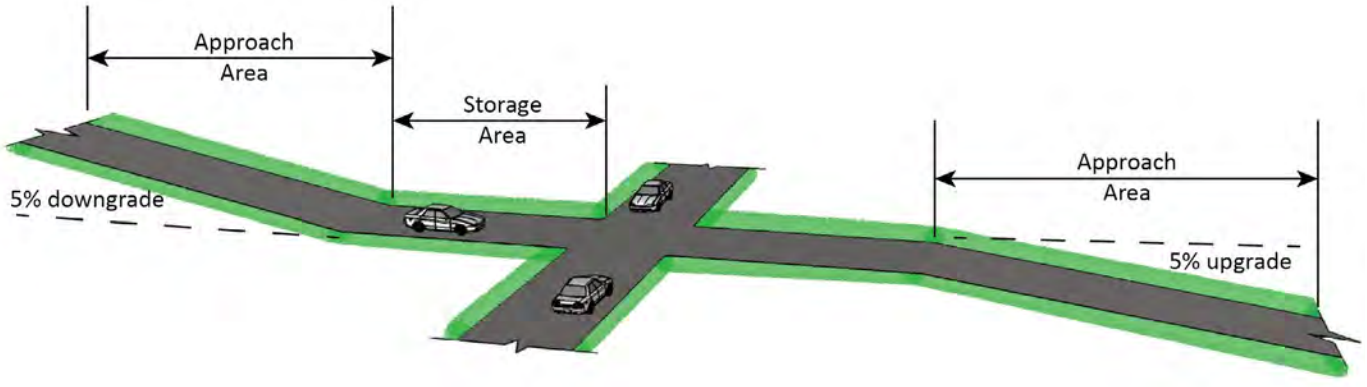
Comments

Intersecting roads should permit users to discern and easily perform the maneuvers necessary to pass through the intersection safely and with minimum interference from other users. A level, storage area prior to the intersection improves the operational capabilities and safety characteristics of an intersection.

Recommendation

- Recommend use of AASHTO standards.

Intersection grades



INTERSECTION GRADES

(Vertical alignment or profile) - The rise and fall of a given roadway at an intersection.

INTERSECTION RADII
(Turning radius, turning path or curb radii) - A measure of the sharpness of the corner formed by two intersecting streets, independent of the angle at which the streets intersect.

Radii

Standards

AASHTO:

Rural	50 Foot minimum
	35 Foot minimum on local roads with low truck volumes
Urban	15 Foot minimum, 25 foot desirable on local roads with pedestrians
	30 Foot minimum for industrial areas and areas with higher truck volumes

PennDOT: Recommended use of AASHTO

Rural	25 Foot minimum for minor cross streets
	30 Foot minimum for major cross streets
	40 Foot minimum with high truck volumes

Comments

Intersections should be designed to accommodate the expected amount and type of traffic and allow for safe turning speeds. Intersections designed with a corner radius to accommodate the largest vehicles anticipated, eliminate the problem of increased traffic conflict and vehicles driving over the curb.

Turning radii should reflect the presence of transit bus routes. It is recommended that minor allowances be made to the standard turning templates to address varying driving conditions and situations. Stop bars at controlled intersections should be placed so that the transit vehicle avoids crossing the center line of the roadway to make turns. The placement of traffic signal loop detectors may also be affected by the need to address buses making turns.

There must be a balance in determining curb radii for collector and local streets. Caution should be taken not to over or under design the radius. As the curb radius increases, the paving cost and intersection area required for pedestrian movement also increase, dangerous "rolling stops" become more frequent, and higher turning speeds are encouraged. (ULI)

Recommendations

- Recommend use of PennDOT standards for state highways.
- Recommend 5-15 foot minimum on local roads.

Sight Distance

Standards

AASHTO:

Minimum Corner Intersection Sight Distance (Feet)

Urban	200 Foot minimum, 300 foot desirable				
	Design Speed (mph)	2-Lane Roadway*		4-Lane Roadway*	
		Local/ Collector	Arterial	Local/ Collector	Arterial
Rural and Suburban	60	650**	1,050**	710**	1,170**
	50	515	875	580	975
	40	415	700	475	790
	30	310	530	350	590
	20	210	N/A	240	N/A

** The number of lanes and highway functional classification refers to the highway being intersected.*
*** At 60 MPH, stopping sight distance governs.*

The primary purpose of establishing a clear sight triangle is where no traffic control device exists or where a yield sign is used. The practice of providing a clear area free of obstructions is still a good practice but it should be used in conjunction with adequate intersection sight distances.

Comments

Each intersection contains several potential vehicle conflicts, the possibility of these conflicts actually occurring can be greatly reduced through the provision of proper sight distances and appropriate traffic controls.

The operator of a vehicle approaching an intersection at-grade should have an unobstructed view of the entire intersection and sufficient length of highway to permit control of the vehicle to avoid collisions. The sight distance considered safe under various assumptions of physical conditions and driver behavior is directly related to vehicle speeds and to the resultant distances traversed during perception and reaction time and braking.

The object being viewed should be measured at a height of 3.5 feet. The reason for this is that the first part of an approaching vehicle that is observed is approximately 3.5 feet high.

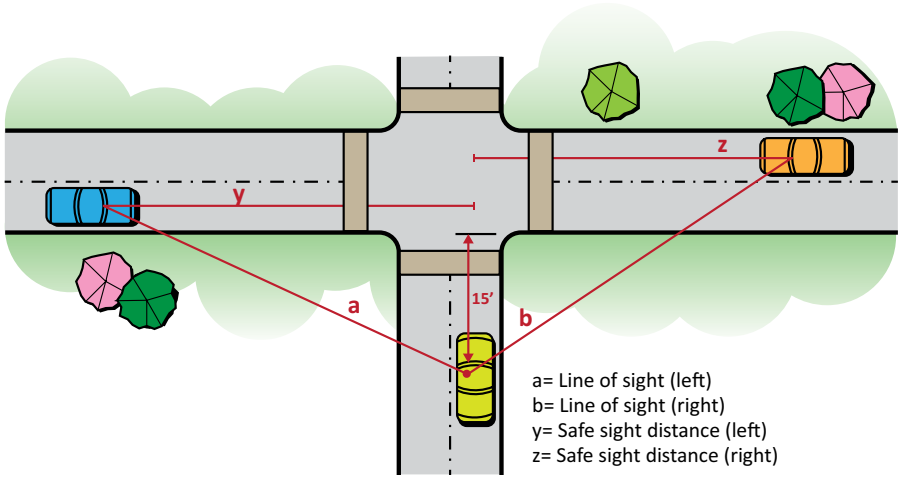
INTERSECTION SIGHT DISTANCE

(Corner sight distance) - The maximum distance that a driver can see objects such as traffic signs, pavement markings and moving objects. Corner sight distance is measured from a point fifteen feet from the edge of the major roadway and measured at eye height, 3.50 feet, to an object 3.50 feet above the pavement.

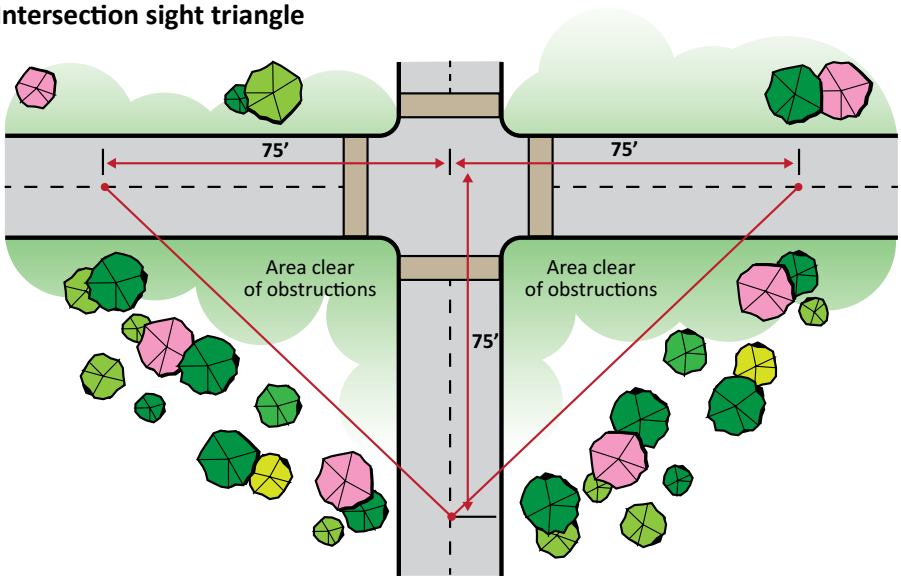
Recommendations

- Follow the recommendations of PennDOT's Publication 70M, ***Guidelines for the Design of Local Roads and Streets*** for intersection sight distances. Use rural and suburban classifications for townships and use the urban classification for boroughs and cities.
- Provide a clear area or, clear sight triangle, free of obstructions in conjunction with adequate intersection sight distances.

Intersection sight distance



Intersection sight triangle



Clear sight triangle is not synonymous with intersection sight distance. There is a distinct difference between the two as illustrated above. Most municipalities use a clear sight triangle of 75 feet. A clear sight triangle improves the sight distance for the approach to the intersection but the more critical value is the sight distance at the stopped position.

Signalization

Standards

PennDOT: Recommended use of the ***MUTCD***; the Pennsylvania Code, Title 67, Chapter 212, ***Official Traffic Control Devices*** for signal warrants; PennDOT Publication 149 ***Traffic Signal Design Handbook***; PennDOT Publication 408 Specifications; and the PennDOT Publication 148 ***Traffic Standard Drawings, TC-8800 Series***.

The system for establishing the need for signal installation is known as "signal warrants". There are twelve warrants for traffic signals. Presented as an example, Warrant 1, Minimum Vehicular Volume, is intended for application where the volume of intersecting traffic is the principal reason for consideration of signal installation. These warrants should be thought of as a guide rather than absolute criteria.

Minimum Vehicular Volumes for Signal Warrant One

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (both approaches)	Vehicles per hour on higher volume minor street approach (one direction only)
Major St.	Minor St.		
1	1	500	150
2 or more	1	600	150
2 or more	2 or more	600	200
2 or more	2 or more	500	200

Comments

Contrary to common belief, traffic signals do not always increase safety and reduce delay. Experience has indicated that, although the installation of signals may result in a decrease in the number and severity of right-angle collisions, signals will, in many instances, result in an increase in rear-end collisions. Further, the installation of signals may not only increase overall delay but may also reduce intersection capacity.

Recommendations

- Follow the recommendations of the: ***MUTCD***; the Pennsylvania Code, Title 67, Chapter 212, ***Official Traffic Control Devices*** for signal warrants; PennDOT Publication 149 ***Traffic Signal Design Handbook***; PennDOT Publication 408 ***Specifications***; and the PennDOT Publication 148 ***Traffic Standard Drawings, TC-8800 Series***.

INTERSECTION SIGNALIZATION

(Traffic control signals) Any power-operated traffic control device, other than a barricade warning light or steady burning electric lamp, by which traffic is warned or directed to take some specific action.

INTERSECTION SPACING (Distance between intersections) The minimum spacing between intersections measured from centerline to centerline.

Spacing

Standards

AASHTO *A Policy on Geometric Design of Highways and Streets*

Comments

The functional deterioration of arterials and collectors is a result of the proliferation of inadequate access management that generates operational and accident problems. The greater the number of access points per mile the greater the accident rate. When adjacent intersections and driveways are situated close together, the overlapping maneuver areas conflict and reduce total capacity. (ITE)

The location and spacing of intersections and driveways should be based on the following factors:

- functional classification;
- design speed and grade of the highway;
- signal spacing;
- number, volume and location of existing access points;
- lot width; and,
- sight considerations.

Recommendations

Based upon a review of the recommendations of various sources, the following charts are suggested as a reference in determining intersection spacing. This process is complex and may be interpreted as an oversimplification and should therefore only be used as a guide. The values provided in these charts are interpolated based on the fundamental points of:

1. signal spacing (1-4 per mile);
2. corner clearance;
3. intersection off-sets;
4. driveway spacing; and,
5. number of driveways per half mile.

The charts only identify suburban and rural roads because most urban roads are already developed. To use the chart, establish whether the area is suburban or rural, then determine the function of the primary road. The next step is to determine the function of the two intersecting roadways. For example: if the primary road is a suburban arterial and the two intersecting roadways are a collector and a local road the suggested distance between these two intersections is 450 feet from centerline to centerline.

Suburban Arterial (feet)

	Arterial	Collector	Local	Driveway
Arterial	2,640	2,000	500	230
Collector	2,000	1,500	450	175
Local	500	450	400	100
Driveway	230	175	100	A

Rural Arterial (feet)

	Arterial	Collector	Local	Driveway
Arterial	5,280	2,640	500	230
Collector	2,640	2,000	450	175
Local	500	450	400	100
Driveway	230	175	100	B

A – For access management purposes, permit no more than 10 access points per half mile.

B – For access management purposes, permit no more than 8 access points per half mile.

Suburban Collector (feet)

	Arterial	Collector	Local	Driveway
Arterial	2,640	1,500	500	115
Collector	1,500	1,000	450	85
Local	500	450	400	50
Driveway	115	85	50	C

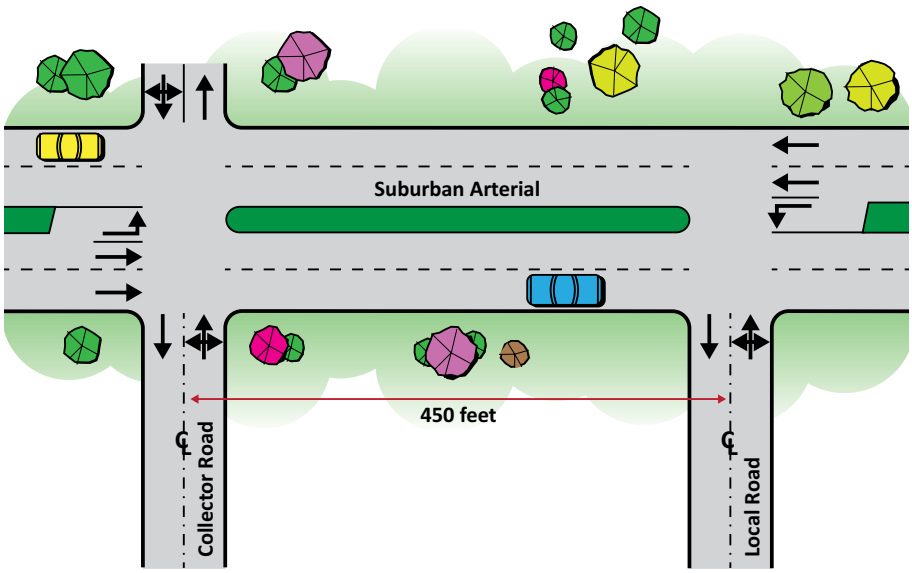
Rural Collector (feet)

	Arterial	Collector	Local	Driveway
Arterial	2,640	2,000	500	115
Collector	2,000	1,500	450	85
Local	500	450	400	50
Driveway	115	85	50	D

C – For access management purposes, permit no more than 12 access points per half mile.

D – For access management purposes, permit no more than 14 access points per half mile.

Intersection spacing



INTERSECTION TRAFFIC CONTROL DEVICES

(Traffic control signals or signs) - Any sign, signal, marking or device placed or erected for the purpose of regulating, warning or guiding vehicular traffic or pedestrians, or both.

Traffic Control Devices

Standards

PennDOT: Recommended use of the ***MUTCD***; the Pennsylvania Code, Title 67, Chapter 212, ***Official Traffic Control Devices*** for signal warrants; PennDOT Publication 149 ***Traffic Signal Design Handbook***; PennDOT Publication 408 ***Specifications***; and the PennDOT Publication 148 ***Traffic Standard Drawings***, ***TC-8800 Series***.

Comments

Signing and marking are directly related to the design of the highway or street and are features of traffic control and operation that the designer must consider in the geometric layout of a facility. The signing and marking should be designed concurrently with the geometrics since future operational problems can be reduced significantly if both are treated as an integral part of design.

Although safety and efficiency of operation depend to a considerable degree on the geometric design of the facility, the physical layout must also be supplemented by effective signing as a means of informing, warning and controlling drivers. Signing plans coordinated with horizontal and vertical alignment, sight distance obstructions , operation speeds and maneuvers and other applicable items should be worked out before design completion. (PennDOT)

Recommendations

- Follow the recommendations of the: ***MUTCD***; the Pennsylvania Code, Title 67, Chapter 212, ***Official Traffic Control Devices*** for signal warrants; PennDOT Publication 149 ***Traffic Signal Design Handbook***; PennDOT Publication 408 ***Specifications***; and the PennDOT Publication 148 ***Traffic Standard Drawings, TC-8800 Series***.

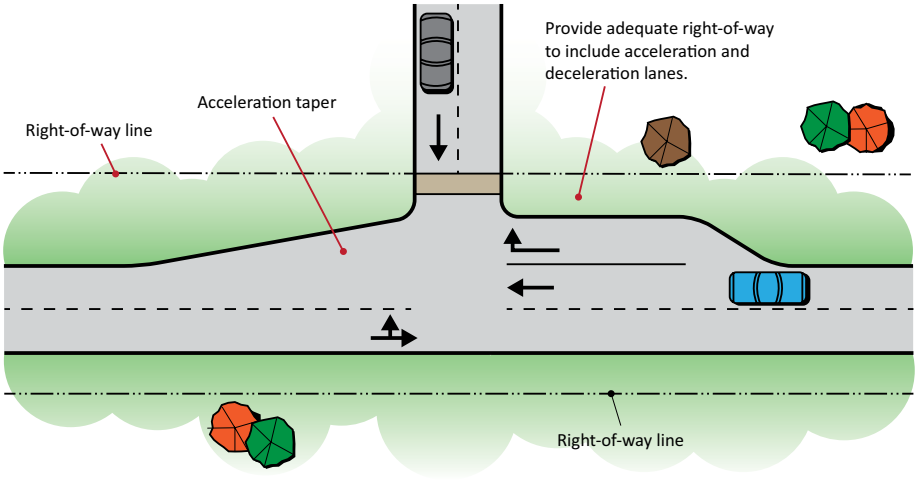
Traffic signals.

Traffic signs.

(Page intentionally left blank)

Lane Design

Acceleration/Deceleration Lane with Taper Only



Acceleration Lane

Standard

PennDOT: The combination of highway speeds, volumes, location and arrangement of driveways and intersections may require the installation of an acceleration lane to serve a proposed low, medium or high-volume driveway. A lane width of 14 feet is recommended where curbs exist and 12 feet where no curbs are in place.

Acceleration lanes are not recommended at driveways. Roadway speed and a higher number of turning movements and the primary factors to consider for acceleration lanes. The length of an acceleration lane is determined on an individual site basis and according to the amount of existing lot frontage. The storage length of an acceleration lane is typically between 150 and 250 feet. The length of the taper is usually between 75 and 150 feet. At un-signalized intersections with deceleration lanes, an acceleration taper is sometimes sufficient to allow vehicles to adjust their path of travel.

Comments

A speed-change lane should be sufficiently long and wide enough to enable a driver to maneuver a vehicle into it properly, and once in it, to make the necessary increase in speed.

Warrants for the use of speed-change lanes cannot be stated definitively. Many factors must be considered, such as speeds, grades, traffic volumes, capacity, type of highway, vehicle type, the arrangement and frequency

ACCELERATION LANE
The portion of a roadway adjoining the traveled way constructed for the purpose of enabling a vehicle that is entering the roadway to increase its speed to a rate at which it can safely merge with the mainstream of traffic.

of intersections, and accident experience. Observations and considerable experience with speed-change lanes have led to the following conclusions:

1. Speed-change lanes are warranted on high-speed and on high-volume highways where a change in speed is necessary for vehicles entering through-traffic lanes.
2. All drivers do not use speed-change lanes in the same manner; some use little of the available facility. As a whole, however, these lanes are used sufficiently to improve the overall safety and operation of the highway.
3. Use of speed-change lanes vary according to traffic volumes, the majority of drivers use them when traffic volumes are high.

Acceleration lanes have limited applicability, are improperly used and often become a place where cinders collect.

Recommendation

- Provide additional right-of-way adjacent to acceleration or deceleration lanes to provide for future road widenings. The extended right-of-way needs to go a minimum of 5 feet beyond the existing width of the acceleration or deceleration lane.

DECELERATION LANE
The portion of a roadway adjoining the traveled way constructed for the purpose of enabling a vehicle that is exiting the roadway to decrease speed to a rate at which it can safely leave the mainstream of traffic.

Deceleration Lane

Design Speed	Distance (Feet)*
30 mph	235
40 mph	315
50 mph	435

** Minimum distance on grade less than 2 percent*

Storage Length

Un-signalized Intersection/Driveways: Storage length is based on the number of turning vehicles likely to arrive in an average 2-minute period during the peak hour. Minimum space for at least one car and one truck with over 10 percent truck traffic should be provided, otherwise, space for two cars is sufficient.

Signalized Intersections/Driveways: The required storage length depends on the signal cycle length, the signal phasing and the rate of vehicular arrivals. It should probably be one and one-half to two times the average number of vehicles that would store per cycle, which is predicated on the design volume.

Comments

A speed-change lane should be sufficiently long and wide enough to enable a driver to maneuver a vehicle into it properly, and once in it, to make the necessary reduction in speed.

The issue of proximity to existing and prospective bus stop locations should be evaluated in the presence, design and placement of acceleration and deceleration lanes. On a case-by-case basis, PennDOT's Engineering District 6-0 has discouraged the use of deceleration lanes for bus stops where the volume of right turns is significant and there is a continuous or periodic free-flow condition. This is because of the potential of merge and weave-related crashes that could occur as curbed buses are leaving the bus stop and returning to the through-traffic flow, using the deceleration lane to accelerate.

The increased use of deceleration lanes has reduced SEPTA's ability to identify safe locations for bus stops that are within reasonable distance of trip generators. This is particularly true where multiple access points are proposed and/or where minimal sidewalk connections exist or are being proposed. As a general rule, development proposals and other projects that touch existing bus stops or that would support the installation of a new stop should be vetted with SEPTA early in the process, particularly if the new stop location is proposed to be sited in an acceleration or deceleration lane.

Many factors must be considered, such as speeds, traffic volumes, capacity, type of highway, vehicle type, the arrangement and frequency of intersections, and accident experience. Observations and considerable experience with speed change lanes have led to the following conclusions:

1. Speed-change lanes are warranted on high-speed and on high-volume highways where a change in speed is necessary for vehicles entering or leaving the through-traffic lanes.
2. All drivers do not use speed-change lanes in the same manner; some use little of the available facility. As a whole, however, these lanes are used sufficiently to improve the overall safety and operation of the highway.
3. Use of speed-change lanes varies according to traffic volumes, the majority of drivers use them when traffic volumes are high.
4. Long tapers enhance the function of speed change-lanes.
5. Deceleration lanes on the approaches to at-grade intersections that also function as storage lanes for turning traffic are particularly advantageous because they reduce hazards and increase capacity.

Recommendations

- Provide a deceleration lane into major subdivisions and commercial or office developments especially where no traffic control device exists and where conditions warrant.
- Provide a deceleration lane on principal arterial roads where only one through lane exists and where conditions warrant.
- PennDOT recommends a 14-foot wide deceleration lane for curbed areas.
- Provide additional right-of-way around acceleration or deceleration lanes to provide for future road widenings. The extended right-of-way needs to go a minimum of 5 feet beyond the existing width of the acceleration or deceleration lane.

'Lane Design' pertains to multiple design factors of travel lanes in the roadway including: lane width, left turn lanes, number of travel lanes, and shoulders.

LANE WIDTH
The paved surface of a street designated for a single lane of travel.

Lane Width: Local & Internal Roadways

Lane widths should not be determined by only one factor, but according to the following: intended function of the road, expected traffic volume, intensity of adjacent land use, lot size, building setbacks, length of driveway, number of garages, parking needs, curbing, mailbox location, and overall neighborhood design.

While access is the primary function of all local roads, some local roads provide limited mobility functions. Local roads should have a sub-classification because of varied functions. Please refer to the following chart and Street Width exhibits (Sections A,B, C, etc.) found on the following pages.

Local & Internal Roadways

Type/Section	Description
Primary Distributor (Section A)	• Generally moves traffic to the arterial or collector networks from neighborhoods or subdivisions. • May extend through a municipality and may serve an inter-municipal function, but it should not provide a regional function. • Parking should be prohibited, except in urban or village areas, and the width of the road should accommodate speeds in the 25-45 MPH range, with daily traffic volumes between 750-2,500 vehicles. • Parcel access should not be prohibited, but should be more limited than a secondary distributor or local access road.

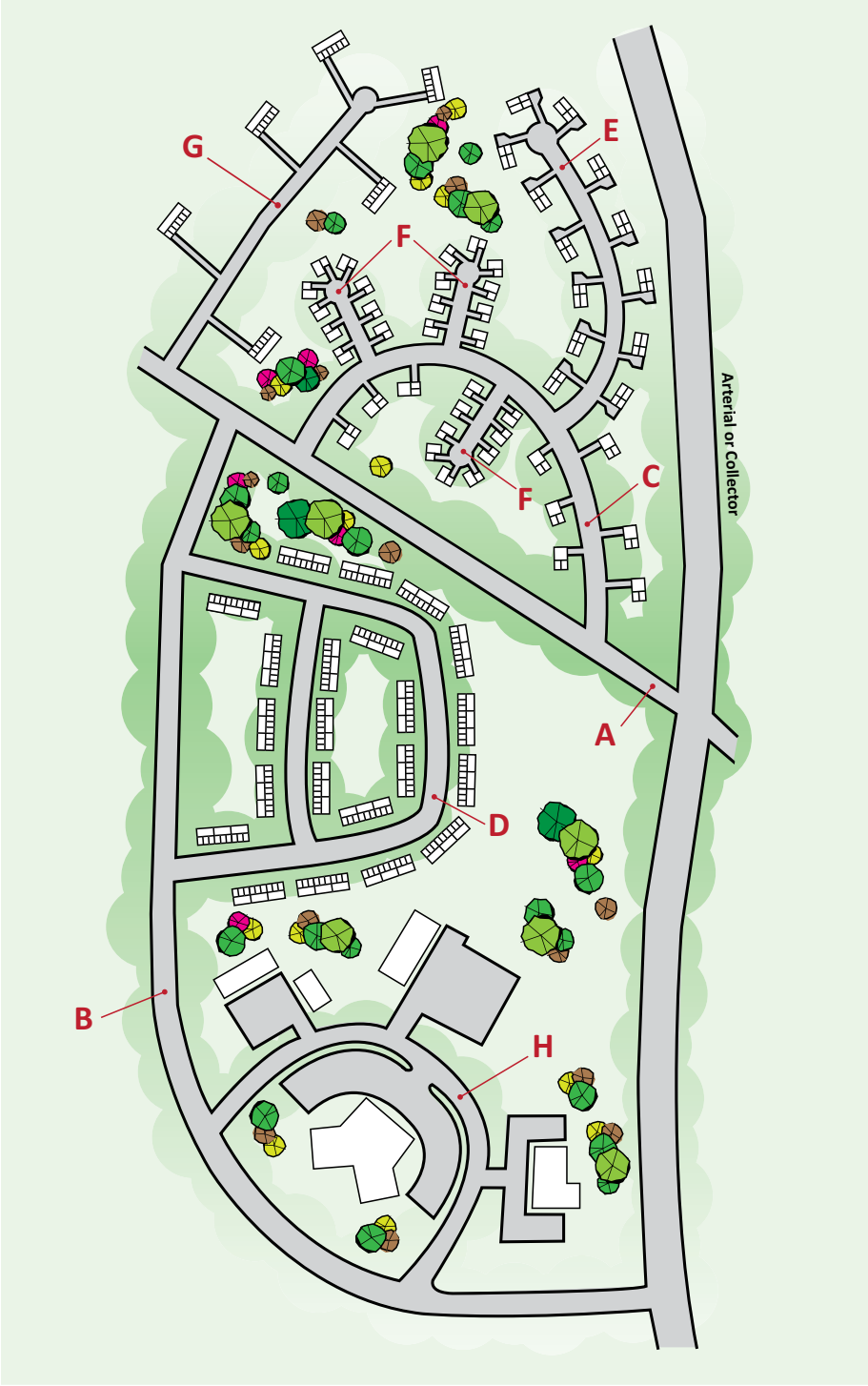
Local & Internal Roadways (continued)

Type/Section	Description
Secondary Distributor (Sections B & C)	• Extends through a neighborhood or subdivision, moving traffic to a primary distributor or directly to the collector network. Secondary distributors basically • On-street parking is not prohibited, but should be limited. • The design of the road should accommodate travel speeds in the 15-25 MPH range, with daily traffic volumes between 200-1,500 vehicles.
Local Access Street (Sections D, E, F)	• A local access street is strictly intended for access to adjacent properties. • Traffic speeds should be less than 15 MPH and daily traffic volumes should be less than 500 vehicles. • Other design features include: short length of road to discourage through traffic, smaller curb radii, driveway and alignment radii to preclude higher speeds. • In a neighborhood of small lots with limited off-street parking, the cartway should be wider to accommodate on-street parking.
Local Access Street (Section G)	• A narrow cartway should be provided in a neighborhood of large lots (cross-section G) which have off-street parking.
Local Access Street (Section H)	• Local roads serving commercial, office and industrial developments. • The width and number of travel lanes on local roads in a large non-residential development depends on the anticipated traffic volumes.

The function of local roads adjacent to or within a new development needs to be carefully considered. A road that is intended to serve as a local access street should be designed accordingly. If a road is intended to eventually connect into another subdivision or neighborhood, then it should be designed as a secondary distributor. Over-design of a local road can lead to wasted expense and higher housing costs and could impact the safety and residential quality of a neighborhood. Under-design can lead to safety problems and expensive reconstruction.

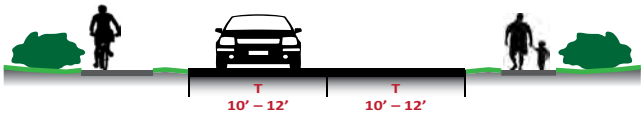
VEHICULAR CIRCULATION

Street width



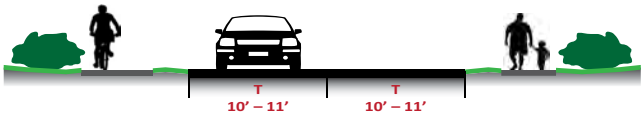
Street width (continued)

A



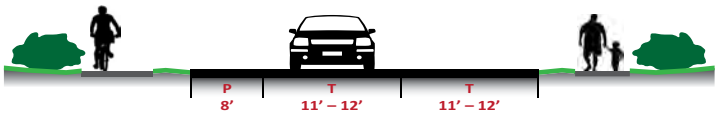
Primary Distributor

B



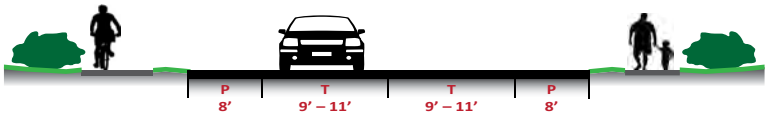
Secondary Distributor

C



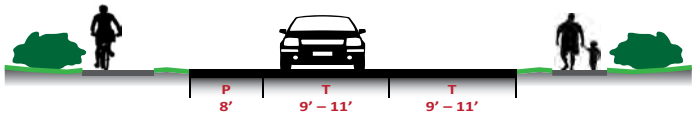
Secondary Distributor

D



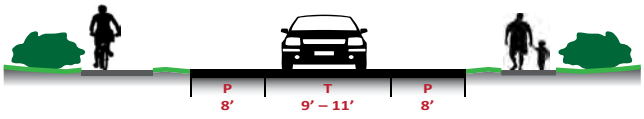
Local Access Street

E



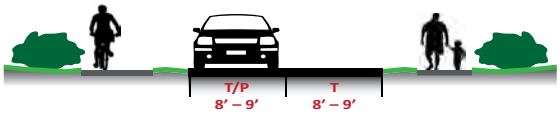
Local Access Street

F



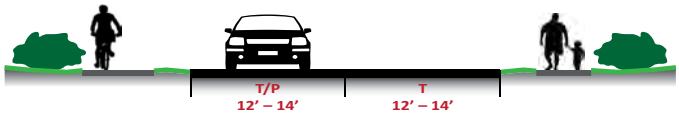
Local Access Street

G



Local Access Street

H



Local Access Street

T=Travel Lane
P=Parking Lane
All measurements in feet

The width of a residential street should be based on its intended use, not on a "one-size-fits-all" standard. The ordinance requirements should link the design of the street to the anticipated number of trips on the street and whether or not on-street parking will be provided. Where smaller lots are proposed, on-street parking should be permitted on at least one side of the street. Benefits of appropriate street design include reduced impervious surface, lower maintenance costs, reduced width of the streetscape, and a reduction in speeding that is encouraged by wide roadways.

Recommendations

Primary Distributor Streets – The primary distributor street is the highest order of street that can be classified as residential and will carry the largest volume of traffic at higher speeds. This level of street is unsuitable for providing direct access to homes and such access should be avoided.

Primary distributor streets shall be required when the ADT anticipated on the street exceeds the limits for residential secondary distributor streets. If the anticipated ADT exceeds three thousand (3,000) the street shall be classified as a higher order than a primary distributor and the township, upon recommendation of their Engineer, shall determine the required design standards. On-street parking shall be prohibited on primary distributor streets. Primary distributor streets should be designed to have no residential lots fronting on them. However, in no case shall the percent of total length of the primary distributor street with residential frontage on and taking access from the street exceed the following:

Average Daily Trips (ADT) Level	Allowable Access Frontage Along Primary Distributor
1,000 to 1,199	20%
1,200 to 1,599	10%
1,600 to 1,999	5%
2,000 +	0%

Travel lane widths shall be based upon anticipated average daily trips as follows. The wider of the two lane widths shall be used when raised curbs are proposed.

Average Daily Trips (ADT)	Travel Lane Width	Total Cartway Width
2,000 ADT or less	10 to 11 feet	20 to 22 feet
More than 2,000 ADT	11 to 12 feet	22 to 24 feet

Secondary Distributor Streets – The secondary distributor street is the middle order street in the residential street hierarchy. It carries more traffic than the local access street but can provide an acceptable if not optimum environment for a residential neighborhood. Each secondary distributor street shall be designed so that no section of it will convey a traffic volume greater than five hundred (500) ADT.

Design parameters for secondary distributor streets

Design Factors			Street Standards			
Development Type Fronting on Street	Parking		Travel Lane[1] Width	Parking Lane Width	Total Cartway Width	Individual Driveway Access
	On-Lot	On-Street/ Spillover				
Permanent open space, no residential frontage	None	None	10 to 11 feet	N/A	20 to 22 feet	N/A
Lots 2 acres[2] or more, deed restricted against further subdivision	On-Lot	None	10 to 11 feet	N/A	20 to 22 feet	Yes
Lot widths 100 feet or greater	On-Lot	None	10 to 12 feet	N/A	20 to 24 feet	Yes
Lot widths 40 to 100 feet	On-Lot	One Side	11 to 12 feet	8 feet	30 to 32 feet	Yes
Lot widths less than 40 feet w/ rear alley access	On-Lot from alley	Two Sides[3]	10 to 12 feet	16 feet (8 each side)	36 to 40 feet	No
Lot widths less than 40 feet or no separate housing lots (apartments)	On-lot or off-street parking lot provided	Off-street parking lot provided	10 to 12 feet	N/A	20 to 24 feet	Yes (for parking lots)

[1] If no curbing or flush curbing is being used, the minimum width should be used. If raised curbing is proposed, at least one additional foot of width above the minimum shown should be provided.
[2] Performance Streets uses a minimum lot size of five acres.
[3] A single parking lane may be provided if houses front on only one side of the street. In such cases, the total cartway width may be reduced by eight (8) feet to a width of 28 to 32 feet.

Local Access Streets – The local access street is the lowest order street in the residential street hierarchy. It is intended to carry the least amount of traffic at the lowest speed and will provide the safest and most desirable environment for a residential neighborhood. Developments should be designed so the maximum number of homes possible front on this class of street. A local access street shall be designed to carry no more traffic than is generated on the street itself. Each local access street shall be designed so that no section of the street carries an Average Daily Traffic (ADT) volume of greater than two hundred (200).

Design parameters for local access streets

Design Factors			Street Standards			
Development Type Fronting on Street	**Parking**		**Travel Lane[1] Width**	**Parking Lane Width**	**Total Cartway Width**	**Individual Driveway Access**
	On-Lot	**On-Street/ Spillover**				
Permanent open space, no residential frontage	None	None	8 to 10 feet	N/A	16 to 18 feet	N/A
Lots 2 acres[2] or more, deed restricted against further subdivision	On-Lot	None	8 to 9 feet	N/A	16 to 18 feet	Yes
Lot widths 100 feet or greater	On-Lot	None	9 to 10 feet	N/A	18 to 20 feet	Yes
Lot widths 40 to 100 feet	On-Lot	One Side[3]	9 to 11 feet	8 feet	26 to 30 feet	Yes
Lot widths less than 40 feet w/ rear alley access	On-Lot from alley	Two Sides[4]	9 to 11 feet	16 feet (8 each side)	34 to 38 feet	No
Lot widths less than 40 feet or no separate housing lots (apartments)	On-lot or off-street parking lot provided	Off-street parking lot provided	10 to 11 feet	N/A	20 to 22 feet	Yes (for parking lots)

[1] If no curbing or flush curbing is being used, the minimum width should be used. If raised curbing is proposed, at least one additional foot of width above the minimum shown should be provided.
[2] Performance Streets uses a minimum lot size of five acres.
[3] Alternatively, for very low volume streets, two parking lanes and one travel lane can be provided (see "Local Access Street" F in Figure 3-3).
[4] A single parking lane may be provided if houses front on only one side of the street. In such cases, the total cartway width may be reduced by eight (8) feet to a width of 26 to 30 feet.

Lane Width: Public Roadways

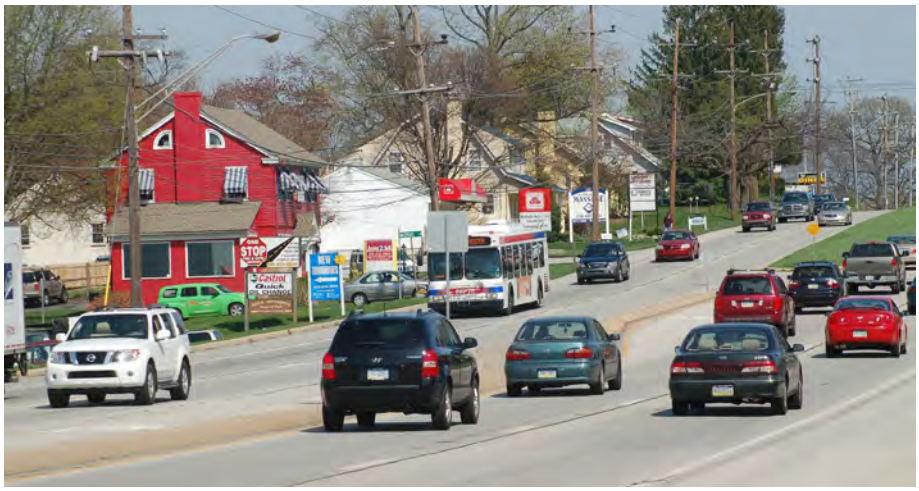
LANE WIDTH
The paved surface of a street designated for a single lane of travel.

According to AASHTO, "No feature of a highway has a greater influence on the safety and comfort of driving than the width and condition of the surface." Lane widths of 10-13 feet are most common in Chester County, with 12-foot lanes predominant on most high-type highways. The County has been working with PennDOT to reduce lanes to 11 feet to improve shoulders for biking. Other research studies by the Federal Highway Administration have generally shown that the accident rates decrease with an increase in the width of the traffic lane.

AASHTO states that a 24-foot cartway is required to permit desired clearance between commercial vehicles. An effective width of 20 feet is considered adequate only for low volume roads where meetings and passings are infrequent and the proportion of trucks is low.

To qualify for financing through PennDOT's Liquid Fuels Tax Fund, roads must be at least 16 feet wide.

Most full-sized transit vehicles are 102 inches (8.5 feet) in width. When adding 1 foot on each side for protruding mirrors, this means that buses need 10.5 feet of clearance for operations. This means that arterials and collectors should be at least that wide if they currently or prospectively would carry transit vehicles in the course of their travels. This also includes any possible routes that would be used in the event of a detour caused either by a recurring or incident-related blockage.



PA 3 in West Goshen Township.

Recommendations

Cartway widths should be flexible and site specific according to lot sizes, the desire or need for on-street parking, the functional classification of the road and overall design of the subdivision.

	All	Growth Area (including Landscapes2 urban, suburban center & suburban)				
Roadway Design	**Expressway**	**Major Arterial**	**Minor Arterial**	**Major Collector**	**Minor Collector**	**Local Road**
Desired Operating Speed	55-65 MPH, 40 MPH minimum	30-55 MPH	25-55 MPH	25-55 MPH	25-30 MPH	20-25 MPH
Travel Lane	12-14'	10' to 12' depending on number of lanes, bike lanes, shoulders, etc.			9'-11'	9'-11'
Shoulder	8'-10'	4-6' (if no bike lane or parking) 8-10' in suburban commercial contexts			4-6' (if no bike lane or parking)	
Parking lane (7-8' parallel)	Prohibited	Recommended in urban landscape; evaulate feasibility in suburban (7-8' parallel)				

	All	Rural Area (including Landscapes2 rural, agricultural, natural, & village centers)				
Roadway Design	**Expressway**	**Major Arterial**	**Minor Arterial**	**Major Collector**	**Minor Collector**	**Local Road**
Desired Operating Speed	55-65 MPH, 40 MPH minimum	45-55 MPH	35-55 MPH	35-55 MPH	20-35 MPH	20-30 MPH
Travel Lane	12-14'	11' to 12' depending on number of lanes, bike lanes, shoulders, etc.			10'-11'	9'-11'
Shoulder	8'-10'	8'-10'	8'-10'	4'-8'	4'-8'	2'-8'
Parking lane (7-8' parallel)	Prohibited	N/A	N/A	N/A	N/A	N/A

Left-Turn Lanes

Standards

PennDOT: Please refer to the section 11.16 of the PennDOT, Traffic Engineering Manual, Publication 46 ***http://www.dot.state.pa.us/public/PubsForms/Publications/Pub%2046.pdf***

Comments

For signalized intersections a Level of Service analysis will determine the need for a left-turn lane. The Federal Highway Administration found that channelization of intersections produces an average 32.4 percent reduction in all types of accidents. Accidents involving personal injuries decreased by over 50 percent.

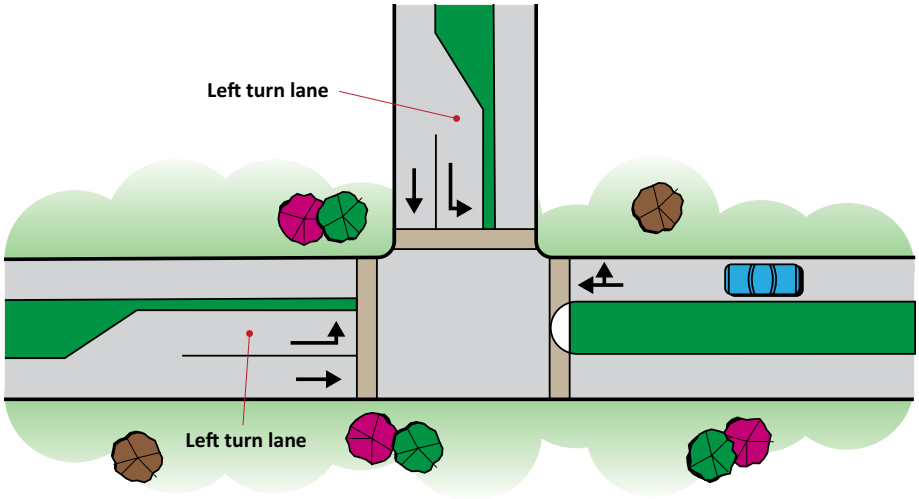
Recommendations

Left-turn lanes should be provided at new and existing driveways and intersections that exhibit the following conditions:

1. Medium-volume (750+ADT) driveways and roads which intersect arterial and collector roads in rural areas;
2. High-volume (1500+ADT) driveways or roads that intersect arterials;
3. Driveways on the crest of a hill where sight distance is limited; and
4. Intersections where sight distance is limited due to a horizontal and/or vertical curve.

In addition to these four conditions , left-turn lanes should be provided where warrants are met based on the recommendations of the section 11.16 of the PennDOT, Traffic Engineering Manual, Publication 46 ***http://www.dot.state.pa.us/public/PubsForms/Publications/Pub%2046.pdf***

Left turn lane



LEFT-TURN LANES
(aka 'Auxiliary Lanes') The provision of a separate distinct travel lane for left-turn movements.

NUMBER OF TRAVEL LANES
The lanes required to move through traffic at desirable operating speeds, not including left and right turning lanes or parking lanes.

SHOULDER
The existing improved or graded portions of the road, contiguous to the traffic lanes.

Number of Travel Lanes

The number of lanes is determined by capacity analysis for selected levels of service. This determination is based on factors such as: traffic volumes; number of trucks, turning movements, grades, parking requirements, and signal timing, etc.

On residential streets, at least one moving lane must be provided even where parking occurs on both sides. The level of user inconvenience on low-density, residential streets with one moving lane is low in areas where single-family units prevail.

Recommendation

Recommend use of the Transportation Research Board's, ***Highway Capacity Manual*** to determine the correct number of travel lanes for roads and intersections.

Shoulders

FHWA studies have generally shown that accident rates are reduced as shoulder width increases. Shoulders have many advantages such as:

- providing an emergency area, a maintenance and snow removal area and a space for bicycle and pedestrian use as well as overall structural support for the pavement;
- improving sight distances, capacity and maintaining uniform speeds, thereby increasing safety;
- providing an area to escape potential accidents or reduce their severity;
- giving the driver a sense of openness contributing to driving ease and freedom from strain; and,
- discharging stormwater from the pavement.

Recommendations

- Local access streets in low-density areas do not require a paved shoulder. A graded, stabilized grass area which provides groundwater recharge is sufficient on these roads.

Public Roadway Shoulder Widths

	Growth Area	Rural Area
Expressway	8-10'	8-10'
Major Arterial	4-6' if no parking or bike lane; 8-10' in suburban commercial contexts	8-10'
Minor Arterial		8-10'
Major Collector		4-8'
Minor Collector	4-6' if no parking or bike lane	4-8'
Local Road	NA	2-8'

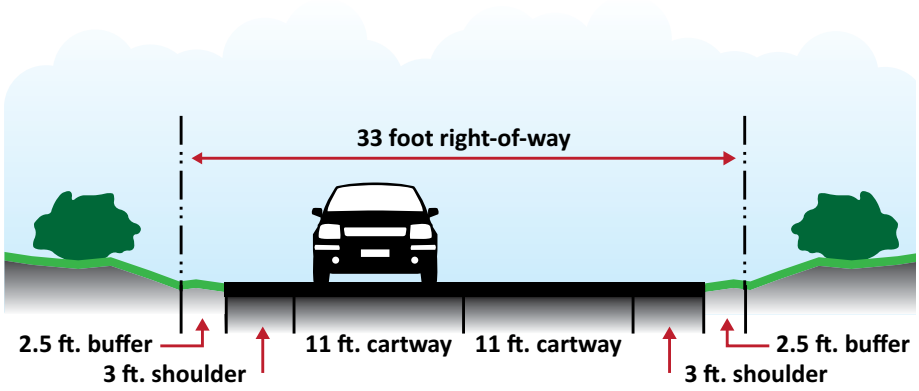
Right-of-Way

Right-of-Way Preservation

Common suburban and rural rights-of-way in Chester County are thirty-three feet. Right-of-Way elements include the cartway, shoulder and buffer area. The buffer provides an area for: snow storage, guide rails, sight distance, drainage, utilities, side slope, and pedestrian facilities. Right-of-way widths should vary according to the intended function of the road. Right-of-way preservation should include allowances for bus passenger facilities, including ADA accessible loading pads, bus shelters and ADA-compliant sidewalk connections, where appropriate.

RIGHT-OF-WAY PRESERVATION

Acquisition of an area of land, through dedication or easement, needed to accommodate the future widening of the roadway or a variety of other functions.



Most preservation actions come under the authority of municipalities. Municipalities should:

- identify corridors in need of preservation;
- coordinate preservation efforts with other local jurisdictions; and,
- identify local resources for right-of-way acquisition and assess their availability in cases where advance acquisition appears appropriate.

The amount of required right-of-way should be based on design criteria listed in this document.

Municipalities may preserve rights-of-way for future use through the Pennsylvania Municipalities Planning Code, particularly in:

- Article III, Comprehensive Plan;
- Article IV, Official Map;
- Article V, Subdivision and Land Development; and,
- Article VI, Zoning.

During the times of diminishing tax bases and increasing costs of infrastructure and services, preserving rights-of-way for future use is important, especially when attempting to keep costs of acquisitions to a minimum.

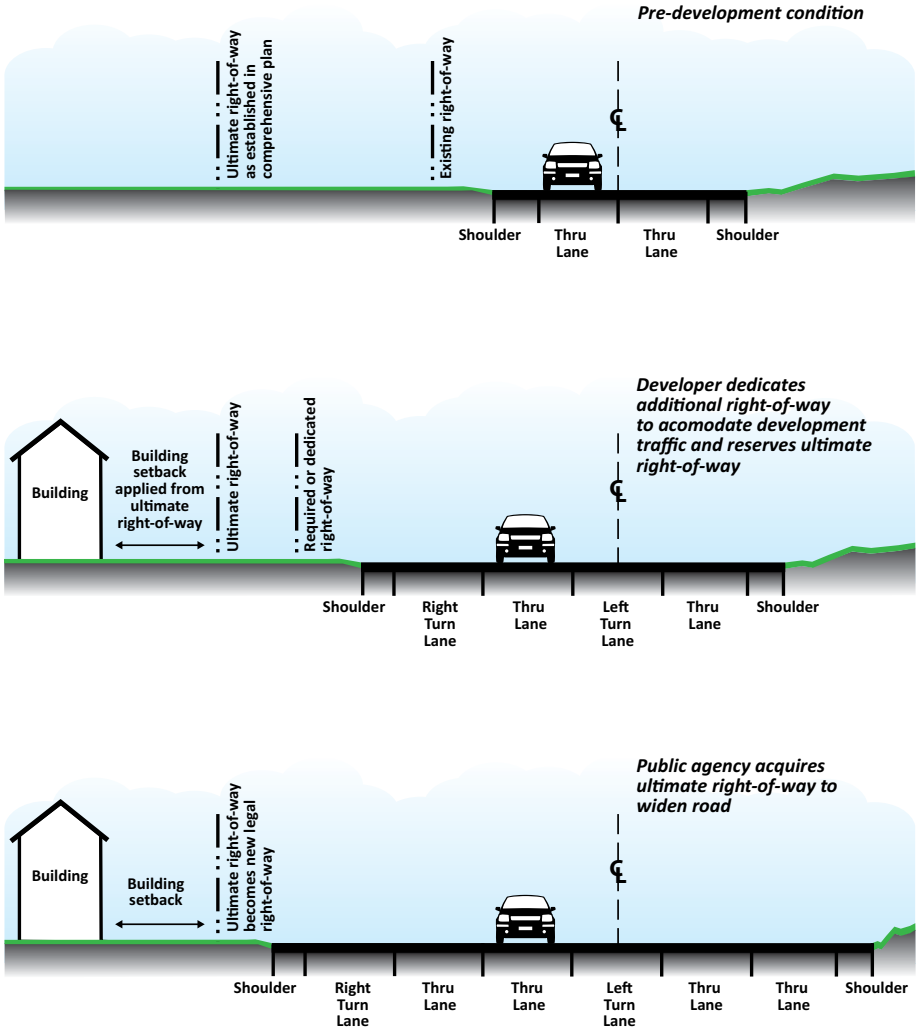
ULTIMATE RIGHT-OF-WAY
An area of land beyond the legal or dedicated right-of-way needed to accommodate the future widening of the roadway, measured from the centerline of the cartway.

Ultimate Right-of-Way

With some land developments, additional right-of-way is necessary to mitigate traffic patterns caused by trips generated by the development. This is generally referred to as "required" or "dedicated" right-of-way. In some cases, additional road widening is necessary to accommodate the greater public interest. While it may not be the responsibility of the developer to accommodate the long term public need, it is in the best interest of the developer to make the ultimate right-of-way available to the public for eventual acquisition and use. This technique will preserve property and building values when the roadway is widened. By precluding buildings and structures within the ultimate right-of-way, the cost of public acquisition is reduced, making the highway project more feasible.

The ultimate right-of-way is owned and maintained by the property owner with the understanding that the public may need to purchase it in the future. This provision can only be applied by a municipality through the subdivision and land development ordinance. The ultimate right-of-way needs to be shown on the subdivision plan and recorded on the deed.

Ultimate Right-of-Way



RIGHT-OF-WAY WIDTH
An area of land, measured from the centerline of the cartway that can be used by the public for travel or to locate utilities. Existing right-of-way width can be determined through highway right-of-way plans or deeds for individual parcels.

Right-of-Way Width

A right-of-way must provide enough width for cartways, medians, shoulders, landscaping strips, sidewalks, utility strips, sign/signal pole placement, and necessary outer slopes and may be used for the future widening and channelization of a street. The width of the right-of-way varies by the functional classification of the roadway. According to the Urban Land Institute's *Residential Streets*: Right-of-way width allowance for future street widening should be unnecessary in most well-planned residential neighborhoods. A need for future widening allowance on collector streets could be argued because of their through characteristic, but widening of a residential collector street will change the character of a neighborhood and increase the attractiveness of the street to through traffic. Such widening is viewed as undesirable--so every reasonable planning strategy should be utilized to preclude future widening needs for most residential area collector streets. By example *Residential Streets* recommends that the lowest right-of-way width for a lower order local road may be 24 feet. The best strategy usually is to assure sufficient arterial street capacity outside of the neighborhood to accommodate foreseeable traffic needs.

Recommendations

- Identify and implement a right-of-way preservation plan through the use of the ultimate right-of-way technique.
- Designate ultimate rights-of-way on all municipal roads which would reflect a built-out scenario.
- The ultimate right-of-way could:
    1. be used in an overlay zoning district along selected corridors; and
    2. be used in conjunction with setbacks to provide adequate distances between the roadway and structures. See SETBACKS design element.
- Credit the area set aside for the ultimate right-of-way in the calculation of overall density or square footage.
- Existing vegetation within the ultimate right-of-way line can remain. New landscaping should be focused as close to the ultimate right-of-way line as possible.
- The Chester County Planning Commission recommends the following inclusion on future subdivision and land development plans:

"The lots with frontage on State Route – shall be conveyed under and subject to a reservation of title granting unto the municipality the right and option of a continuing offer of dedication without further consideration of the right to accept all or any part of the lands lying within the area from the affected lot line to the proposed right-of-way line. This frontage area may

be accepted at any time or from time to time by the municipality for use thereof for highway improvements to be made by them at its sole cost and expense. This area is not dedicated by this plan."

Suggested Right-of-Way Widths (feet)

	Land Use Context		
Functional Classification	**Rural**	**Suburban**	**Urban**
Expressway	300	225	150
Major Arterial	150	150	100
Minor Arterial	100	100	80
Major Collector	80	80	80
Minor Collector	80	80	80
Local: Primary Distributor	60	60	50
Local: Secondary Distributor	50	50	50
Local Road*	50	50	50
Local Road**	33	33	33

** = Average Daily Traffic – more than 100 vehicles*

*** = Average Daily Traffic – less than 100 vehicles*

(Page intentionally left blank)

Roadway Design Standards

'Roadway Design Standards' pertains to multiple design elements, including: curbs, grades, medians, pavement, shoulder, signage, speed, and sight distance:

Curbs

Standards

AASHTO:

	Arterial	Collector	Local
Rural	No curb	6 In. vertical on right side	4 To 9 inch vertical
Urban	Vertical curb when needed	6 In. vertical on right side	4 To 9 inch vertical

PennDOT recommends use of AASHTO standards and PennDOT's Publication 408, Specifications.

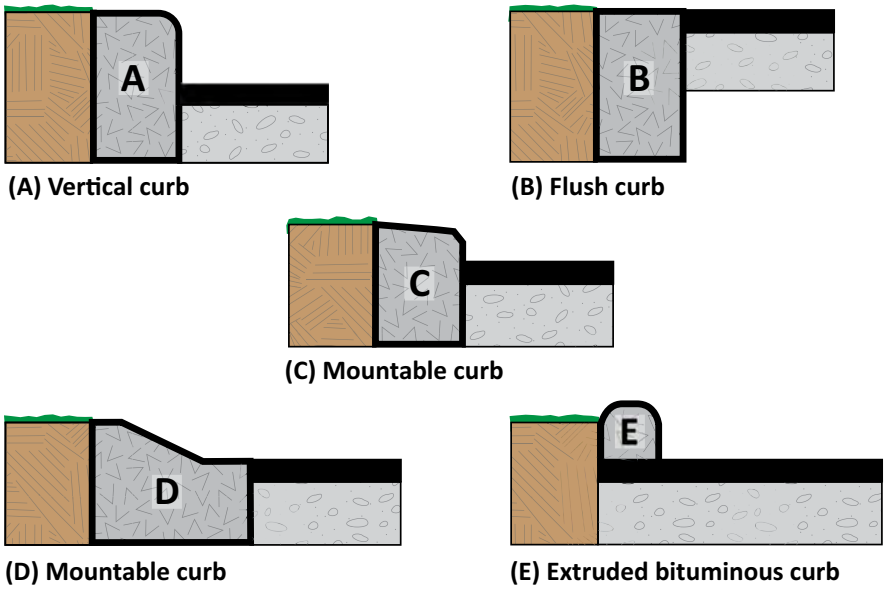
Comments

A curb serves one or more of the following purposes: drainage control; access control; pavement edge delineation and support; right-of-way reduction; aesthetics; delineation of pedestrian walkways; protection of pedestrians, signs, trees and grass; reduction of maintenance operations by preventing water seepage under the pavement; and assistance in orderly roadside development.

Mountable curb application to a center median.

CURBS
(aka barrier curb, vertical curb, mountable curb, extruded bituminous curb or combination curb with a gutter) - vertical or sloping structure generally along and defining the edge of a roadway.

Types of curbs



(A) Vertical curb

(B) Flush curb

(C) Mountable curb

(D) Mountable curb

(E) Extruded bituminous curb

Vertical curbs (A) are steep faced. They are designed to inhibit or at least discourage vehicles from leaving the roadway. They can provide support to the pavement and protect the cartway from rapid deterioration. Vertical curbs are used for drainage control and in snow areas curbs protect the grass from damage by snow plows. Initial construction cost is higher, but vertical curbs are more durable than any other type of curbing. During the construction of a subdivision, driveway locations must be determined prior to development because curb depressions need to be made. For aesthetic purposes, a more expensive vertical granite or Belgian block curb may be used. An added feature of granite or Belgian block curbing is that it is easy to replace short segments.

Flush curbs (B) provide support for the pavement and allow stormwater to run off into a drainage swale. Parked vehicles can also park on the curb. Economical driveway construction can be undertaken without curb depression. Driveway locations can be determined at a later date allowing flexibility in the timing and location of driveway construction. Flush curbs should be used in conjunction with an open drainage system using swales. Drainage patterns should be closely examined to determine the pattern of stormwater runoff.

Mountable curbs (C and D) are several inches lower than vertical curbs and are slanted since they are designed to be crossed when required. Economical driveway construction can be undertaken without curb depression. Driveway locations can be determined at a later date allowing flexibility in the timing and location of driveway construction. They are also quite durable, but must be properly installed to be effective. Mountable

curbs are used for drainage control. Over time, mountable curbs may face more expensive repaving costs because of the limited area available to be resurfaced.

Extruded bituminous curbs (E) are initially less expensive than both vertical and mountable curbs, but are less durable and require a significant amount of maintenance by comparison. In areas with snow, damage is caused by snow plows. This type of curbing is customarily found in areas with low traffic volumes. Bituminous curbs provide no support for the pavement, but are good for drainage control on short segments of roadway.

Recommendations

- Recommend use of vertical and mountable curbs whenever applicable using AASHTO's ***A Policy on Geometric Design of Highways and Streets***, and PennDOT standards. Specifically, PennDOT's Publication 408, ***Specifications***.
- Recommend the use of curbing in all new developments. Type of curbing depends on the intended function of the road. Use the following guidelines to determine which curb type to use:
- Vertical or mountable curbs should be used to control drainage.
- Flush curbing should be used to recharge the groundwater.
- Mountable curbing should be used where vehicles are expected to cross over the curb.
- Extruded bituminous curbing should be used to control drainage on short segments of roadway.
- Flush curbing should be used on narrow cartways in low density developments for pavement edge support.
- Use combinations of different curbing where warranted by different drainage patterns.
- The use of Belgian block curbing creates greater risk for tire damage and should be discouraged along transit routes unless adequate roadway width is provided to avoid its traverse.

Grades and Roadway Alignment

Standards

Rural

	Arterial			Collector						Local				
Design Speed mph	50	60	70	20	30	40	50	60	70	20	30	40	50	60
Level (%)	4	3	3	7	7	7	6	5	4	N/A	7	7	6	5
Rolling (%)	5	4	4	10	9	8	7	6	4	11	10	9	8	6
Mountainous (%)	6	6	5	12	10	10	9	8	6	16	14	12	10	--

Urban

	Arterial			Collector						Local
Design Speed mph	30	40	50	60	20	30	40	50	60	15% Max for Residential
Level (%)	8	7	6	5	9	9	9	7	6	8% Max, 5% Desirable for Industrial, Commercial
Rolling (%)	9	8	7	6	12	11	10	8	7	
Mountainous (%)	10	10	9	8	14	12	12	12	9	0.3% Min., 0.2% Acceptable for Drainage

PennDOT: AASHTO standards with these additions

	Arterial	Collector	Local
Rural	0.5% Min.	0.5% Min.	0.5% Min.
Urban	0.5% Min.	0.5% Min.	0.3% Min. – 15% Max.

Comments

Grades below the maximum values are always desirable, a minimum gradient on all curbed streets is necessary to prevent water from ponding. It is desirable to provide the flattest grades practicable that are consistent with the surrounding terrain.

Horizontal and vertical alignments should be designed together to complement one another to provide increased safety, uniformity of speeds and pleasing appearances. Avoid sudden changes in horizontal alignment by integrating the design speed and curvature of the roadway. Another way to reduce curvature is to super-elevate, or bank, the roadway. Super-elevation, side-friction and vehicle speed are the factors used to determine the horizontal alignment of a road. The topography, soil, geologic conditions, drainage patterns, potential runoff quantities, length and type of streets, and desired design characteristics should also be evaluated.

GRADES
(aka vertical alignment, gradient, or profile)
The rise and fall of the roadway.

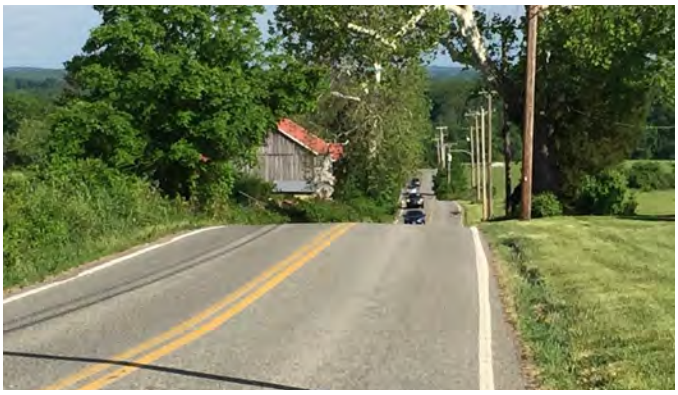
FHWA research on arterial roads shows that as the radius decreases, the accident rate increases. Residential streets can be designed to discourage high speed traffic by providing minimum horizontal alignment.

According to AASHTO, vertical curves should be simple in application and should result in a design that is safe, comfortable in operation, pleasing in appearance, and adequate for drainage. The major control for safe operation on crest vertical curves is the provision of ample sight distances for the design speed. Minimum stopping sight distances should be provided in all cases. Wherever economically and physically feasible, more liberal stopping sight distances should be used. Additional sight distance should be provided at decision points.

Recommendations

- Review each situation to determine the impact on the environment of altering roadway grades to meet specific standards.
- For grades, follow the general recommendations of ***PennDOT Design Manual Part II: Highway Design: Chapter 2 –Design Elements***
- For roadway alignment, follow the recommendations of AASHTO's ***A Policy on Geometric Design of Highways and Streets***.
- Local roads within developments and streets within villages should be designed to discourage high-speed traffic by allowing the use of small horizontal radii.
- Preclude the use of maximum grade with the minimum curve radii.

Example of good roadway alignment.



Example of poor roadway alignment.

MEDIANS
The part of the divided highway separating opposing directions of travel.

Medians

Standards

AASHTO:

- **Rural Arterial** – Four to 6 feet wide under restricted conditions. Twelve to 30 feet at intersections to provide protection for left turning vehicles. Sixty feet or greater where feasible.
- **Urban Arterial** – A minimum width of 4 feet. A minimum of 12 feet, 18 feet desirable, at intersections to provide protection for left turning vehicles.
- Rural Collectors and all local roads do not require a median.
- **Urban Collector** – Two to 4 feet wide for a paint-stripe. Two to 6 feet wide for a narrow, raised median or curbed section. Ten to 16 feet wide for the above conditions with a left-turn lane.* Desirably 16 to 40 feet wide for left-turns and open space.

** An urban collector must have 4 lanes. For a list of suggested median opening widths for turning movements and U-Turns see AASHTO's, A Policy on the Geometric Design of Highways and Streets.*

PennDOT:

- Recommended use of AASHTO standards. Medians must be a minimum of six feet wide to allow for a pedestrian refuge area.

Comments

A median is a highly desirable element on roadways carrying four or more lanes since they provide:

- a storage area for left-turning and U-turning vehicles; a recovery area for out-of-control vehicles;
- a stopping area in case of emergencies;
- an area to provide safety treatment, such as a median divider or barrier;
- open space; and,
- extra right-of-way for future lanes.

Where intersections are signalized, wide medians may be disadvantageous by increasing the time required for vehicles to cross the median resulting in inefficient signal operations.

Recommendations

- Follow the recommendations of AASHTO Policy on the Geometric Design of Highways and Streets for median widths.
- Provide medians on four lane arterials.
- Preclude the opening of medians on arterial roadways for new development unless full channelization, and perhaps signalization, is provided.
- Provide some form of a barrier to preclude illegal left- and U-turn movements across grass medians.
- Provide landscaped medians, where practical, to reduce amount of impervious surfaces and to improve aesthetics.

Pavement

The selection of pavement type is determined by the volume and composition of traffic, soil characteristics, weather, performance of pavements in the area, availability of materials, energy conservation, the initial cost and the overall annual maintenance and service life cost. Pavement for residential streets should be designed to accommodate the volume and characteristics of traffic expected to use the streets.

Recommendations

- Follow the recommendations of PennDOT Publication 242 – ***Pavement Policy Manual*** and Publication 408 – ***Specifications***.
- Consider the use of porous pavement on low turnover parking areas.

Signage

Although safety and efficiency of operation depend to a considerable degree on the geometric design of the facility, the physical layout must also be supplemented by effective signing as a means of informing, warning and controlling drivers. Signing plans coordinated with horizontal and vertical alignment, sight distance obstructions, operation speeds and maneuvers and other applicable items should be worked out before design completion.

Recommendations

- Follow the recommendations of the: ***Manual on Uniform Traffic Control Devices*** (MUTCD); the Pennsylvania Code, Title 67, Chapter 211, ***Official Traffic Control Devices***; and PennDOT Publication 111 ***Pavement Markings and Signing Standards TC-8600 and TC-8700***.
- Prohibit signs within clear sight triangles, except for traffic signs.
- Provide a breakaway device where signs are not protected.
- Place street name signs on traffic signal mast arms where applicable.

PAVEMENT
The combination of sub-base, base course and surface course placed on a subgrade to support the traffic load or distribute it on the roadbed, or both. The term normally includes the traveled portion of the highway and extends to the face of the curb in a curbed section, not including shoulders.

SIGNAGE
(aka markings) - Any sign, marking or device placed or erected for the purpose of regulating, warning or guiding vehicular traffic or pedestrians, or both.

DESIGN SPEED
The maximum safe speed that can be maintained over a specific section of road when conditions are so favorable that the design features of the road govern vehicle operation.

Speed

The designed speed should be a logical one with respect to the topography, the adjacent land use and the functional classification of the road. The design speed selected should be consistent with the speed the driver is likely to expect and all the pertinent features of the highway should be related to this speed to obtain a balanced design. (ITE)

Establish the design speed to attain a desired degree of safety and efficiency while under the constraints of environmental quality, economics, aesthetics, and social and political impacts

Recommendations

- Follow the recommendations of PennDOT Publication 70M, ***Guidelines for the Design of Local Roads and Streets***.
- Design speeds for local roads should be calculated according to their intended function. Design speeds are not intended to replace legally posted speed limits.

SPEED LIMITS
A restriction placed upon a road which legally establishes the minimum or maximum speed which vehicles may travel.

Speed Limits

Proper use of speed regulation is based on the recognition that lower speeds reduce stopping distances and generally reduce the severity of accidents. Traffic moving at fairly uniform speeds flows more smoothly, with resultant improvements in both capacity and safety.

Transportation officials often receive requests to lower speed limits reflecting the opinion that the street is improperly posted or that vehicles are traveling at unsafe speeds. Such requests are based on the public misconception that lowering the speed limit will in fact reduce vehicle speeds and accidents.

The most effective means of controlling excessive speed is through enforcement.

Recommendation

- Follow the recommendations of the Pennsylvania Code, Chapter 33, ***Rules of the Road***, to establish speed limits on new roads or altering speed limits on existing roads.

Stopping Sight Distance

Standards

AASHTO: See, ***A Policy on Geometric Design of Highways and Streets*** for specific formulas related to stopping sight distance. The following tables provide general guidance.

Safe Stopping Sight Distances

Design Speed (mph)	70	60	50	40	30	20
Distance (feet)	625	525	400	275	200	125

Safe Stopping Sight Distances on Horizontal Curves

Design Speed (mph)	70	65	60	50	40	30	20
Distance (feet)	850	725	650	475	325	200	125

Minimum stopping distances and adjustments are based on wet pavement conditions.

Effect of Grade on Stopping Sight Distances

Increase for Downgrades				Decrease for Upgrades			
Design Speed (mph)	3%	6%	9%	Assumed Speed (mph)	3%	6%	9%
30	10	20	30	28	Nv	10	20
40	20	40	70	36	10	20	30
50	30	70	NV	44	20	30	NV
60	50	110	NV	52	30	50	NV
70	70	160	NV	58	40	70	NV

Comments

Values exceeding the minimum stopping sight distance should be used as the basis for design wherever conditions permit since the use of a higher value will only increase the margin of safety.

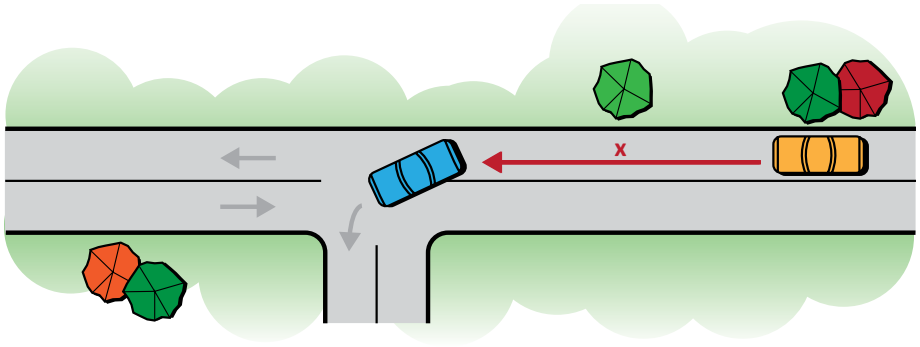
Recommendation

- Follow the recommendations of AASHTO and for further details see ***PennDOT's Design Manual Part II***, ***Chapter 2***.
- See also the PennDOT Driveway Sight Distance Measurements Form M-950S ***http://www.dot.state.pa.us/public/PubsForms/Forms/M-950S.pdf***

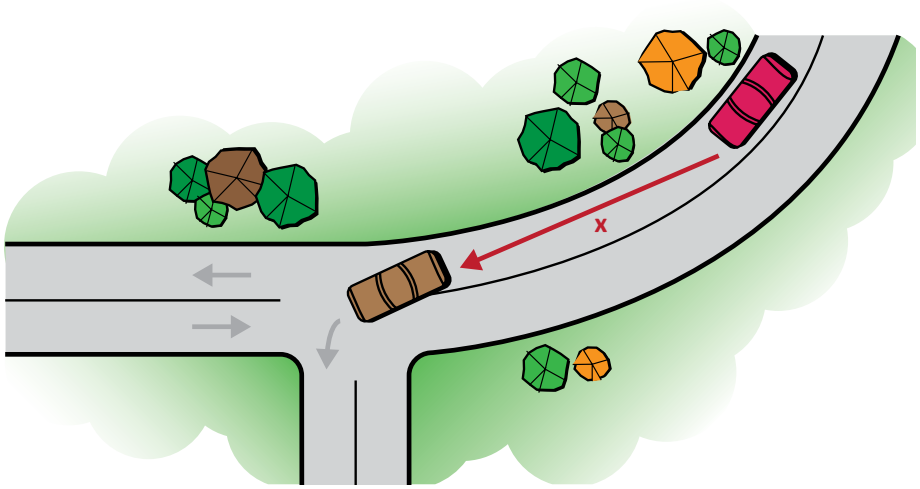
STOPPING SIGHT DISTANCE

(aka sight distance on horizontal curves) minimum distance required for a vehicle traveling at a given speed to stop before reaching a vehicle in its path. It is measured from a height of 3.5 feet above the pavement surface to an object 2.0 feet high.

Safe Stopping Sight Distance



Safe Stopping Sight Distance on Horizontal Curves



Roundabouts

Roundabouts are a subset of circular intersections with specific design and traffic control features. These features include yield control of all entering traffic, channelized approaches, and geometric curvature and features to induce desirable vehicular speeds (***Roundabouts: An Informational Guide***, Second Edition, 2010, Transportation Research Board, p.1-4).

Standards

PennDOT: Follow the recommendations contained in the Transportation Research Board's National Cooperative Highway Research Program (NCHRP) Report 672: ***Roundabouts: An Informational Guide***.

Comments

Roundabouts reduce traffic conflicts (for example, left turns) that are frequent causes of crashes at traditional intersections. Unlike a traffic circle or a rotary, a roundabout's incoming traffic yields to the circulating traffic. (FHWA)

The following is an excerpt from the Federal Highway Administration's ***Technical Summary on Roundabouts*** (FHWA-SA-10-006) regarding the benefits of roundabouts:

Roundabouts are becoming more popular based on the multiple opportunities to improve safety and operational efficiency, and provide other benefits. Of course, roundabouts are not always feasible and do not always provide the optimal solution for every problem. The benefits of roundabout intersections, and some constraining factors, are described below.

- **Traffic Safety** – Numerous studies have shown significant safety improvements at intersections converted from conventional forms to roundabouts. The physical shape of roundabouts eliminate crossing conflicts that are present at conventional intersections, thus reducing the total number of potential conflict points and the most severe of those conflict points. The most comprehensive and recent study showed overall reductions of 35 percent in total crashes and 76 percent in injury crashes [4]. Severe, incapacitating injuries and fatalities are rare, with one study reporting 89-percent reduction in these types of crashes [5] and another reporting 100-percent reduction in fatalities [6].

- **Operational Performance** – When operating within their capacity, roundabouts typically have lower overall delay than signalized and all-way stop-controlled intersections. The delay reduction is often most significant during non-peak traffic periods. These performance benefits can often result in reduced lane requirements between intersections. When used at the terminals of freeway interchanges, roundabouts can often reduce lane requirements for bridges over or under the freeway, thus substantially reducing construction costs. However, as yield-controlled intersections, roundabouts do not provide priority to specific users such as trains, transit, or emergency vehicles.
- **Environmental Factors** – Roundabouts often provide environmental benefits by reducing vehicle delay and the number and duration of stops compared with signalized or all-way stop-controlled alternatives. Even when there are heavy volumes, vehicles continue to advance slowly in moving queues rather than coming to a complete stop. This can reduce noise and air quality impacts and fuel consumption significantly by reducing the number of acceleration/deceleration cycles and the time spent idling.
- **Access Management** – Because roundabouts can facilitate U-turns, they can be a key element of a comprehensive access management strategy to reduce or eliminate left-turn movements at driveways between major intersections.
- **Traffic Calming** – Roundabouts can have traffic calming effects on streets by reducing vehicle speeds using geometric design rather than relying solely on traffic control devices.
- **Pedestrian Safety** – Due to the reduction of vehicle speeds in and around the intersection, roundabouts can improve pedestrian crossing opportunities. Additionally, the splitter island refuge area provides the ability for pedestrians to focus on one traffic stream at a time while crossing. However, pedestrians with visual impairments may not receive the same level of information at a roundabout as at a typical signalized intersection, and they may require additional treatments, such as pedestrian signalization. Specific design treatments for enhancing accessibility for visually impaired pedestrians are receiving continued study [7].
- **Aesthetics** – The central island and splitter islands offer the opportunity to provide attractive entries or centerpieces to communities through use of landscaping, monuments, and art, provided that they are appropriate for the speed environment in which the roundabout is located.

- **Land Use** – Roundabouts can provide a transition area between high-speed rural and low-speed urban environments. They can also be used to demarcate commercial areas from residential areas.
- **Ongoing Operations and Maintenance** – A roundabout typically has lower operating and maintenance costs than a traffic signal due to the lack of technical hardware, signal timing equipment, and electricity needs. Roundabouts also provide substantial cost savings to society due to the reduction in crashes, particularly fatal and injury crashes, over their service life. As a result, the overall life cycle costs of a roundabout can be significantly less than that of a signalized intersection.
- **Approach Roadway Width** – A roundabout may reduce the amount of widening needed on the approach roadways in comparison to alternative intersection forms. While signalized or stop-controlled intersections can require adding lengthy left-turn and/or right-turn lanes, a roundabout may enable maintaining a narrower cross section in advance of the intersection. However, roundabouts usually require more space for the circulatory roadway, central island, and sidewalks than the typically rectangular space inside traditional intersections. Therefore, roundabouts often have greater right-of-way needs at the intersection quadrants compared with other intersection forms.

The following table (Exhibit 1-9: Roundabout Category Comparison from the National Cooperative Highway Research Program (NCHRP) Report 672: ***Roundabouts: An Informational Guide*** – page 1-12) summarizes the basic geometry and capacities of roundabouts to provide for a quick assessment on the applicability of a roundabout for any proposed location.

Design Element	Mini-Roundabout	Single-Lane Roundabout	Multi-lane Roundabout
Desirable maximum entry design speed	15-20 mph (25 to 30 km/h)	20-25 mph (30 to 40 km/h)	25-30 mph (40 to 50 km/h)
Maximum number of entering lanes per approach	1	1	2+
Typical inscribed circle diameter	45 to 90 ft (13 to 27 m)	90 to 180 ft (27 to 55 m)	150 to 300 ft (46 to 91 m)
Central island treatment	Fully traversable	Raised (may have traversable apron)	Raised (may have traversable apron)
Typical daily service volumes on 4-leg roundabout below which may be expected to operate without requiring a detailed capacity analysis (veh/day)*	Up to approximately 15,000	Up to approximately 25,000	Up to approximately 45,000 for two-lane roundabout

** Operational analysis needed to verify upper limit for specific applications OR for roundabouts with more than two lanes or four legs.*

Existing Roundabout in Unionville, Chester County.

Roundabout in the Uptown Worthington development in East Whiteland Township, Chester County, PA.

Recommendations

- Refer to ***PennDOT's Roundabout Website*** for the latest guidance regarding roundabouts.
- Follow the recommendations contained in the Transportation Research Board's National Cooperative Highway Research Program (NCHRP) Report 672: ***Roundabouts: An Informational Guide***.

Traffic Calming

Also known as: Residential Street Controls

> *"The combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior, and improve conditions for non-motorized street users."- Institute of Transportation Engineers (ITE)*

Standards

The following is an excerpt from ***Pennsylvania's Traffic Calming Handbook***, (PennDOT Pub 383):

When Is Traffic Calming Appropriate?
Using a well-defined "Traffic Calming Study and Approval Process" will help determine when and where traffic calming measures are appropriate. Because traffic calming measures have the potential to create controversy, their installation often occurs as the final step of a three-step process referred to as the "three E's" (education, enforcement, and engineering). However, this three-step process only addresses problems with speeding, not with cut-through volumes. If the first two steps are not effective in lowering speeds on neighborhood streets, the need for traffic calming measures becomes more apparent.

Education
Municipalities with educational programs seek to remind speeding drivers of the negative effects of their actions, often by stressing that the community's children are the most at risk. Educational campaigns may use brochures or neighborhood newsletters to spread this message. Newsletters may also contain information on speeding fines (particularly in school zones), pedestrian and bicycle safety tips, and information on average speeds in the neighborhood.

Enforcement
Enforcement involves a more intensive police presence and a greater allocation of time to enforcing the speed limit in a particular neighborhood. Unfortunately, it is often not practicable to maintain a police presence at the level needed to permanently lower speeds. However, consistent visible enforcement does lead to respect of the speed limit by motorists.

Engineering
Engineering includes, but is not limited to, traffic calming measures. It can also include the use of signs and pavement markings to obtain the desired effect. Prior to installing traffic calming measures on local or collector streets, traffic conditions on adjacent arterial streets should be investigated to determine if operational deficiencies are contributing to the identified traffic concerns. If the adjacent arterial streets are the responsibility of the local government, these deficiencies should be addressed before traffic calming is considered. In addition, when the use of traffic calming measures may divert large volumes of traffic from local streets, the effects on adjacent roadways should be addressed.

Where are traffic calming measures appropriate?
As outlined in the "Traffic Calming Study and Approval Process", functional classification and land use should be primary criteria in determining whether traffic calming measures are appropriate for a particular roadway. When conditions warrant, traffic calming measures may be appropriate on the following roadway types (local or State-owned):

- Local residential streets
- Collector streets with predominantly residential land uses
- Arterial roads within downtown districts or commercial areas (with posted speeds of 40 mph or less)

Traffic calming measures addressed in the PennDOT handbook include:

- Curb Extensions/Bulb-Outs
- Chicanes
- Gateways
- On-Street Parking
- Traffic Circles
- Roundabouts
- Speed Humps
- Speed Cushions/Speed Pillows
- Raised Intersections
- Diagonal Diverters
- Right-In/Right-Out Island
- Raised Median Through Intersection
- Street Closures
- Pedestrian Safety Enhancement Devices

Comments

The first function of residential streets is to serve abutting properties. They provide access to homes by all who enter and leave, make deliveries and provide services. A secondary function is to provide routes for those who wish only to pass through the area. Residential streets offer opportunities to provide landscaped vistas, trees, shrubs, paths for walking and rights-of-way for utilities. Basic conflict arises due to the discrepancy between the impact of vehicular traffic and the tranquility of residential streets.

When considering the use of residential street controls, residents should be included in the process. Residents will determine the needs and priorities of the neighborhood. Their response to the proposed plans and the ultimate approval will be important in implementing the plan.

Recommendations

- Follow the recommendations contained in PennDOT Publication 383, ***Pennsylvania's Traffic Calming Handbook***.
- Evaluate existing conditions relative to community needs and desires;
- Allow traffic implications to be evaluated by a traffic engineer to determine the appropriate control; and,
- Municipalities should seek professional advice to avoid liability issues.

Traffic calming measures.

(Page intentionally left blank)

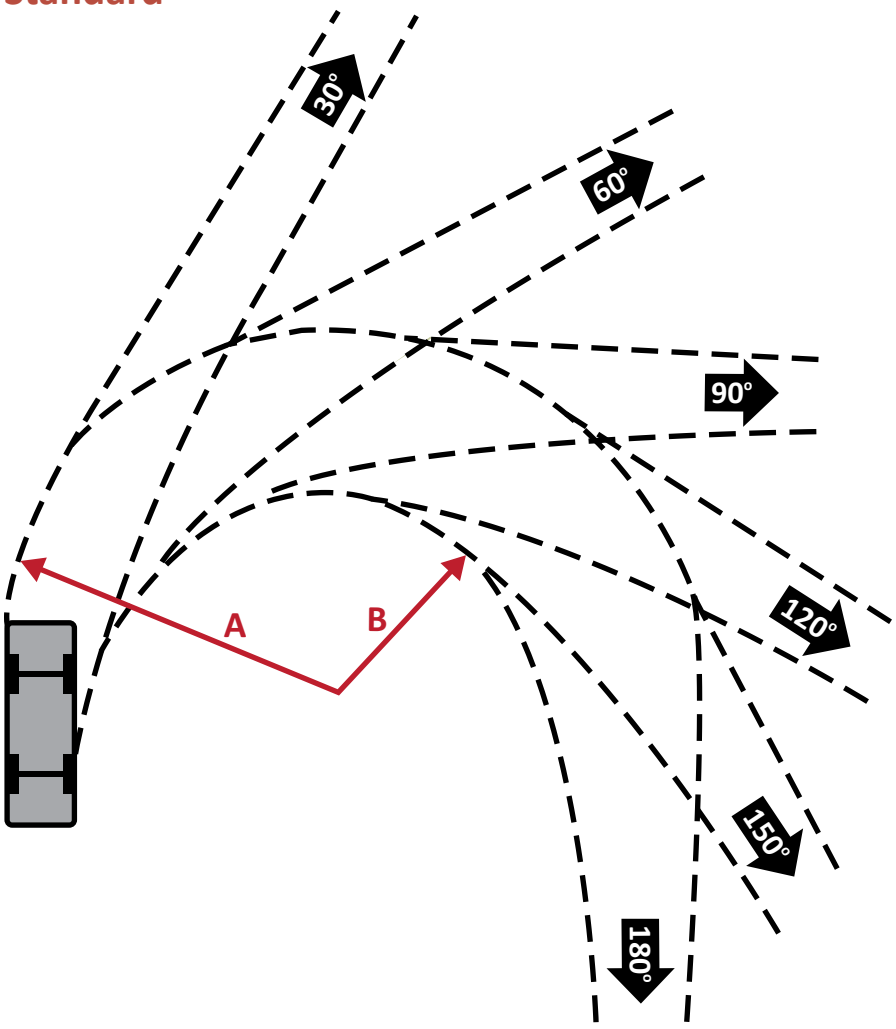
Vehicle Characteristics

Also known as: Vehicle turning radii and dimensions.

Definition

The dimensions and operating characteristics of selected motor vehicles.

Standard



Please refer to the chart on the following page for the Minimum Design Turning Radius (A) and Minimum Inside Turning Radius (B) values.

VEHICULAR CIRCULATION

Select Vehicle Dimensions and Turning Radii

Symbol	Design Vehicle Type	Width (ft)	Length (ft)	A Minimum Design Turning Radius (ft)	B Minimum Inside Turning Radius (ft)
P	Passenger Car	7.0	19	24	14.4
Su	Single Unit Truck/Ambulance	8.0	30	42	28.3
Bus-40	Intercity Bus	8.5	40	45	27.6
A-Bus	Articulated Bus	8.5	60	39.8	25.4
Wb-40	Intermediate Semitrailer	8.0	45+	40	19.3
Wb-50	Large Semitrailer	8.5	55	45	17.0
Wb-62	Interstate Semitrailer	8.5	69	45	7.9
Wb-67	Interstate Semitrailer	8.5	74	45	4.4
Wb-100T	Triple Trailer Combination	8.5	105	45	9.9
Wb-109D	Turnpike Double Combination	8.5	114	60	14.9
Mh	Motor Home	8.0	30	40	25.9
P/T	Car and Camper Trailer	8.0	49	33	17.4
P/B	Car and Boat Trailer	8.0	42	24	8.0
Mh/B	Motor Home and Boat Trailer	8.0	53	50	35.1

Source: AASHTO – A Policy on Geometric Design of Highways and Streets (2004)

Recommendation

- Follow the recommendations of AASHTO's, ***A Policy on the Geometric Design of Highways and Streets***.