Planning and Designing Streets to be Safer and More Accessible for People with Vision Disabilities

A toolbox for Montgomery County and the Metropolitan Washington Region

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Introduction

Loss of sight can have a profound impact on a person's ability to navigate the built environment and take care of daily needs, particularly those needs associated with transportation. This report provides guidance for designing streets and public spaces in urban areas that are more accessible to people with low vision or vision loss. This report is intended for consideration by Montgomery County stakeholders as well as stakeholders across the Metropolitan Washington Region.

The report was developed for Montgomery County through support from the Metropolitan Washington Council of Government’s (MWCOG) Transportation and Land Use Connections program. It is based on best practice research and a robust stakeholder engagement process in Montgomery County. The best practice research included outreach to local government officials, accessible design specialists, and disability advocacy groups in the United States, Canada, England, Scotland, Netherlands, and Japan. The stakeholder engagement process emphasized input from people with vision disabilities but also involved people with other types of disabilities, including mobility-related disabilities. It included one online meeting, two online surveys, a series of stakeholder interviews, a design critique of a proposed concept for an intersection in downtown Silver Spring, and review by staff members from multiple Montgomery County agencies.

This report includes:

- Facts about people with vision disabilities that are important for planners and designers to consider when designing streets and outdoor public spaces.
- An overview of approaches taken and lessons learned in other communities and countries.
- Principles of accessible design within public rights-of-way for people with vision disabilities.
- A discussion of processes and design tools that may be helpful in developing streets that are more accessible to people with vision disabilities.
- A discussion of how these tools can be coordinated for specific street designs.
- Guidance for process tools, design tools, and street designs, including considerations related to people with other types of disabilities, legal constraints, cost, privacy, and other issues.
- Appendices, including a table listing key national-level documents for accessible design, design examples, guidance on maintaining accessibility in the case of temporary changes, and background material and documentation from the stakeholder engagement process.

Each guidance section includes a subsection on “Concerns About Existing Approaches.” The bullets in this section are based on input provided by the Montgomery County Commission on People with Disabilities and people with vision disabilities during the engagement process for this project as well as needs identified by people with vision disabilities through other processes.
People with Vision Disabilities

Planners and designers should consider the following facts when planning and designing streets and other outdoor public spaces.

- **People with vision disabilities constitute a significant and growing segment of the population.** According to a 2016 study by the National Institutes of Health, the number of people with visual impairment or blindness in the United States is expected to double to more than 8 million by 2050, an increase largely driven by an aging population.

- **A small percentage of people with vision disabilities are totally blind.** Most retain some sight or light sensitivity, including approximately 85% of people classified as legally blind.

- **There are different types of vision disability.** Major categories include reduced visual acuity, peripheral field loss, central field loss, night blindness, and color blindness.

- **People with vision disabilities may have other disabilities.** For example, a person may be deafblind or have a vision disability with peripheral neuropathy, which affects the sense of touch.

- **People with vision disabilities travel independently to new places.** Their comfort with doing so depends on several factors, including their personality, the type of vision disability they have, and the degree to which the built environment accommodates them.

- **People with vision disabilities use a variety of personal mobility aids to get around.** Examples include long white canes, guide dogs, and mobile technologies.

- **Personal mobility aids have various strengths and weaknesses.** For example, long white canes are only capable of detecting obstacles up to about waist level and some cues, such as a change in surface texture, may or may not be detectable based on the cane tip or caning technique used.

- **Guide dogs do not make decisions on behalf of their handlers.** A guide dog cannot decide when it is safe to cross a street or bike lane, distinguish between pedestrian space and vehicular space in situations where curbs are lacking, or lead a person to a destination based on a command like, "Take me to the bus stop."

- **Pedestrians with vision disabilities use many cues to assist them with navigation.** Key cues include curbs, landscaped strips, other detectable edges, contrasting colors and textures, sounds from traffic, accessible pedestrian signals (APS), and other pedestrians.

**Definitions**

- **Partially sighted**—means a person has partial vision, either in one or both eyes.

- **Low vision**—refers to a severe visual impairment in which visual acuity is 20/70 or poorer in the better-seeing eye and cannot be improved with glasses or contacts.

- **Legally blind**—means a person has corrected vision of 20/200 or worse in their best-seeing eye.

- **Totally blind**—refers to complete loss of sight.

In this document, people who fit into these categories are referred to collectively as people with vision disabilities.
• **Pedestrians with vision disabilities use cues in different ways depending on their disability.** For example, a person with low vision is likely to rely heavily on visual cues while a person who is legally blind is likely to rely more on audible and tactile cues.

• **People with vision disabilities often rely heavily on their mental map of a street or expectations of how streets are laid out based on training and experience.** As a result, temporary changes to the street, such as changes due to construction or special events, and unconventional street designs may be disorienting.

• **Not all people with vision disabilities have received orientation and mobility training.** For many people vision loss happens later in life. They may not consider themselves as having a disability or be aware that training exists to help them.

• **Having a vision disability may create significant life challenges.** In addition to the day-to-day challenges of getting around and operating in a world optimized for people with “normal” vision, over a quarter of non-institutionalized people with vision disabilities live below the poverty line. Less than a third of working age, non-institutionalized people with vision disabilities have full-time employment.

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**Orientation and Mobility (O&M)** are skills people with vision disabilities learn to navigate their environment safely and efficiently. Orientation refers to a person’s ability to know where they are in their environment, using both visual and nonvisual cues as well as tools to aid in orientation. Mobility refers to the person’s ability to move around safely in their environment, using both visual and nonvisual skills as well as tools to aid in safety, such as a white cane or guide dog. O&M training is provided by an Orientation and Mobility Specialist and can include learning to use a white cane, crossing a street, and riding public transportation, among other various skills used to navigate safely and independently.
Overview of Approaches and Lessons Learned in Other Communities and Countries

Over the past 30 years, jurisdictions across the United States have worked to improve accessibility for people with vision disabilities in the public rights of way. This work has been motivated by advocacy from the vision disability community and federal anti-discrimination laws and accessibility standards. It has largely centered on retrofitting curb ramps with detectable warning surfaces, as prescribed in the 2010 ADA standards, and more recently installing and retrofitting pedestrian signals with accessible pedestrian signals (APSs) as prescribed in the Manual on Uniform Traffic Control Devices (MUTCD).

Relatively few jurisdictions in the United States have ventured beyond minimum federal accessibility requirements, although many have pursued improvements to the pedestrian realm that overlap with best practices for accessible design for people with vision disabilities. Those jurisdictions that have gone beyond the minimum requirements are generally large urban areas that are implementing separated bike lanes, shared spaces, roundabouts, and other street designs that are nonconventional in the United States, often as part of a commitment to Complete Streets and Vision Zero.

These nonconventional street designs can create challenges for people with vision disabilities if appropriate design provisions are not included; however, federal accessibility guidance is currently limited. (See Appendix A for a summary of existing national level design guidance for people with vision disabilities). As a result, local jurisdictions are innovating and/or drawing on examples and lessons learned from abroad, often in response to feedback from local disability advocates.

Lessons Learned

- **Proactively engage people with vision disabilities throughout the street planning and design process.** Engagement is critical for:
  - Nonconventional street designs where there is limited federal guidance on how to accommodate people with vision disabilities.
  - Intersection designs that are known to pose challenges for people with vision disabilities, such as T-intersections and skewed intersections.
  - Street designs that involve changes to how people with vision disabilities access public transit.

  Not only does proactive engagement yield better plans and designs, it can also help avoid unexpected costs associated with post-construction retrofits, lawsuits, and other inefficiencies.

- **Educate people on the goals and features of nonconventional street designs.** Many people in the United States have limited experience with nonconventional street designs like separated

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**Complete Streets and Vision Zero**

- **Complete Streets** is a street design philosophy that emphasizes designing streets that comfortably accommodate all transportation modes—not just cars.
- **Vision Zero** is an approach to traffic safety that emphasizes the responsibility of street designers and political leaders for implementing systemic measures to reduce traffic fatalities and serious injuries, particularly changes to street designs that improve safety for...
bike lanes, floating bus stops, shared spaces, flush streets, and roundabouts, so it is important to educate them about the goals and features of these designs.

- **Monitor the performance of nonconventional street designs post-construction.** After a nonconventional street design is constructed, it is important to monitor how well it works for people with vision disabilities and others and identify adjustments needed to ensure safety and accessibility.

- **Be willing and able to tweak the design of streets and outdoor public spaces to better accommodate people with vision disabilities and other users.** It is not uncommon for nonconventional street and public space designs to require adjustments, even when the jurisdiction has pursued an inclusive engagement process.

- **Be consistent about applying tactile surfaces and make sure they are reliably detectable underfoot and with a long-white cane.** In some cases, jurisdictions have installed tactile surfaces inconsistently or incorrectly, e.g., for a decorative purpose in one location but a navigational purpose in another. This kind of installation or misuse of tactile guidance can be very confusing for people with vision disabilities. In other cases, jurisdictions have installed tactile surfaces intended to benefit of pedestrians with vision disabilities that are not reliably detectable.

Additional notes about approaches taken elsewhere and lessons learned are integrated into the sections below.
Principles of Accessible Design for People with Vision Disabilities

Safety

*Streets and other outdoor public spaces are safer for all users than they are today, especially vulnerable users such as people with vision disabilities.*

Montgomery County has a goal of eliminating serious and fatal crashes by 2030, with a particular focus on vulnerable road users, including people with disabilities, pedestrians, and bicyclists.

Compliance

*Streets and other outdoor public spaces comply with all applicable federal and state laws and standards.*

Key federal laws and standards include but are not limited to:

- Section 504 of the Rehabilitation Act of 1973 (Section 504)
- The Americans with Disabilities Act of 1990 (ADA)
- United States Department of Transportation, ADA Standards for Transportation Facilities, 2006 (USDOT ADA Standards)
- United States Department of Justice, ADA Standards for Accessible Design, 2010 (USDOJ ADA Standards)
- The Maryland Manual of Uniform Traffic Control Devices (MdMUTCD)

Inclusiveness

*Plans and designs for streets and other outdoor public spaces are developed through an inclusive process that seeks to address diverse user needs.*

Inclusiveness is an essential concept when designing for people with vision disabilities. If people with vision disabilities avoid using a public facility based on the belief that it is unsafe or uncomfortable, then the facility is not truly inclusive or accessible. In addition, it is important to consider the diverse needs of people with different types of vision disabilities. What works for a person who has low vision may not work for a person who is blind. What works for a person who is blind and has average hearing may not work for a person who is deafblind. The goal is to develop a range of solutions that addresses these diverse needs.

Consistency and Predictability

*Streets and other outdoor public spaces are designed in a way that is consistent and predictable. A person with a vision disability should be able to navigate a street they’ve never been to before.*

Consistency and predictability are critical for people with vision disabilities, who often rely on mental maps and assumptions about the built environment for navigation. If a tactile surface is used one way in one place and another way in another place, then it can be extremely confusing. Temporary changes in

\(^1\) PROWAG has not yet been adopted by the U.S. Department of Justice or the U.S. Department of Transportation; however, PROWAG provides a useful framework to help public entities meet their obligations to make their programs, services, and activities in the public right-of-way readily accessible to and usable by individuals with disabilities. For that reason, the Federal Highway Administration (FHWA) considers PROWAG a best practice for the design and construction of sidewalks, pedestrian facilities, and other elements in the public right-of-way.
the built environment because of construction or other activities can also be confusing and disorienting if not handled appropriately.

Maintenance

All streets and outdoor public spaces are well-maintained.

It is especially important that elements such as APSs, detectable warning surfaces, and crosswalk markings that are essential for navigation by pedestrians with vision disabilities are well-maintained.
Process Tools

This section discusses strategies that can be implemented as part of the planning, design, and post-construction process for a street or outdoor public space to improve safety and accessibility for people with vision disabilities. The discussion under each "tool" includes a description of the tool, a description of concerns expressed by people with vision disabilities about existing approaches, and recommended guidance for consideration by Montgomery County and other jurisdictions in the Metropolitan Washington Region.

Engaging People with Vision Disabilities

Engaging people with vision disabilities means going beyond the ADA requirements for accessible meetings and materials and proactively reaching out to people with vision disabilities and Orientation and Mobility Specialists to understand their experiences, solicit their input, and involve them in the decision-making process.

Concerns About Existing Approaches

- People with vision disabilities do not feel adequately involved in street design decisions that impact their lives. They are often not aware of street planning and design processes until after key decisions are made.
- The decisions that are made as part of street planning and design process can sometimes have negative impacts on the ability of people with vision disabilities to get where they need or want to go safely and/or comfortably.
- Failure to adequately address needs of people with vision disabilities as part of street planning and design processes can sometimes result in costly retrofits and other unanticipated costs.

Figure 1: Charlie Crawford and Montgomery County Department of Transportation staff discussing concerns about the design of a floating bus stop in downtown Silver Spring. Mr. Crawford, who died in fall 2020, had a vision disability and was a tireless advocate for pedestrian safety and accessible transportation. (Source: MCDOT)
Recommended Guidance

Context

- People with a range of vision disabilities should be actively engaged in the transportation planning process, including in street planning and design projects from start to finish.
- Engaging people with vision disabilities is particularly important in the case of street designs that have not been tested locally or are not well-covered by federal accessibility guidance, such as shared spaces, separated bike lanes, floating bus stops, and roundabouts or other nonconventional intersection designs.

Application

- Project scopes, timelines, and budgets should account for the need to meaningfully engage people with vision disabilities. Meaningful engagement means solicitation of feedback from people with vision disabilities prior to making key project decisions and informing them about what is proposed in ways that are accessible to them, e.g., by providing tactile graphics of proposed street designs.
- A public participation plan should be developed for each project that clarifies how people with disabilities, including people with vision disabilities, will be proactively engaged at each stage in the project.
- People with vision disabilities should have an active role as project stakeholders, e.g., by establishing a project stakeholder committee that includes people with vision disabilities or representatives of organizations that represent them, such as the National Federation for the Blind, American Council for the Blind, and AARP. Orientation and mobility specialists can also provide valuable insights on accessibility needs for people with vision disabilities.
- People should be asked ahead of project meetings if they require any special accommodations and if so who to notify with their needs.
- Any project meetings or materials that are intended for the public must be accessible to people with vision disabilities. Best practices for meetings and meeting materials that are accessible to people with vision disabilities are outlined in Appendix D: Engagement Best Practices.
- Meeting materials in large print and/or an accessible format compatible with screen readers should be provided to participants at least 48 hours ahead of the meeting to allow sufficient time for review.

Figure 2: Tactile graphic developed for this project showing a preliminary concept for the intersection of Fenton Street and Ellsworth Drive in downtown Silver Spring.
Pre-Construction Accessibility Audit

An accessibility audit is an accessibility-focused assessment of an existing or proposed street design by an independent auditor or group of auditors with expertise in accessible design.

Concerns About Existing Approaches

- Important accessibility needs can be missed when the same group of people that developed a design is responsible for assessing it for accessibility. This is due to the difficulty this group may have evaluating the design dispassionately or their lack of experience with key aspects of accessible design, such as tactile guidance.
- When accessibility is assessed pre-construction, the focus is often on access for wheelchair users rather than people with other types of disabilities.
- Accessibility needs that are missed pre-construction can sometimes result in negative impacts on people with disabilities and costly retrofits and other unanticipated costs.

Recommended Guidance

Context

- An accessibility audit should be performed in conjunction with any significant street construction, reconstruction, or alteration project upon development of a 15% design and again upon development of a 65% design.

Application

- The auditor should not be a member of the design team and should have expertise in accessible design for people with vision disabilities, including the application of detectable warning surfaces, detectable guidance surfaces, and other conventional and nonconventional techniques for assisting pedestrians with vision disabilities with navigation.
- The accessibility audit should include:
  - An assessment of the design’s compliance with existing federal, state, and local accessibility guidelines, including PROWAG.
  - An assessment of potential impacts (positive and negative) of the proposed design on various groups of people with disabilities, including the spectrum of people with vision disabilities (overall acuity loss, depth perception loss, peripheral vision loss, central vision loss, total vision loss, color blindness, night blindness, etc.).
- The results of the audit should be compiled in a document and include recommendations for proposed designs and issues and mitigations for negative impacts.
- The audit documentation should be shared with the planner or designer, relevant local government agencies, and advisory bodies representing people with disabilities for review and comment.
Performance Evaluation
The goal of the performance evaluation is to determine if a street or outdoor public space design is achieving the goals and objectives established for it, including accessibility goals and objectives, and if those goals are not being met, to determine what can be done to improve outcomes. Performance evaluations can also inform development of similar designs in the future.

Concerns About Existing Approaches
- When nonconventional street designs are implemented, their effects on different types of users, including people with vision disabilities, are often not well understood or documented in the United States.
- Lack of information about these effects can: a) undermine awareness of issues that could be corrected either in the current design or a future design and b) lead to unsupported claims about a design’s benefits or perceived shortcomings that can negatively influence implementation elsewhere.

Recommended Guidance

Context
- Performance evaluations should be conducted for street or outdoor public space designs that have not been extensively studied or implemented in the United States and/or locally.
- Performance evaluations should be considered for other types of designs, particularly if the circumstances under which they have been implemented are atypical or if concerns have been raised about the design that would benefit from evaluation.

Application
- Goals and objectives related to accessibility for people with disabilities should be identified at the start of a project and included with other project goals and objectives.
- A plan for performance evaluation should be developed prior to implementation of the project. The plan should:
  - Clarify the purpose and timeline for the evaluation process, specify roles and responsibilities, establish performance measures, and detail data needs and methods.
  - Describe how and with whom evaluation results will be shared.
- A baseline study should be conducted to establish existing conditions relative to the goals and objectives for the project.
- A post-construction study should be performed to determine how the design performs against the baseline with respect to the goals and objectives for the project.
- If the post-construction study reveals deficiencies in the design that did not meet the performance measures, potential mitigations should be considered and implemented if practical to better achieve those performance measures.
- With nonconventional street designs, the need for minor post-construction design alterations should be anticipated and are not indicative of a failed design.

Involving key stakeholders in the development of an evaluation plan and making the plan document and evaluation results available to the public, can help develop a shared understanding of what success looks like and build support for the project.
Post-Construction Education and Outreach

Post-construction education and outreach involves efforts to inform members of the public of the features and goals of nonconventional street designs and how to use them.

Concerns About Existing Approaches

- There is a need for additional outreach to people with disabilities and others to educate them about these designs. People with vision disabilities often rely on mental maps and/or previous training or experience for navigation.

Recommended Guidance

**Context**

- Outreach and education should be provided to people with vision disabilities whenever a nonconventional street or outdoor public space design is installed.

**Application**

- Local governments should coordinate with Orientation and Mobility Specialists and disability advocates on education and outreach activities.
- Potential education and outreach activities include:
  - Informational/educational pieces on media channels frequented by people with vision disabilities.
  - Informational/educational materials in a range of formats sent to disability groups, senior centers, and other relevant community groups for distribution.
  - Information posted in libraries, community centers, buses, and other public places.
  - Online or in-person meetings that target people with vision disabilities.
  - Training with an Orientation and Mobility Specialist at a testing facility or off-street location.
  - Training with an Orientation and Mobility Specialist at the location with the nonconventional design.
- Education and outreach materials should be provided in a variety of formats, as appropriate, including audio messages, large print, braille, and Spanish language.

Figure 3: Screen clip of video produced by Montgomery County’s Bicycle and Pedestrian Priority Areas (BiPPA) program to educate bicyclists and drivers about the County’s new separated bike lanes. There is a need for additional education and outreach to people with vision disabilities.
Regular Training on Accessible Planning and Design
A series of trainings provided to relevant local government officials, engineers, and planners consisting of a baseline training and a series of follow-up trainings.

Concerns About Existing Approaches
- Local government officials, engineers, and planners often lack knowledge of certain facets of conventional accessible planning and tactile guidance, including issues that impact people with vision disabilities, which can result in these issues being overlooked.
- The fields of accessible planning and design are constantly changing. There is a need to refresh and update the knowledge of key local government decisionmakers periodically.

Recommended Guidance

Context
- Regular training on accessible planning and design should be provided to all local government officials, and any engineers and planners involved in planning and designing streets and outdoor public spaces.

Application
- A baseline training should be provided covering:
  - The legal framework for accessibility, including the Architectural Barriers Act of 1968, Rehabilitation Action of 1973, the Americans with Disabilities Act of 1990, key court decisions that impact how these laws are applied to the public right of way, the DOT and DOJ ADA standards, and PROWAG.
  - Requirements for accessible meetings and materials.
  - Techniques for proactively engaging people with disabilities, including people with vision disabilities, in street planning and design processes.
  - Existing federal, state, and local standards, guidelines, policies, and best practices for accessible street design.
  - Protocols for handling tactile guidance that are not covered in existing standards and guidelines.
- The baseline training materials should be updated every five years to include new requirements, standards, and guidance.
- The baseline training should be provided to relevant new local government staff and consulting staff soon after the start their employment.
- A refresher training should be provided to highlight key issues, provide updates, discuss changes or innovations, and respond to questions encountered on recent projects.
- Input on the training should be solicited from Orientation and Mobility Specialists, travel trainers, and others with knowledge about the experiences of people with vision disabilities and/or expertise on accessible design for people with vision disabilities.
- Trainings should also be provided to Orientation and Mobility Specialists, who may not be familiar with the use of guidance strips, tactile delineators, and other treatments.
Accessible Design Testing and Training Facility

An accessible design testing and training facility would enable people with vision disabilities to experience and provide feedback on nonconventional street and outdoor public space design concepts and technologies. The facility could be also used by Orientation and Mobility specialists to update their knowledge and train people with vision disabilities, and would enable planners and engineers to test designs before deploying them.

Concerns About Existing Approaches

- There is currently no place locally or regionally where pedestrians with vision disabilities can test and provide feedback on nonconventional street and outdoor public space design concepts and technologies before they are implemented.
- There is currently no place locally or regionally where Orientation and Mobility Specialists can train pedestrians with vision disabilities on nonconventional street design concepts and technologies without exposing them to these concepts and technologies in street conditions.

Recommended Guidance

- An accessible design testing and training facility should be established in Montgomery County or at another location in the Metropolitan Washington region that is accessible to Montgomery County residents.

Figure 4: The City of Portland built a mock-up of a "shared platform" bus stop in a parking lot, so that staff from different City agencies and representatives of several advocacy groups, including the Oregon Commission of the Blind and Oregon Walks, could experience the design feedback on how it operated before the City moved forward with constructing a shared platform stop.
**Design Tools**

This section discusses specific features that can be incorporated into a design for a street or outdoor public space to make it safer and more accessible to people with vision disabilities, including tactile cues, visual cues, audible cues, and signage. This section also discusses mobile technologies. The discussion under each "tool" includes a description of the tool, a description of concerns expressed by people with vision disabilities about existing approaches, and recommended guidance for consideration by Montgomery County and other jurisdictions in the Metropolitan Washington Region.

**Tactile Cues**

Tactile cues take advantage of a person’s sense of touch to provide navigational information. People with vision disabilities typically receive this information through their hands and feet. Some people with vision disabilities use a long white cane to extend the reach of their hands. Others may use guide dogs that are trained to detect specific tactile cues, including curbs and curb ramps.

People who are legally blind or blind often rely heavily on tactile cues, particularly those who are deafblind. However, tactile cues are not the primary means of receiving navigational information for all or even most people with vision disabilities and some people with vision disabilities have disorders, such as peripheral neuropathy, that make it more difficult to detect tactile cues. Consequently, for a street to be accessible to the full spectrum of people with vision disabilities, it should also include visual cues and audible cues that help people with vision disabilities navigate.

**Types of Tactile Cues**

Tactile cues include:

- Detectible edges
- Detectable changes in surface texture
- Detectable changes in slope
- Tactile walking surface indicators
- Tactile delineator surfaces

*Figure 5: Example of a vertical curb incorporated into a curb ramp design in Takoma Park. This design includes multiple tactile cues for orientation and alignment, including: 1) a detectable change in slope indicating a transition from the sidewalk and roadway; 2) a detectable warning surface marking the end of the ramp; and 3) a vertical curb incorporated into the ramp design that can be used for alignment.*
Detectible edges

Detectable edges are linear features that have a vertical profile greater than 2.5” and are cane detectable, meaning that a person with a vision disability using a long white cane can reliably detect them with the cane. They include building faces, fences, curbs, landscaping, and other vertical features.

Curbs

Curbs are a particularly important form of detectable edge for people with vision disabilities because they often mark the boundary between the sidewalk and the travel way or the sidewalk and a landscaping feature.

Vertical curbs can be incorporated into crossing designs to help people with vision disabilities align to the crosswalk, e.g., as part of a curb ramp design or as part of a crossing island with a channelized pedestrian access route. (Figure 5)

To be reliably detectable to people with vision disabilities, curbs must be at least 2.5” high. However, vertical curbs should not be used perpendicular to a pedestrian’s logical path of travel because they can be a tripping hazard.

In addition to vertical curbs, curbs can be rolled or beveled to enable people with vision disabilities to detect them while still being traversable by people riding bicycles or using wheelchairs and suitable for conveying stormwater. (Figure 6)

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Raised trapezoidal delineators

Raised trapezoidal delineators (Figure 7) are like beveled curbs except that they have a bevel on both sides. This type of detectable edge treatment is most often used to delineate pedestrian and bicycle facilities in cases where the facilities are parallel and flush (i.e., at the same level and directly adjacent) and wheelchair users will generally not need to cross the bicycle facility (e.g., to access parking). Where maintaining access for wheelchair is needed, the tactile delineator surface is preferred. The tactile delineator surface is discussed in greater detail below.

Detectable changes in slope

A slope change can be used to indicate to people with vision disabilities that they are transitioning from one type of space to another. In a conventional street environment, one of the most familiar slope changes is a curb ramp, with the slope of the ramp indicating a transition between the sidewalk and the crosswalk. When the running slope of a ramp is not in line with the crosswalk, it can make it more difficult for a person with a vision disability to align properly to cross. Ramps that have a slope aligned with the crosswalk are called directional ramps. This type of ramp is discussed in greater detail below.

Detectable changes in surface texture

People with vision disabilities expect that pedestrian access routes will be untextured/smooth and provide friction when wet or dry. This expectation can be leveraged to provide valuable tactile navigation information. When a surface with a detectably different texture is installed adjacent to the pedestrian access route (e.g., in the furniture or buffer zone), it can indicate to people with vision disabilities that they are no longer in the pedestrian access route (Figure 8). Surfaces that are likely to be detectable to people with vision disabilities if installed adjacent to a smooth, concrete pedestrian access route include Belgian blocks, textured pavers, grass, ground cover, and other similar materials.

3 Nonvisual Cues for Aligning to Cross Streets (nih.gov).

Figure 7: Example of a raised trapezoidal delineator. (Source: Marshalls)

Figure 8: Example from Malmo, Sweden showing how detectable changes in surface texture and tactile walking surface indicators can be used to provide tactile guidance to people with vision disabilities. Notice how the pedestrian access route is defined by a smooth surface with rougher surfaces on either side. In addition, a detectable guidance surface is arranged perpendicular to the pedestrian access route to guide people with vision disabilities to the mid-block crossing. A detectable warning surface indicates the end of pedestrian space and the beginning of the crosswalk. (Source: Tony Hull)
Smooth brick may not be detectably different from a smooth concrete sidewalk.

**Tactile walking surface indicators**

Tactile walking surface indicators (TWSIs) are specialized surfaces that are installed on a walking surface to provide navigational information to people with vision disabilities. The two most used TWSIs, the detectable warning surface and detectable guidance surface are discussed in greater depth in the sections below.

**Tactile delineator surfaces**

Tactile delineator surfaces are another type of surface. They are meant to help people with vision disabilities identify the boundary between pedestrian and vehicular space in situations where a detectable edge, such as a curb, is not present. Tactile delineator surfaces can also be used to define the edges of the crosswalk in situations where people with vision disabilities are more likely to veer outside the crosswalk.

**Concerns About Existing Approaches**

People with vision disabilities report the following challenges with existing tactile cues:

- Edge treatments that are not cane detectable, e.g., ropes and chains hung between bollards
- Long white canes getting caught in fencing for tree boxes and other landscaped areas
- Surface texture changes that are intended to be detectably different but are not, e.g., the transitions between concrete and smooth brick
- Surface texture changes in the pedestrian access route that are detectable but have a purely decorative purpose

**Needs specific to curb ramps, detectable warning surfaces, detectable guidance surfaces, and tactile delineator surfaces** are discussed in the relevant sections below.

**Recommended Guidance**

- Tactile cues that are used in the public right-of-way should comply with PROWAG and federal, state, and local accessibility requirements.
- Tactile cues that are used in streets and outdoor public open spaces must be applied consistently. Consistency is especially important in the case of TWSIs and the tactile delineator surface, which are intended to convey specific information to people with vision disabilities.
- People with vision disabilities should be engaged in all street design processes that involve consideration of the detectable guidance surface or tactile delineator surface due to the lack of detailed federal guidance on these surfaces.
- When detectible changes in surface texture are contemplated as a method for providing navigational information to people with vision disabilities, the detectability of the change in surface texture should be verified by people with vision disabilities prior to installation. Through this process, minimum requirements for surfaces textures may be identified to better standardize the palette of allowable surfaces.
• Except at crosswalks, the boundary between pedestrian space and vehicular space should be defined with a detectable edge or delineator strip. The detectable edge should typically be a vertical curb; however, if the adjacent space is a bicycle facility a beveled curb or raised trapezoidal delineator may be a more appropriate edge treatment, particularly in constrained locations.

• On conventionally designed streets, where feasible and consistent with PROWAG, directional ramps should be installed instead of ramp styles that do not align with the crosswalk. Additional detail is provided below regarding **directional curb ramps**.

• Where feasible and consistent with PROWAG, vertical curbs should be incorporated into curb ramp and pedestrian crossing island designs to help people with vision disabilities align to cross.

• Fences and other vertical elements intended as a detectable edge must be cane detectable and not pose a hazard to people with vision disabilities or other pedestrians. Bollards by themselves and bollards that are linked by chains or ropes or that have horizontal ornamental projections should be avoided if they are immediately adjacent to a pedestrian access route.

• Barriers installed around tree boxes and other landscaped areas to prevent people from walking on them should be designed to avoid catching the tips of white canes.

![Figure 10: Example of fencing design for cane detectability. The cane detection range is up to 27” above the finished surface. (Source: Seattle Department of Transportation)](source)
Directional Curb Ramps

Directional curb ramps are curb ramps where the direction of the ramp is aligned with the crosswalk.

Concerns About Existing Approaches

People with vision disabilities report the following challenges with different curb ramp orientation:

- Curb ramps that are not aligned with crosswalks make it more difficult for people with vision disabilities to orient properly to the crossing. The initial alignment at the start of the crossing can affect how likely a person with a vision disability is likely to stay within the crosswalk through the duration of the crossing. Curb ramps not aligned with crosswalks also require people using wheelchairs to reorient themselves at the bottom of curb ramps, thus increasing the time they may spend within the crosswalk.

Recommended Guidance

Context

- Directional curb ramps should be considered as the preferred design at all conventional crossing locations.
- On flush streets, there are no ramps but directional approaches to the crossings are best practice. An alignment cue can be provided by a vertical curb around planter islands and corner islands.

Key Dimensions and Characteristics

- Directional ramps should comply with PROWAG.

Application

- The ramp should be oriented so that the running slope/approach is aligned with the crosswalk.
- The grade breaks at the top and the bottom of the ramp must be perpendicular to the direction of the ramp run.
- The grade breaks should not be so abrupt that a wheelchair user might tip forward or backward.
• If the directional ramp has a triangular area at the bottom, this area must slope toward the flowline at 2.0% maximum. These triangular landing areas are necessary when the ramp is placed along a corner radius but is not perpendicular to the curbline. (Figure 11)
• To provide an additional alignment cue, consideration should be given to whether a vertical curb can be incorporated into the design along one or both sides of the ramp in lieu of a flared side. Such a design requires that the area behind the vertical curb is not a walkable surface, e.g., a landscaped area.
• In cases where the ramp is within a walkable area where pedestrians are crossing the ramp perpendicular to the slope of the ramp, flared sides must be provided.

Considerations
• Directional ramps need to be designed carefully to avoid posing a tipping hazard to people in wheelchairs.

Detectable Warning Surface
The detectable warning surface is a type of TWSI. Detectable warning surfaces are used to indicate the interface between a sidewalk and a travel lane or railroad crossing, locations with vertical drops (e.g. a transit platform), or a decision point.

Concerns About Existing Approaches
People with vision disabilities report the following challenges related to detectable warning surfaces:
• Curb ramps without detectable warning surfaces
• Wrap-around depressed curbs with detectable warnings at the crossing locations but no detectable edge or warning surface in other locations, leaving gaps where a person with a vision disability might unintentionally walk into the intersection (Figure 12)
• Detectable warning surfaces that don’t contrast visually with the underlying surface.
• Detectable warning surfaces that need repairs, particularly in locations where vehicles have driven over them.

Recommended Guidance

Context
• Detectable warning surfaces should be installed in the following contexts per PROWAG:
  o Curb ramps
  o Blended transitions
  o Pedestrian refuge islands
  o Pedestrian at-grade rail crossings not located within a street or highway
  o Rail platforms not protected by screens or guards

Figure 12: Example of a wrap-around depressed curb in Montgomery County. There are detectable warning surfaces at the crosswalk but not in other parts of the depressed curb.
• Bus platforms not protected by screens or guards where the height of the curb is greater than 6\textsuperscript{4}"
• Rail boarding and alighting areas at street or sidewalk level not protected by a screens or guards

In addition, detectable warning surfaces may be used in conjunction with the detectable guidance surface, as prescribed below.

**Key Dimensions and Characteristics**

- The physical dimensions of the detectable warning surface should comply with PROWAG for conventional applications.
- The luminance contrast between the detectable warning surface and the adjacent surface must be 50% or greater using the Michelson contrast formula.

**Application**

- When used on curb ramps or blended transitions, the detectable warning surface must extend across the entire area of a curb ramp or blended transition that is level with the street.
- Detectable warning surfaces shall not be used to provide wayfinding for pedestrians with vision disabilities.
- Detectable warning surfaces shall not be used as a method for indicating the edge of the circulatory roadway at roundabouts.
- Detectable warning surfaces shall not be used as an edge treatment to indicate the boundary between the comfort zone and the shared zone of a shared space.
- Detectable warning surfaces shall not be used at crossings of residential and lower volume driveways.
- Detectable warnings surfaces should be considered at crossings of higher volume commercial driveways that are configured like street intersections (e.g., no driveway apron).

**Maintenance**

- Detectable warning surfaces must be kept clear of snow, ice, and debris.
- Detectable warning surfaces must be replaced when damaged or when the luminance contrast between the surface and the adjacent surface is less than 50% using the Michelson contrast formula.

**Considerations**

- Although detectable warning surfaces are often used at detectable guidance surface junctions and termini in other countries, there is currently no federal or State of Maryland guidance on this use. See Junctions, Turns, and Termini in the section on detectable guidance surfaces for more information on this use.

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4 Transit Curbs | National Association of City Transportation Officials (nacto.org)
A joint project of the Transit Cooperative Research Program and the National Cooperative Highway Research Program (TCRP B-46) is currently investigating surfaces that can be used as detectable guidance surface junctions. The project will result in publication of *A Guide to Tactile Wayfinding in Transportation Settings for Travelers Who Are Blind or Visually Impaired*. The guide was expected to be published in fall 2021; however, the timeline for delivery is now uncertain due to pandemic-related delays.

Nothing in current federal or state guidance documents limits the use of detectable warning surfaces as detectable guidance surface junctions and termini in Montgomery County.

**Detectable Guidance Surface (Guidance Strips)**

The detectable guidance surface (Figure 13) is a type of TWSI used to indicate the direction of travel or, when placed perpendicular to the path of travel, a point of interest, such as a midblock crossing, bus stop or access to an important building, destination, or information kiosk.

In other countries, people with vision disabilities are taught to walk on top of the surface. However, in the United States, people with vision disabilities are less familiar with the detectable guidance surface and are more likely to walk to the side. This will likely change with familiarity, practice, and/or training.

This guide uses the term “guidance strip” to refer to detectable guidance surfaces, because detectable guidance surfaces are typically arranged in a line.

For more information on the guidance surface, see

- ISO Standard 23599, Assistive Products for Blind and Vision-Impaired Persons -- Tactile Walking Surface Indicators
- FHWA, Accessible Shared Streets: Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities
- Guidebook for the Proper Installation of Tactile Ground Surface Indicators (Braille Blocks): Common Installation Errors
- Standards Australia/Standards New Zealand, Design for access and mobility – Part 4.1: Means to assist the orientation of people with vision impairment: Tactile ground surface indicators
- FHWA, Accessible Shared Streets: Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities
- CNIB Foundation, Clearing Our Path: Tactile Walking Surface Indicators
Concerns About Existing Approaches

People with vision disabilities report the following concerns related to guidance strips:

- Trouble navigating in situations where guidance strips might help, e.g., finding midblock crossings, bus stops, and important buildings, navigating transit stations and complex street environments
- Lack of familiarity with guidance strips and their purpose
- Surface mounted guidance strips can be tripping hazards
- Guidance strips may be challenging for wheelchair users to cross
- Guidance strips that are not reliably detectable underfoot, e.g., due to stepping over the surface when the surface is too narrow for the context or peripheral neuropathy

Recommended Guidance

**Context**

- Guidance strips should be prioritized for situations where other available navigational cues, such as curbs, building faces, and landscaping, do not provide sufficient information for people with vision disabilities to reliably navigate to their intended destination.
- Guidance strips should be prioritized to help people with vision disabilities navigate:
  - To and through high-capacity transit stations.
  - To midblock crossings.
  - To bus stops.
  - To the crosswalk at skewed intersections, intersections with curb extensions, or intersections with large corner radii.
  - Along and across shared spaces and flush streets.
  - Through complex intersections, such as roundabouts and intersections with channelized turn lanes.
  - To Important buildings and destinations.
  - Through large open plazas or large interior spaces (e.g. at airports, bus stations).
  - To APSs, accessible signage, public transportation ticket sales booths, and other points of interest.

Figure 14: Example of guidance strips used to direct pedestrians with vision disabilities to a floating bus stop in the Netherlands.
**Key Dimensions and Characteristics**

- Guidance strips must also comply with ADA requirements for vertical changes in level and horizontal openings.
- Guidance strips must be slip-resistant.
- The luminance contrast between the guidance strip and the adjacent surface must be 50% or greater using the Michelson contrast formula.
- The height, width, spacing, and length of guidance surface’s raised bars must comply with the guidance provided by the International Standards Organization in ISO 23599 Assistive Products for Blind and Vision-Impaired Persons–Tactile Walking Surface Indicators (2012). This guidance is based on international research regarding the detectability of guidance surfaces underfoot and with a long white cane. See Table 1 for top width and spaces of axes of the guidance surface’s raised bars.
- When guidance strips need to be detected by people with vision disabilities approaching perpendicular to the guidance strip, they should be a minimum of 24” in depth measured along the path of travel.
- When guidance strips need only be detected by people with vision disabilities walking along the guidance strip, they should be a minimum of 12” depth.
- Guidance strip widths at intersection corners must consider that pedestrians can approach from multiple directions and should use the wider widths where people with vision disabilities walk both along and perpendicular to the guidance strips.
- Guidance strips should be cast in place or recessed rather than surface-mounted for greater durability and to avoid creating a tripping hazard.

**Application**

**Placement within Pedestrian Access Route**

- Guidance strips should be installed within an ADA-compliant pedestrian access route that is kept free of permanent or temporary obstructions, such as utility poles, bicycle racks, tree limbs, open doors, sandwich boards, outdoor seating, street vendors, etc. Guidance strips should not zig zag back and forth unnecessarily, contain confusing breaks (e.g., at a manhole cover), or be used for aesthetic purposes.
- When guidance strips are installed on a sidewalk or in an area of a shared space that is intended for the exclusive use of pedestrians, they should generally be placed towards the side of the pedestrian access route closest to the street or shared zone. This is the side of the pedestrian

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**Table 1: Specifications for guidance surface bar width and bar spacing. (Adapted from ISO 23599)**

<table>
<thead>
<tr>
<th>Top width of the flat-topped elongated bars (in)</th>
<th>Spacing of bar axes (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.67</td>
<td>2.25 – 3</td>
</tr>
<tr>
<td>0.8</td>
<td>2.35 – 3.15</td>
</tr>
<tr>
<td>1</td>
<td>2.55 – 3.25</td>
</tr>
<tr>
<td>1.2</td>
<td>2.75 – 3.35</td>
</tr>
</tbody>
</table>
access route that is most consistent (e.g., it is not affected by different building setbacks). Also, placing guidance strips on this side minimizes impacts on wheelchair users, who can travel through the comfort zone and enter a building without having to cross a guidance strip.

- If there is a furniture (or buffer) zone between the pedestrian access route and a vehicular lane, bicycle lane, or shared zone, then the width between the guidance strip and the edge of the pedestrian access route closest to the furniture zone should be no less than 24” (18” in constrained rights of way).
- If the pedestrian access route is directly adjacent to a vehicular lane, bicycle lane, or shared zone (i.e., no furniture zone), then the width between the guidance strip and the edge of the pedestrian access route closest to the vehicular lane, bicycle lane, or shared zone should be no less than 42” to 54”. This provides the minimum space for the 18” of space to the edge of the pedestrian access route and the 24” to 36” for a delineator strip between the comfort zone and the shared zone.

- Guidance strips should be installed in a way that minimizes impacts on pedestrians who use wheelchairs and other mobility devices. Designers should seek to maintain a minimum width of 3’ within the pedestrian access route, on the building side of the guidance strip, that has a smooth surface and is unobstructed by guidance strips (except where guidance strips perpendicular to the pedestrian path of travel cross over the pedestrian access route).
- Guidance strips should not be installed within a pedestrian access route that is less than 6’ wide.

Do Not Use as an Edge Treatment

- Guidance strips should not be used to define the edge between pedestrian space and vehicular lanes. Guidance strips should also not be used to define the edge between a pedestrian comfort zone and the shared zone in a shared space design.

Coordination with Pedestrian Pushbuttons and Accessible Signage

- If a guidance strip is used to guide people with vision disabilities to a signalized intersection or signalized midblock crosswalk, its placement should be coordinated with the location of the APS pushbutton so that people with vision disabilities who follow the guidance strip will also be guided to within easy reach the pushbutton.
- Guidance strips should also be coordinated with accessible signage, so that people with vision disabilities following the strip are led to a location where they can access the signage.
Junctions, Turns, and Termini

- Where guidance strips cross, they should cross at angles as close to 90 degrees as feasible. The intersection of the guidance strips should be marked by a detectable warning surface that is 24” to-36” on each side, depending on the width of the intersecting guidance strips (24” if the widest intersecting guidance strip is 12” wide, 32” if the widest intersecting guidance strip is 24” wide).

- Where guidance strips turn, the appropriate treatment depends on the angle of the turn. If the angle of the turn is 30 degrees or more, the turn should be marked by a detectable warning surface. If the angle of the turn is less than 30 degrees, no detectable warning should be used. Detectable warning surfaces signal to people with vision disabilities that there is a decision point. Frequent or unnecessary stops and decision points may be inconvenient and frustrating. (Figure 16)

- In general, each end of a guidance strip should terminate in a detectable warning surface.

Maintenance

- Guidance strips should be installed in a way that prevents the edges from lifting. The application should be durable enough to withstand expected use, including motor vehicle traffic and snowplows if used in shared spaces where motor vehicle traffic and/or snowplows will be present.

- Guidance strips must be kept clear of snow, ice, and debris.

- Guidance strips must be replaced when damaged or when the luminance contrast between the surface and the adjacent surface is less than 50% using the Michelson contrast formula.

- Adjacent business and property owners must be educated about the purpose of guidance strips and why they and adjacent areas must always be kept clear of obstacles.

- Routes with guidance strips must be routinely inspected to identify and address cases where obstacles such as trash cans, sandwich boards, café seating, locked bicycles, and e-scooters impede use of the strips by a person with a vision disability.

Considerations

- Guidance strips are not currently addressed in any guidance documents published by the State of Maryland.

- Federal guidance on the guidance surface is limited to the FHWA publication Accessible Shared Streets: Best Practices and Considerations for Accommodating Pedestrians with Vision Disabilities, which includes a list of “notable practices” for the use of guidance surfaces focused
on shared space implementation.\(^5\) This document was reviewed by multiple teams at FHWA, including the MUTCD and infrastructure teams.\(^6\)

- The Transit Cooperative Research Program and the National Cooperative Highway Research Program study (TCRP B-46) is currently investigating the use of guidance strips and is expected to publish guidance on their use.

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\(^5\) Note that the guidance surface is referred to as a “directional indicator” in Accessible Shared Streets.

\(^6\) If there is a concern about using guidance strips because they are not in the MUTCD, consider implementing them using FHWA’s Experimental Features Program.
Tactile Delineator Surface (Delineator Strips)

The tactile delineator surface is a specialized tactile surface used to help people with vision disabilities identify the boundary between pedestrian and vehicular space in situations where a detectable edge, such as a curb, is not present. Example situations include shared spaces, flush streets, parallel flush pedestrian and bicycle facilities (e.g., a sidewalk-level separated bike lane next to a sidewalk), and crosswalks.

This guide uses the term “delineator strip” to refer to the tactile delineator surface, because the delineator strip surface is typically arranged in a line parallel with the travel way, separated bicycle facility, or shared zone.

This guide uses the term “crosswalk delineator strip” to refer to a type of delineator strip that is applied adjacent to and on both sides of a crosswalk to help people with vision disabilities identify where the edge of the crosswalk is located and reduce the potential for them to unintentionally veer outside the crosswalk.

Note that other concerns related to delineator strips:

- Trouble navigating in situations where delineator strips might help, e.g., crosswalks that are long or skewed, shared spaces, flush streets, parallel flush pedestrian and bicycle facilities
- Lack of familiarity with delineator strips

Recommended Guidance

Context

- Delineator strips should be considered for the following designs:
  - Flush streets
  - Shared spaces
  - Parallel flush pedestrian and bicycle facilities
- Crosswalk delineator strips should also be used to define the edges of crosswalks, particularly when crosswalks are long (over 40’), skewed, or part of an intersection design that people with vision disabilities are likely to have difficulty navigating without veering outside of the crosswalk due to the lack of traffic sounds parallel to their path of travel, such as a T-intersection, roundabout, or intersection with channelized turn lane.

Key Dimensions and Characteristics

- Delineator strips must be reliably detectable and distinguishable underfoot and with a long white cane.
• When used to delineate the travel way on flush streets or shared zones within shared space, delineator strips should be made of a rough-cut cobble that contrasts in color with adjacent surfaces.

• When used as a crosswalk edge, delineator strips should be made of a cobble that is imbedded in concrete so that it is durable enough to withstand expected motor vehicle traffic and snowplows and that contrasts in color with adjacent surfaces. Concrete headers should be installed on both sides of the crosswalk delineator strips to enhance durability.

• Delineator strips must be traversable by a person in a wheelchair.

• Delineator strips must not create a tripping hazard.

• Surfaces adjacent to delineator strips should have a contrasting color and texture to enhance the detectability of the delineator strips.

• When used to indicate the boundary between parallel flush pedestrian and bicycle facilities, delineator strips should ideally be 36” wide, although a minimum 12” wide delineator strip is acceptable if the pedestrian path of travel is parallel to the bicycle facility.

• Delineator strips should be ideally be 36” wide (minimum of 24” wide) when used as part of a shared space or flush street design.

• Crosswalk delineator strips should be a minimum of 24” wide.

**Application**

**Shared Spaces and Flush Streets**

• When used as part of a shared space design, delineator strips must be placed between the shared zone and comfort zone of the shared space.

• When used as part of a flush street design, delineator strips must be placed at the edge of the travel way.

**Parallel Flush Pedestrian and Bicycle Facilities**

• When used as part of a parallel flush pedestrian and bicycle facility design, delineator strips can be placed between the pedestrian and bicycle facility.

**Important**

Although this delineator strip surface was tested in New Zealand and determined to be both detectable by people with vision disabilities and accessible to people in wheelchairs, it is recommended that the County confirm detectability and accessibility with County stakeholders before implementing broadly, e.g., by installing it at a test or pilot location and inviting stakeholders for feedback.
Crosswalks

- When used as part of a crosswalk design, delineator strips must:
  - Be placed adjacent to but outside of the crosswalk markings.
  - Start and end as close as possible to the edge of pedestrian space while allowing for drainage.
  - Be durable enough to withstand expected motor vehicle traffic and snowplows.

Don’t Use for Other Purposes

- Delineator strips should not be used for purposes other than those described above. For guidance along the pedestrian access route and to specific locations, mid-block crossings, etc., use guidance strips.

Maintenance

- Delineator strips must be kept clear of snow and debris.

Considerations

- Delineator strips are not currently addressed in any guidance documents published by the State of Maryland or the federal government.
- Nothing in current federal or state guidance documents would limit the use of delineator strip surfaces in Montgomery County.
- The recommendations in this document represent best practices from around the world and would represent a large advancement in accessibility in Maryland.

Figure 19: The City of Seattle uses guidance strips to help people with vision disabilities maintain their orientation through the crosswalk at skewed intersections. This toolbox recommends crosswalk delineator strips in this situation, since some people with vision disabilities interact with guidance strips by walking on top of them. This toolbox also recommends that crosswalk delineator strips be of a contrasting color to adjacent surfaces. (Source: Dongho Chang)
**Visual Cues**

Most people with vision disabilities have some sight. Visual cues take advantage of the sight they have to provide useful navigational information.

People with vision disabilities who are partially sighted or have low vision rely heavily on visual cues. Visual cues are also important for people who are legally blind but have some sight. However, people who are completely blind cannot use visual cues. Consequently, for a street to be accessible to the full spectrum of people with vision disabilities, it must also include tactile cues and audible cues.

**Types of Visual Cues**

Visual cues include:

- Contrasting colors and shades.
- Familiar patterns.
- Lighting.

**Contrasting Colors and Shades**

Contrasting colors and shades can be extremely helpful navigational cues for people with vision disabilities. In a typical street environment, the sidewalk is made of concrete and the street is made of asphalt. The light gray color of the concrete contrasts with the adjacent landscaping or street color in a way that makes the sidewalk easier to follow. Contrasting colors can be similarly effective in other contexts, such as shared spaces, flush streets, and parallel flush pedestrian and bicycle facilities to help distinguish the pedestrian access route or differentiate between pedestrian and vehicular space. However, it’s important to remember that some people are colorblind. Red and black may look very different to a person with full color vision but appear very similar to someone who is colorblind. Taking a photo of surfaces and displaying it in black and white can be a helpful way to determine whether the surfaces may contrast visually for a person who is colorblind (i.e., different shades).

**Familiar Patterns**

Familiar patterns can also be helpful to people with vision disabilities for navigation. For example, the familiar pattern of crosswalk markings can help people with vision disabilities distinguish it from other street areas. Familiar patterns can also lead to confusion if they are mimicked by other surfaces. (Figure 20)

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*Figure 20: People with low vision sometimes misinterpret a pattern of parallel light and dark colored bars like this as steps. The bars in this photo, taken near the main entrance to the Silver Spring Public Library, are purely decorative and serve no navigational purpose.*
Lighting

Good lighting is critical to the effectiveness of visual cues, and is a visual cue in its own right since differences in lighting level can indicate to people with vision disabilities that they are moving from one type of space to another or arriving at a particular location, such as an entry. Lighting is discussed in greater detail in the sections below.

Concerns About Existing Approaches

People with vision disabilities report the following challenges with visual cues:

- Difficulty following the pedestrian access route due to the lack of color contrast between it and adjacent surfaces
- Failure to see obstacles due to lack of color contrast
- Tripping due to a failure to see curbs, steps, and other abrupt changes in elevation due to a lack of color contrast
- Tripping or loss of balance due to misinterpreting a series of light and dark bars perpendicular to pedestrian path of travel as stairs
- Decorative patterns in the pedestrian access route creating confusion
- Abrupt changes in lighting level creating the illusion of a barrier or obscuring the visibility of barriers, curbs, steps, or other abrupt changes

Needs specific to crosswalk visibility and lighting are discussed in high-visibility crosswalks and lighting sections below.

Recommended Guidance

- The pedestrian access route should contrast visually with adjacent spaces and should generally be of a continuous and consistent color. Additional guidance regarding pedestrian access routes is provided below.
- TWSIs should contrast visually with the underlying surface. Additional guidance regarding TWSIs is provided above.
- The travel way should generally contrast visually with the delineator strip on flush streets.
- Changes in elevation, including curbs and wheel stops, should contrast visually with adjacent surfaces. Consider applying reflective paint to these locations, so they show up better in dark conditions when light is reflected off them.

Figure 21: The National Institute of Building Sciences has developed performance criteria for surfaces and materials used in exterior spaces for pedestrians with low vision, including light reflectance value, minimum contrast, and maximum sheen. See Table 4D-2 in the guide.
• Vertical elements that are located within a pedestrian circulation path, 7 such as fences, bollards, and light poles, should contrast visually with the surface of the pedestrian circulation path and with other background colors in the public right of way.

• The selection of contrasting colors should consider whether people who are colorblind perceive the colors as contrasting.

• A series light and dark bars arranged perpendicular to the pedestrian path of travel on a pedestrian access route should be avoided, since this pattern may be misperceived by some people with vision disabilities as stairs.

• Patterns and colors that are used in the pedestrian access route should be used consistently within a block or section of roadway.

• Pedestrian routes should be provided with adequate, even lighting levels. Additional guidance on lighting is provided below.

High-Visibility Crosswalk Markings

High-visibility crosswalk markings come in a range of styles including continental, ladder, and zebra. They are easier for both drivers and pedestrians with low vision to see.

Concerns About Existing Approaches

People with vision disabilities report the following challenges with crosswalk markings:

• Difficulty maintaining the correct heading in the crosswalk due to faded crosswalk markings, lack of edge lines parallel to the path of pedestrian travel, long crossings, and/or adjacent surfaces that do contrast visually with the markings

Recommended Guidance

Context

High-visibility crosswalk markings should be installed at:

• Signalized intersections.

• Intersections with relatively high pedestrian and/or motor vehicle volumes.

• Midblock crossings.

• Skewed or long crossings (over 40’).

• Locations where there is a higher concentration of people with vision disabilities.

Application

• The ladder-style high-visibility crosswalk marking should be preferred. Many people with low vision favor the ladder-style marking, because the transverse edge lines help them maintain the

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7 PROWAG defines pedestrian circulation path as “a prepared exterior or interior surface provided for pedestrian travel in the public right-of-way.”

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correct heading in the crosswalk. Studies have also demonstrated that ladder-style markings are the most visible to drivers and have the greatest impact on driver behavior.  

- High-visibility crosswalk markings should be paired with stop bars and appropriate signing to encourage drivers to stop in advance of the crosswalk rather than in it when a pedestrian is present. At uncontrolled multilane crossings, the stop bar should be set back 20 to 50 feet from the crosswalk to avoid multiple threat crashes.
- Roadway surfaces adjacent to and within high-visibility crosswalks should contrast visually with the white crosswalk markings.

**Maintenance**

- High-visibility crosswalk markings should be inspected regularly.
- Markings that are damaged or faded should be replaced when they are near or at minimum retro reflectivity levels, or when they are deemed by inspection to be damaged and not effective at communicating to drivers and pedestrians, including pedestrians with low vision.

**Street Art**

Street art has become increasingly popular to beautify the street, create a sense of community, and calm traffic. However, when street art is incorporated into a crosswalk, it can affect the navigability of the crosswalk to people with vision disabilities.

**Recommended Guidance**

- If street art is installed at a crosswalk location, the visual contrast between any crosswalk markings and the underlying surface or design must be maintained.

**Lighting**

Lighting enables pedestrians to navigate streets in dark or low-light conditions, allowing them to see, recognize, and react to obstacles, read street signs, and recognize the facial expressions and movements of fellow travelers. For people with vision disabilities, the task of discerning wayfinding cues and avoiding hazards can be especially difficult in dark, low light, or high glare conditions.

Effective street lighting for navigation depends on the following factors:

- **Illuminance**—the amount of light reaching a surface for pedestrians, measured in foot-candles
- **Luminance**—reflected light, or brightness, measured in candelas per square inch
- **Contrast (or Luminance Contrast)**—the difference between luminance of an object and its immediate background or adjacent object, e.g., difference in light reflected from detectable surfaces and adjacent sidewalk
- **Uniformity**—the evenness of light, which must be balanced with contrast so that objects in the visual field don’t all look the same

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8 [NCHRP-03-78b_Final-Guidelines.pdf (ncsu.edu)](ncsu.edu)
• Glare—brightness that causes discomfort or loss of visual performance or visibility.10

Light levels for ease of pedestrian navigation are typically calculated with lighting software. Inputs include the design parameters of the area to be lit, the activity level of the area (high use area vs. lower use area), and the type of available luminaire.

Needs Not Being Met by Existing Approaches

People with vision disabilities report the following challenges with lighting:

• Lack of lighting in general, with midblock crossings specifically called out as locations where more lighting is needed
• Lighting that is uneven, creating a series of dark and light spaces
• Lighting that is too bright or glaring

Recommended Guidance

Context

- Lighting should be provided to illuminate the pedestrian access route, crosswalks, transit stops, stairs, and ramps.
- Pedestrian lighting should be provided on corridors with high pedestrian volumes or where a pedestrian safety and access need has been identified that requires supplemental lighting focused on pedestrian areas. Pedestrian lighting is lighting whose primary function is to illuminate sidewalks and other pedestrian areas,
- Visual information that is important for wayfinding should be illuminated so it can be seen in dark or low-light conditions. This includes, but is not limited to, signs, maps, and TWSIs.

Lighting Levels

- Pedestrian access routes should be illuminated at a minimum average illumination level of 1.0 Foot-candles.11
- Pedestrian access routes should have a uniformity ratio of 3:1.12
- If lighting levels change, e.g. from light to dark, a gradual transition should be provided to prevent temporary blindness.


**Pedestrian-Scale Lighting**
- Pedestrian-scale light should:
  - Be even and consistent in quality.
  - Avoid the creation of strong shadows, dark areas, glare, or hot spots.
- Pedestrian-scale lighting should be 9-14 feet tall.
- Since pedestrian-scale light poles are shorter than street lighting, they must be placed at more frequent intervals. The exact frequency depends on the height of the poles and other factors.
- A light loss factor (LLF) must be included to account for drops in light levels over time due to wear, dirt, and aging equipment.

**Crosswalk Lighting**
- Per FHWA guidance, luminaires should be located at least 10 feet from the crosswalk and positioned to light the side of the pedestrian facing the approaching vehicle.

**Considerations**
- Consider enhancing pavement, building, and other edges used for wayfinding with lighting or photoluminescent material.
- Trees, signs, and other vertical elements should not interfere with the output from light poles.
- Care should be taken to avoid lighting vertical objects from the front at the same level as they are lighted from the back, which creates a neutral vertical contrast and makes it difficult to distinguish the vertical element from its background.
- When positioning lights, care should be taken to avoid light trespass and pollution.

**Audible Cues**
People with vision disabilities can use their sense of hearing to take advantage of audible cues to navigate. People who are legally blind or blind often rely heavily on audible cues. People with low vision tend to focus less on audible cues than on visual cues, while people who are deafblind generally cannot take advantage of audible cues. Consequently, for a street to be accessible to the broad spectrum of people with vision disabilities, it must also include tactile cues and visual cues.
Types of Audible Cues

Audible cues include:

- Traffic sounds, including the sounds of motor vehicle engines and tires.
- The sounds of other pedestrians.
- Differences in the sounds surfaces make when tapped on by a long white cane.
- Differences in the way sounds echo off objects in the environment.
- Distinctive sounds, such as the sound of a fountain.
- Accessible pedestrian signals (APSs).
- Audible messaging.

Traffic Sounds

Traffic sounds are a particularly important navigational cue for people with vision disabilities. People with vision disabilities use the sounds of parallel traffic as a cue for maintaining alignment in crosswalks and on sidewalks, parallel traffic surging forward as cue for when to cross if APSs are not provided, and perpendicular traffic as cue for arriving at an intersection.

Traffic sounds may become a less reliable audible cue in the future due to the electrification of the motor vehicle fleet. Although NHTSA now requires electric and hybrid electric vehicles to emit a noise when traveling below 18 mph\(^{13}\), electric and hybrid electric vehicles are still generally quieter than vehicles with internal combustion engines and may be more difficult for people with vision disabilities to detect increasing the importance of providing other alternative cues.

Concerns About Existing Approaches

People with vision disabilities report the following challenges with audible cues:

- Difficulty hearing traffic sounds, APSs, and other important audible cues due to ambient noise
- Difficulty hearing bicycles, scooters, and electric vehicles
- Difficulty hearing and/or interpreting traffic sounds at certain types of crossings, including channelized turn lane crossings, T-intersection crossings, bike lane crossings, and roundabout crossings
- Difficulty navigating along and across pedestrianized streets and shared spaces due to the lack of traffic sounds

Recommended Guidance

- APSs must be installed at all signalized crossings with a pedestrian signal and all pedestrian hybrid beacon crossings. Additional guidance on APSs is provided below.
- Audible information devices must be installed at all crossings supported by rectangular rapid flashing beacons or warning beacons that are triggered by a pedestrian pushbutton or passive pedestrian detection.
- Consideration must be given to how the design and use of a public space may impact the ability of people with vision disabilities to hear audible cues such as traffic noise, APSs, and speech messaging. Appropriate adjustments should made to mitigate potential negative impacts.
- Consideration should be given to making relatively quiet vehicles such as electric cars and bicycles more audible at unsignalized pedestrian crossing locations through the use of technologies such as textured/audible pavement or vehicle detection.

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\(^{13}\) [Federal Register :: Federal Motor Vehicle Safety Standard No. 141, Minimum Sound Requirements for Hybrid and Electric Vehicles]
Consideration should be given to how additional audible cues can be incorporated into a street design to facilitate navigation by people with vision disabilities, including audible messaging or signage and surfaces that make distinctive sounds when tapped on by a white cane.

Echoey spaces should be avoided. The sound distortion caused by echoey spaces can make it harder for people with vision disabilities to distinguish sounds and determine where they are coming from, which can affect navigation.

Accessible Pedestrian Signals

Accessible pedestrian signals (APSs) are devices integrated or affixed to the pedestrian signal poles at pedestrian crossings, that provide information about “Walk” and “Don’t Walk” intervals in audible and tactile formats to assist pedestrians who are blind or have low vision. APSs can be configured to provide information about street names and intersection geometry with speech messages, Braille, raised print, maps, and diagrams. APSs can also be configured to provide audible beacons that can help people with vision disabilities maintain their alignment while crossing long crosswalks.

Figure 24: Map of accessible pedestrian signal locations in Portland, OR. The City of Portland began installing APSs in the late 1970s.

Figure 25: Accessible Pedestrian Signal with raised arrow button.

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Concerns About Existing Approaches

People with vision disabilities report the following challenges with APSs:

- Difficulty hearing APS locator tones above ambient background noise
- APSs that are too loud
- APS pushbuttons that are not in predictable locations
- APS pushbuttons that are too far from the crosswalk
- APS pushbuttons that are too low, e.g., difficult to reach for a person navigating with a guide dog (Figure 26)
- APS pushbuttons that are difficult to reach from a wheelchair (Figure 27)
- APSs that are malfunctioning
- Tactile arrows on APS pushbuttons that are not aligned with the crosswalk

Figure 26: Person with guide dog having difficulty reaching an APS pushbutton that is too low.

Figure 27: Person in wheelchair can’t reach APS pushbutton button due to large concrete base.

Recommended Guidance

Context

- Pedestrian signal heads should be provided for all crosswalks/pedestrian street crossings that are supported by a traffic control signal or pedestrian hybrid beacon.
- Where pedestrian signals are provided, they should include an APS. Audible information devices should also be installed at all RRFB-supported crossings.
- APSs are required at all newly constructed or reconstructed intersections where pedestrian signals are installed.
- Existing pedestrian signals must include APS when the signal controller and software are altered, or the signal head is replaced.
• APSs are required for all signals that incorporate a leading pedestrian interval, protected left turn, or exclusive pedestrian phase.
• APSs are required on median islands if the pedestrian clearance time is sufficient only to cross from the curb or shoulder to a median that is at least 6’ wide.
• APSs are required for each multilane segment of a roundabout or channelized turn pedestrian crossing, including on the splitter island (roundabouts) or for the turn lane crossing (channelized turn lanes), where applicable.15
• The following types of intersections should be prioritized for APS retrofits:
  o T-intersections
  o Intersections with large turning radii or curb extensions
  o Intersections with long crosswalks (over 40’)
  o Skewed intersections
  o Intersections with channelized turn lanes
  o Roundabouts
  o Other complex intersections, e.g., intersections where more than two streets intersect-
• APSs must be installed upon request along a specific route of travel for an individual or group of individuals who are blind or have low vision.

Application
• APS must comply with the MUTCD and should comply with PROWAG.

Location and Spacing
• APS pushbuttons must be located:
  o Lateral placement--Between the edge of the crosswalk line (no less than 5 feet) and the side of the curb ramp.
  o Longitudinal placement--Between 1.5 and 6 feet from the edge of the curb ramp, shoulder, or pavement.
• When the crossing is served by a ramp, the pushbutton should generally be placed at the top of the ramp on the side that is opposite to parallel traffic. (Figure 28)
• The pushbutton must be within a 10” reach of a level landing area that is at least 4’ by 4’ and has a level surface (slope less than 2%). This ground space must connect to or overlap the pedestrian access route that connects to the crossing.
• Two pedestrian pushbuttons on a corner should be separated by a distance of at least 10’.

15 [https://www.access-board.gov/prowag/chapter-r3-technical-requirements/#r3064-channelized-turn-lanes-at-roundabouts](https://www.access-board.gov/prowag/chapter-r3-technical-requirements/#r3064-channelized-turn-lanes-at-roundabouts)
[https://www.access-board.gov/prowag/chapter-r3-technical-requirements/#r3065-channelized-turn-lanes-at-other-signalized-intersections](https://www.access-board.gov/prowag/chapter-r3-technical-requirements/#r3065-channelized-turn-lanes-at-other-signalized-intersections)
• Pedestrian clearance times should be calculated based on the time needed for a pedestrian standing at the APS location to travel across the crosswalk to the opposite side of the traveled way.

Pushbutton
• APS pushbuttons should be provided even in cases where pedestrian signals do not require a pushbutton for signal activation to enable people with vision disabilities to take advantage of APS features, such as speech messaging and additional crossing time.
• APS pushbuttons should emit a locator tone that can be heard above ambient background noise. The locator tone should adjust automatically to changes in level of ambient background noise.
• The face of the pushbutton must be aligned parallel to the crosswalk that it serves.
• A tactile arrow that can provide a vibrotactile walk indication must be included on the pushbutton to indicate the direction of the crosswalk it serves.
• The pushbutton shall be mounted at a height of 42” min. to 48” max. above the sidewalk or finished pedestrian surface measured to the midpoint of the button.
• The pushbutton shall be 2” minimum in diameter.
• A maximum of 5 lbs. of pressure shall be required to push the button and activate the pedestrian signal.

Sign
• A sign must be located directly adjacent to the pushbutton to explain the purpose of the device and how to use it. The sign should include both visual and braille information.
• The adjacent sign must clearly indicate the direction of the crosswalk that it serves.
• At complex intersections or crossings, consider providing a tactile map of the intersection near the APS for additional wayfinding guidance. The map should comply with the guidance in PROWAG regarding protruding objects.

Walk Indication
• When the walk signal is activated, the tactile arrow on the pushbutton must vibrate to indicate to people with vision and hearing difficulties that they may cross the intersection.
• When the walk signal is activated an audible signal or speech message must be emitted from the APS to indicate to people with vision disabilities that they may cross.
• The audible signal must dynamically adjust its intensity to be heard above variable levels of ambient background noise.
• If two APS devices are located less than 10’ apart, they must use an audible speech message to indicate which walk signal is on. Audible speech messages are also preferred at locations where APS devices are located more than 10’ apart to avoid confusion between the sound of the APS and other ambient sounds, such as trucks backing up.
• For walk signals concurrent with vehicle signals, the speech messages must indicate that a walk signal is on and the street that the crossing applies to.
• For walk signals in an exclusive pedestrian phase (e.g. pedestrian scramble phase), the speech message must indicate that the walk signal is on for all crosswalks.
• If a leading pedestrian interval is implemented, the walk indication must remain on until after parallel traffic is given the green light. Otherwise, people with vision disabilities who wait for the surge of parallel traffic because they are uncertain whether they are hearing the correct APS may have insufficient time to cross.
• When the walk signal is off, a speech message is not required. If it is used, the speech message must begin with the term "wait" to indicate that the “do not walk” signal is active.
Extended Press Pushbutton Features

- Extended presses of the pedestrian pushbutton may be used to activate additional features of the device such as additional walking time, an audible beacon, or additional speech messaging if these additional features were required in the APS specification.
- If an extended press is used, pushes less than one second must activate only the walk signal, while pushes greater than one second must activate the walk signal and additional features.

Audible Beaconing

Audible beaconing is the use of an audible signal to help pedestrians with vision disabilities maintain the correct heading while in the crosswalk. The signal is usually triggered by an extended press of the APS pushbutton and is broadcast from a speaker on the far side of the crossing that directed at the middle of the crosswalk.

- Audible beaconing should be considered to help people with vision disabilities orient to cross and maintain the proper heading while crossing in the following situations, as specified by the MUTCD:
  - Crosswalks longer than 70 feet, if not divided by a median where an APS is already installed
  - Skewed crosswalks
  - Intersections with irregular geometry
  - Crosswalks where beaconing is requested by an individual with vision disabilities
  - Intersections where the use of beaconing is considered beneficial
- Audible beacons are discouraged in the case of channelized turns and split phasing due to the possibility of the signal being heard at the wrong crosswalk.
- The audible beaconing loudspeaker should:
  - Be mounted at the far end of the crosswalk within the width of the crosswalk.
  - Be mounted at a height of 7’ to 10’ above the pavement.
  - Be pointed toward the middle of the associated crosswalk (i.e., the centerline of the road).

Maintenance

- Accessible Pedestrian Signals – A Guide to Best Practices suggests conducting a checkup of APS units on a regular basis to avoid malfunctions that could lead to dangerous misinformation for people with vision disabilities. In addition, checkups should be performed after any repairs to intersection signals, poles, controllers and after any changes to signal timing.
- Some common failures need to be checked at every inspection, such as:
  - The raised arrow button may not vibrate correctly or is missing or pointing in the wrong direction.
  - The WALK indications tone or speech may have stopped working or be delayed.
  - Pushbutton may be stuck or malfunctioning.
  - The noise response may not respond correctly, is going slower or not responding at all.
- Locator tones and audible beaconing should also be checked every six months. The locator tone may be too slow or have ceased to respond. Wiring, tone level, and orientation must be checked at every inspection. \(^{16}\)

\(^{16}\) [http://www.apsguide.org/chapter7_maintenance.cfm](http://www.apsguide.org/chapter7_maintenance.cfm)
Considerations

- Consider installing APS that can be activated using a mobile device in addition to the pushbuttons. These systems can also provide information about intersection geometry, location, WALK, DON’T WALK, directionality, and clearance on a person’s smartphone. There are multiple potential advantages, including that they provide a touchless option for APS activation for people with smartphones, which can help prevent the spread of germs and viruses.

- Achieving the appropriate APS volume and signal time of day duration can be challenging. APS volumes have been reported to be a nuisance after peak hour traffic volumes have subsided. While APS may require a high audible volume during peak traffic times, the same volume in the evening can be a nuisance in some locations, such as residential areas.

Signage

There are many different types of signs. Some signs provide directions, warnings, or other information exclusively for pedestrians. These are called pedestrian signs below. Other signs, such as street name signs, are intended to provide information to both pedestrians and motorists. Still other signs identify the routes served by transit stops, which are referred to as transit signs.

Signs can be visual, audible, and tactile, and potentially all three. The most common type of sign is visual. Most people with vision disabilities retain some vision and do not know braille, especially older adults who experience vision loss later in life. Consequently, visual signage can be extremely helpful for wayfinding for many people with vision disabilities when legible.

Concerns About Existing Approaches

People with vision disabilities report the following challenges with signage:

- Difficulty seeing wayfinding signs (font too small, too high up, poorly illuminated)
- Difficulty seeing signs at transit stops from a distance
- Difficulty seeing street signs at crossings
- Lack of tactile and audible signs
- Tactile/Braille signs that are difficult to reach and/or placed in locations where they’re unlikely to be found
- Signs that obstructed the pedestrian access route, particularly temporary signs such as sandwich boards or work zone signs

In Austin, the high audible volumes of APS in the evenings and early mornings were reported as a problem. As a result, the volumes are now automatically lowered between 8:00 p.m. and 5:00 a.m.
Recommended Guidance

**Context**

- Pedestrian signs should be provided to effectively guide pedestrians of all abilities to key destinations, including:
  - Transit stations
  - Bus stops
  - Libraries/community resources
  - Hospitals/health care facilities
  - Civic offices

- Pedestrian signs should also be provided to help people with vision disabilities navigate in atypical situations where they might otherwise have difficulty navigating. Examples include complex intersections and floating bus stops.

**Key Dimensions and Characteristics**

- Pedestrian signs should comply with requirements in PROWAG 402 for protruding objects (PROWAG R210 in the case of shared use paths) and PROWAG R410 for finish and contrast, character height, height from finished surface, stroke thickness, character spacing, and line spacing.

- Pedestrian signs should be provided in formats that are accessible to people with vision disabilities, including visual and tactile formats.\(^\text{17}\)

**Application**

Legibility and Font

- The minimum character height on pedestrian signs must comply with the guidance in Table 2.
- The lettering used on pedestrian signs should be in a conventional san’s serif font.
- If the lettering is visual only (no tactile properties), then it should be a mix of uppercase and lowercase characters. If the lettering is also meant to be read by touch, then it should be all uppercase.\(^\text{18}\)
- The lighting and positioning of the signage should be carefully considered to avoid glare under all expected lighting conditions.
- Internally illuminated or backlit signs should be avoided because they may be difficult for persons with low vision due to glare.

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17 Requirements for tactile and braille signage can be found in Section 703 of the [USDOJ ADA Standards](https://www.ada.gov).

18 *Clearing Our Path: Letter Size, Type Style and Distance*
Pedestrian signs should be placed in locations that are consistent, predictable, and accessible to people with vision disabilities.

Pedestrian signs are particularly important at decision points, points where people with vision disabilities are likely to have trouble navigating (e.g., because of nonconventional street designs), and points where people with vision disabilities and other pedestrians may need reassurance, such as along a lengthy pathway.

Pedestrian signs should be approachable via a pedestrian access route to a point close enough for pedestrians with a vision disability to access the sign content.

- Signage that provides only visual information should ideally be placed at eye level (approximately 5’ above the walking surface) outside the pedestrian circulation route. However, if the sign protrudes into a pedestrian circulation route more by more than 4”, then it must be 7’ above the walking surface.

- Signage that includes tactile information should be placed at a height of 42” min. to 48” max. The face of the sign must be within 10” reach of a 4’ by 4’ level landing located adjacent to the sign.

- If information on the sign is provided in an audible format, people with vision disabilities must be able to get close enough to trigger and hear the audible message.

Pedestrian signs should be legible to people with vision disabilities from various vantage points, and enough space should be provided near the sign to enable multiple people to view it at once.

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19 Clearing Our Path: Location of Signs
Other Signage

- Street name signs for cross streets along a pedestrian path of travel should be provided at all intersections. Ideally, these signs are visible to a pedestrian with corrected vision of 20/200 in their best eye without having to cross the street at the intersection.

Considerations

- Consider using distinctive sign pole shapes and colors to provide navigational information. For example, poles with a distinctive shape and color can be used as bus stop markers.
- Consider how the location of a sign may impact other roadway users. Section 2D.50 of the MdMUTCD provides guidance on how to locate pedestrian wayfinding signs to avoid confusing drivers.
- Where possible, consider installing pedestrian signs on the same post as motor vehicle signs to reduce the number of posts along a roadway. This may require round or square posts to allow signs to be installed at different orientations.

Mobile Technologies

A variety of mobile technologies exist to assist people with vision disabilities with wayfinding by identifying routes, detecting obstacles, and determining the location of front doors, bus stops, or other destinations. These technologies fall into two basic categories: stand-alone units and smartphone applications.

Stand-alone units are generally more expensive but do not require the user to own or know how to use a smartphone. A common example of a stand-alone unit with GPS is the Victor Reader Trek by Humanware, which can provide turn by turn directions to an exact point, indicate nearest address and direction of travel, etc., though other standalone units have been developed over the past 20-years.

Smartphone applications come in multiple types. Several apps specialize in turn-by-turn navigation for people with vision disabilities, including BlindSquare, WeWalk, Nearby Explorer, and GetThere. These apps rely on information gathered through the phone’s GPS and Bluetooth capabilities as well as crowdsourced information from platforms like FourSquare and OpenStreetMap.

Apps specific to public transit are also available. For example, BlindWays uses crowd-sourced data and Bluetooth beacons to guide users to bus stops and help them avoid nearby obstacles. An app called NaviLens is being piloted by New York City’s Metropolitan Transit Authority to direct users to bus stops...
and navigate train stations. The app translates visual signs to audio and provides information on the bus or train using QR-style codes.\textsuperscript{20}

Some apps connect people with vision disabilities to sighted people. Volunteers or agents then direct the app user through live video calls. Be My Eyes, BeSpecular, and Viz Wiz are examples of this type of app.

Other apps use artificial intelligence (AI) to read text and describe objects through a smartphone camera. Seeing AI, TapTapSee, and Aipoly Vision are examples of this type.

Finally, an app, called PedPal, which is being developed by Carnegie Mellon University with funding from FHWA, uses connected vehicle technology and adaptive traffic signal control systems to enable pedestrians to communicate their crossing time needs and desired crossing direction to traffic signals without having to locate and push a pedestrian pushbutton.

Concerns About Existing Approaches

Many people with vision disabilities find mobile technologies helpful for navigation; however, people with vision disabilities also reported several challenges with these technologies, including:

- Lack of familiarity/comfort with mobile technologies.
- Mobile technologies that rely on GPS mapping are sometimes unable to guide people with vision disabilities to specific destinations such as bus stops and front doors with a high degree of accuracy.
- Difficulty paying attention to mobile technologies while actively navigating the street, such as balancing audible instructions with audible cues from the street or other road users.
- Lack of information about temporary changes to the built environment, such as construction-related sidewalk closures.

Recommended Guidance

- Local governments can do several things to support mobile technologies, including:
  - Publicizing the availability of mobile technologies.
  - Partnering with accessibility services.
  - Supporting data collection for accessibility mapping. Most turn-by-turn navigation apps draw information from web mapping products such as FourSquare, OpenStreetMap, and Google Maps. Transportation agencies can participate in these products to ensure information on points of interest, street design, and transit is up to date. Such participation allows local data to be reflected accurately in multiple accessible mobile apps without having to partner with each app’s developer.
- In the metropolitan region, WMATA is pursuing a Beacon Wayfinding Project that combines Bluetooth beaconing technology with a mobile application to assist customers with disabilities in

\textsuperscript{20} https://www.intelligenttransport.com/transport-news/110722/mta-smartphone-app-blind-low-vision-busriders/
finding Metrobus stops and navigating transit centers and Metrorail stations. Local governments may wish to partner with WMATA in piloting this technology and/or implement a similar technology at bus stops and transit stations in their jurisdiction.

Considerations

- Mobile technologies have benefits for some people with vision disabilities and are increasingly used, particularly by younger people with vision disabilities.
- There are privacy concerns associated with some technologies due to the potential for the capture and resale of personal data to third parties, often for advertising purposes. Most mobile technologies need access to information on the user’s location. While users can clear location data from an app, it can be difficult to do so. Many people often want to store personal addresses long-term. In addition to location information, mobile applications may store and sell audio, image, or video information.
- Privacy concerns can also arise from eavesdropping. Bystanders can see magnified fonts or hear screen readers. This visual or aural eavesdropping can share personal information, such as the app user’s destination, with bystanders.
- Mobile technologies can be expensive and may require users to own devices, such as smartphones, headphones, or smart glasses. Not all people with vision disabilities can afford these expenses.
- Older adults constitute a large and growing portion of people with vision disabilities. Older adults may be less likely to own or feel comfortable using mobile technologies than younger adults, although there are training programs available through the Columbia Lighthouse for the Blind, American Council for the Blind, and other similar organizations.

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21 Metro to launch new app and website to help riders with disabilities navigate rail and bus - The Washington Post
Designs

This section focuses on specific design types, include sidewalk designs, crosswalk designs, and bus stop designs, showing how the process and design tools discussed above can be integrated to create designs that are safer and more accessible to people with vision disabilities. The discussion under each design type includes a description of the tool, a description of concerns expressed by people with vision disabilities about existing approaches, and recommended guidance for consideration by Montgomery County and other jurisdictions in the Metropolitan Washington Region.

Pedestrian Access Routes

Pedestrian access routes (pedestrian access route) are a continuous and unobstructed path of travel provided for pedestrians with disabilities within or coinciding with a pedestrian circulation path in the public right-of-way or in an outdoor public space.25

A distinguishable pedestrian access route is not always provided and can be difficult for people with vision disabilities to find if: a) the pedestrian access route location is not intuitive; b) it blends with adjacent spaces; or c) if it is not made obvious for people with vision disabilities via tactile guidance. A curved or winding pedestrian access route is more difficult for people with vision disabilities to follow and more difficult for frequent users to memorize. People with low vision or night blindness may have difficulty navigating a pedestrian access route at night or in low-light conditions when familiar visual cues, such as the contrasting color of a sidewalk or path, are obscured by darkness.

Recommended Guidance

- A pedestrian access route must be provided within:
  - Sidewalks and other pedestrian circulation paths located in the public right-of-way or outdoor public spaces.
  - Pedestrian street crossings and at-grade rail crossings, including medians and pedestrian refuge islands.
  - Overpasses, underpasses, bridges, and similar structures.
- The pedestrian access route should meet PROWAG requirements for minimum clear width. Additional space is needed to account for doors, awnings, sidewalk cafes, and other obstacles, as well as tactile guidance in complex situations. Additional space can also be helpful to people with vision disabilities to maneuver with a long cane or guide dog, although pedestrian access routes that are extremely wide can pose navigation challenges to people with vision disabilities due to reduced visual, tactile and auditory orientation cues.
- The surface of any pedestrian access route must be firm, stable, and slip resistant, and should meet PROWAG requirements for running slope, cross slope, and vertical changes in level.
- In order to be accessible, a pedestrian access route must be free of all permanent or temporary obstacles such as streetlights, utility poles and equipment cabinets, fire hydrants, sign posts and signs, parking meters, trash receptacles, benches, cafe seating, transit shelters, kiosks, bicycle racks, bicycles, e-scooters, planters and planted trees, bollards, and street sculptures. Objects between 27” and 80” tall must not protrude more than 4” into any portion of the pedestrian access route and must not reduce the clear width required for a pedestrian access route.

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25 PROWAG defines pedestrian circulation path as “a prepared exterior or interior surface provided for pedestrian travel in the public right-of-way.” Pedestrian circulation paths must include a pedestrian access route, but all portions of a pedestrian circulation route are not held to the same standards as the pedestrian access route, e.g., they may contain inaccessible features such as stairs.
• The pedestrian access route must connect to accessible elements, spaces, and facilities in the public right-of-way, such as: pedestrian signals and pedestrian pushbuttons, accessible street furniture, accessible transit stops and transit shelters, accessible on-street parking spaces and parking meters and parking pay stations serving those parking spaces, and accessible passenger loading zones.
• A pedestrian access route in the public right-of-way must connect to accessible routes at building and facility site arrival points.
• Pedestrian access routes should be provided with adequate, even lighting levels. Lighting design and surface materials should not produce glare. See Lighting above for additional detail.
• Pedestrian access routes should be linear and intuitive, avoiding unnecessary zig zags or curves.
• In cases where the path of a pedestrian access route is not intuitive, guidance strips will help people with vision disabilities stay within it. The path of a pedestrian access route may not be intuitive if it is not straight or is not distinguished by other detectable cues, such as a building or edge line.

Sidewalks

Concerns About Existing Approaches
People with vision disabilities report the following challenges/needs with sidewalks:

• Missing sidewalks
• Narrow sidewalks
• Sidewalks with tripping hazards, e.g., vertical heaves, missing bricks, mud, scooters, bicycles, etc.
• Sidewalks with protruding objects, e.g., branches, guy wires, signs, boxes on poles
• Café/restaurant seating obstructing the sidewalk, particularly on narrow sidewalks
• Driveways, curbs, and street corners that are difficult to detect
• Sidewalks that slope toward the roadway
• Sidewalks without landscaped buffers between the sidewalk and street
• Sidewalks without a detectable edge between the sidewalk and a parking area

Figure 31: A person with vision disabilities uses a long white cane to navigate a brick sidewalk. Brick sidewalks can be tripping hazards if the bricks are not well maintained.
Recommended Guidance

Key Dimensions and Characteristics

- Sidewalks should be provided on one or both sides of streets, as specified in the Montgomery County Code and Complete Streets Design Guidelines.
- Sidewalks must contain a pedestrian access route that complies with the guidance in the pedestrian access route section above as well as the width requirements in the Montgomery County Complete Streets Design guide for pedestrian clear zones. Wherever feasible, the pedestrian clear zone should meet or exceed the default clear zone width indicated in the Complete Streets Design Guide. The minimum width is only acceptable if the default width cannot be achieved due to right-of-way constraints.
- Sidewalks should follow the straightest feasible path along the fronts of the adjacent buildings or other destinations. In the case of outdoor public space, sidewalks should generally be parallel to the adjacent street. Sidewalks should not wind in and out or curve unnecessarily.
- The pedestrian access route within the sidewalk should be made of concrete with a brushed finish. In the absence of tactile guidance and delineator strips, adjacent zones should contrast visually and texturally with this surface. Brick sidewalks and pedestrian access routes should generally be avoided due to their tendency to become uneven.

Buffer/Furniture Zone

- Wherever possible, there should be a buffer zone/furniture zone between the sidewalk and travel way.
- Features in the buffer zone should be arranged in a continuous linear fashion. Where possible, elements within the buffer zone should be combined to minimize clutter, e.g., attach signs to light poles.

Bicycle and Scooter Parking

- Freestanding elements like bike racks should be placed outside of the pedestrian circulation path.
- In central business districts and town centers, there should be designated parking locations for dockless shared bicycles and e-scooters that do not conflict with the pedestrian access route. Dockless vehicle operators should be required to deploy to designated parking locations. Dockless vehicle operators should be required to incentivize users to use park in designated locations.

Sidewalk Repair and Maintenance

- A proactive sidewalk inspection and repair program should be established that results in all sidewalks being inspected and repaired on a cyclical basis.
- There should be a quick and efficient process for handling sidewalk safety hazards identified through 311 and other mechanisms in the immediate term, including marking hazardous conditions with high contrast paint.
• Standards should be established to: a) regulate overhanging trees, edging, and protrusions to ensure sidewalk accessibility; and b) clarify property owner related responsibilities. An edging ordinance should require property owners to trim and maintain vegetation along abutting sidewalks as needed to maintain a minimum four- or five-foot clear width. A protrusion ordinance should specify that objects protruding more than four inches into the pedestrian access route must be shorter than 27 inches or taller than 80 inches, or a curb must be built around them.

Considerations
• Consider implementing “no park” and/or “no ride” zones for dockless mobility, especially in areas with high pedestrian activity.

Shared Spaces
A shared space is a space in which the boundary between pedestrian space and vehicular space is blurred to create a flexible and inviting public space that is both safe and comfortable for pedestrians and open to vehicular traffic at reduced speeds. This is accomplished through a range of design features meant to distinguish shared spaces from conventional streets, often including, but not limited to, a lack of curbs and limited or no traffic control devices.

Shared spaces can be streets, intersections, plazas, squares, and other types of spaces. In a shared space, the expectation is that most pedestrians can and will use the entire space, while vehicular traffic may be limited to a shared zone and designated parking and loading/unloading areas.

If shared spaces are not designed to include tactile guidance, then shared spaces can be challenging for people with vision disabilities to navigate, because of the lack conventional cues such as curbs, defined crossing locations, and traffic controls. Unlike conventional streets, with their clearly defined spaces, rules, and controls, interactions on shared spaces are meant to be negotiated, and the means of negotiation is primarily visual—eye contact, nods, gestures. The ambiguity of shared spaces is what causes motorists to slow down and pay more attention, improving safety outcomes.

Recommended Guidance

Engagement
• Since poorly designed shared spaces can create significant navigational challenges for people with vision disabilities, people with a range of vision disabilities, Orientation and Mobility Specialists, and others with expertise on how people with different types of vision disabilities navigate should be actively engaged early in the planning and design process.

Overall Design
• The design of shared spaces should clearly convey to drivers that they are entering a different type of space where pedestrians have priority and drivers must proceed slowly and cautiously. This can be accomplished in a variety of ways (e.g., with paving materials and colors that clearly distinguish the space from the asphalt and concrete used on conventional streets, enclosure, the arrangement of street furniture and trees, and the absence of conventional cues.

Comfort Zone
• Where there is sufficient right-of-way, shared spaces should include a zone that is intended primarily for pedestrians. This zone is referred to as a "comfort zone."26

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26 Where there is insufficient right-of-way for a comfort zone, judgment must be used to determine the best way to make the space accessible to people with vision disabilities.
• Comfort zones must include pedestrian access routes and should generally be provided on both sides of the shared zone. If a comfort zone is only provided on one side, additional consideration should be given to destination access on the side without a comfort zone.
• Delineator strips should be used to mark the boundary between the comfort zone and the shared zone, except at defined crossing locations, in which case a detectable warning surface must be used.
• Guidance strips can be used to help pedestrians with vision disabilities stay within the pedestrian access route. Guidance strips should be used to guide people with vision disabilities to defined crossing locations.
• At transition points between the comfort zone and a conventional street, the design should communicate a clear change in environment (e.g., through a detectable change in surface texture, differently colored pavement/pavers, scale, cross-section, and/or other cues).
• One of the reasons that shared spaces work is due to the ambiguity of the zones. If the shared zone appears like the territory of the motorist, then they will feel ownership and command the space. However, the design needs to inform motorists to not use the comfort zone. That design message can be made through material changes, such as delineator strips, street furniture, street trees, the drainage line (i.e., the lowest part of the shared space that may be indicated by a French drain, valley gutter, brick pattern change, etc.), and/or other elements.

Furniture Zone
• A “furniture zone” is optional and can be used between the shared zone and the pedestrian access route, along the whole route or along parts of the route. The functions of the furniture zone are to provide a place for street trees, signs, fire hydrants, benches, newspaper racks, dining areas, kiosks, etc.
Flush Streets

A flush street is a street without curbs that operates as a conventional street much of the time but can be closed to motorists for festivals, farmers markets, and other activities.

Despite the lack of curbs, flush streets have sidewalks and vehicular travel lanes that are clearly delineated. There are traffic controls and designated crosswalks as on other conventional streets, and pedestrians are expected to use the sidewalk and cross at designated crosswalks, except when the street is closed to vehicular traffic.

If tactile guidance or contrasting furniture zones are not provided, flush streets can be challenging for people with vision disabilities to navigate due to the lack of curbs.

Figure 33: Illustration of how guidance strips, delineator strips and other tactile cues can be used to help pedestrians with vision disabilities stay within the pedestrian access route and find crossings in a shared space or flush street design. The street shown here is a flush street, but the arrangement of tactile cues shown here could also be applied to a shared space.
Recommended Guidance

Engagement

- Since poorly designed shared spaces can create significant navigational challenges for people with vision disabilities, people with a range of vision disabilities, Orientation and Mobility Specialists, and others with expertise on how people with different types of vision disabilities navigate should be actively engaged in the planning and design process.

Sidewalks

- Flush streets must include sidewalks that comply with the guidance in the Sidewalks section above.

Navigational Cues

- Flush streets must incorporate sufficient navigational cues to prevent people with vision disabilities, including people with vision disabilities who are deafblind, from inadvertently crossing from the sidewalk into vehicular lanes when the flush street is not closed to motor vehicle traffic. Cues may be included but are not limited to:
  - A delineator strip or a well-defined, linear buffer/furniture zone defined with landscaped strips, street furniture, and/or a surface textures and colors that contrast with the pedestrian access route on the sidewalk.
  - The use of guidance strips and delineator strips as described in the Shared Space, Guidance Surface, and Delineator strip surface sections above.

Crosswalks

A crosswalk is a zone in a street where pedestrians have the legal right-of-way. Uncontrolled crossings at intersections are legally defined as crosswalks regardless of whether they are marked with crosswalk markings. Crosswalks can exist at midblock locations if they are marked.

Recommended Guidance

- Crosswalks should generally be marked with ladder-style high visibility markings. See High-Visibility Crosswalk Markings above for guidance on location where ladder-style high-visibility crosswalk markings should be prioritized.
- Crosswalks at signalized intersections must be supported by an APS. The pedestrian clearance time should be calculated based on the time needed for a pedestrian standing at the APS...
location to travel across the crosswalk to the opposite side of the traveled way. A walking speed lower than the 3.5 feet per second should be considered for this calculation at locations where there is a higher concentration of people with vision disabilities.

- Where pedestrian signals are provided, they should include an APS.
- Crosswalks should include a pedestrian access route that meets PROWAG requirements, whether marked or not.
- Crosswalks should be straight and either in line with or perpendicular to pedestrian access routes on the sidewalk. They should not be offset from the pedestrian access route on the sidewalk or skewed.
- Crosswalks should be as short as possible to reduce pedestrian exposure to motor vehicle traffic and make it easier for people with vision disabilities to maintain the proper heading to the other side of the crosswalk. Wherever possible, curb extensions should be installed to shorten pedestrian crossing distances and provide space for directional curb ramps aligned with each crossing.
- In cases where crosswalks are long (over 40'), a pedestrian refuge island, crossing delineator strips at the edges of the crosswalk, and/or beaconing APSs should be considered as part of the crosswalk design.
  - Pedestrians refuge islands must be at least 6’ wide and should be channelized (i.e., vertical curbs on both sides) where the pedestrian access route crosses the island. The channelized pedestrian access route on the island should be aligned with the crosswalk and should have detectable warning surfaces at the entry and extend across the entire pedestrian access route per PROWAG.
  - Consider incorporating short ramps that ramp up and down an inch or two at the entry and exit points of the refuge island to further signal to people with vision disabilities that they are on an island and reduce ponding in the refuge area.27
- Measures should be incorporated into the design to encourage drivers to slow down and yield to pedestrians in the crosswalk. Slower motor vehicle speeds also help people with vision disabilities determine when it is safe to cross.

27 This advice comes from NCHRP 834.
Intersection Crosswalks

Concerns About Existing Approaches

People with vision disabilities report the following challenges at intersection crosswalks:

- Locating crosswalks at skewed intersections, T-intersections, and intersections with large curb radii or curb extensions due to the not being in the expected location, e.g., further from the pedestrian path of travel in the case of a curb extension
- Orienting to the crosswalk when the curb ramp does not align with the crosswalk or the corner consists of a wrap-around blended transition
- Determining when it is safe to cross at T-intersections, intersections with channelized turn lanes, and roundabouts (due to the lack of traffic parallel to the crossing)
- Maintaining the correct heading in the crosswalk at T-intersections and intersections with crosswalks that are long and/or skewed

Recommended Guidance

Key Dimensions and Characteristics

- Intersection crosswalks should comply with the guidance above for crosswalks.
- Newly constructed intersections should ideally be designed so that the intersecting streets cross at approximately 90-degree angles.
- Corner radii should be minimized. The Montgomery County Complete Streets Design Guide provides specific guidance about how to minimize corner radii while accommodating the turning needs of vehicles.
- On conventional streets, two directional curb ramps should be provided on each corner. On flush streets, two approaches should be provided.
- If the intersection is signalized, APSs with a locator tone should be installed on each corner.

Figure 35: This crossing of Wayne Avenue at Fenton Street is both relatively long and skewed. In addition, there are wrap-depressed corners at both ends. These characteristics can make it difficult for a person with a vision disability to align properly to and maintain the correct heading when in the crosswalk.
Channelized right turn lanes should be highly discouraged, because they present a number of challenges to pedestrians with vision disabilities, including the challenge, in most cases, of crossing free-flowing motor vehicle traffic, i.e., without signalization or STOP control.\textsuperscript{28} When a leading pedestrian interval is implemented, right turn on red restrictions should be implemented wherever feasible. (Note that leading pedestrian intervals should only be implemented where there is an APS.)

**Skewed Intersections**

- Detectable edges, such as landscaped strips and/or guidance strips, should be used to help people with vision disabilities find the crosswalk location.
- On conventional streets, directional curb ramps should be used to help people with vision disabilities align properly to cross.
- Crosswalk delineator strips and/or beaconing APSs should be used to help people with vision disabilities maintain their heading while in the crosswalk.

**T-Intersections**

- Guidance strips should be used to help people with vision disabilities find crosswalk locations at the top of the T.
- Crosswalk delineator strips and/or beaconing APSs should be used to help people with vision disabilities maintain their heading while in the crosswalk.

**Wrap-Around Depressed Curbs**

- Wrap-around depressed curbs should generally be avoided. When incorporated into an intersection design:
  - Detectable edges and/or guidance strips should be used to help people with vision disabilities find the crosswalk locations and align with the crosswalk.
  - The detectable edges and/or guidance strips used to help people with vision disabilities find the crosswalk location should be coordinated with an APS pushbutton with a tactile arrow (or bollard with a tactile arrow, in the case of an unsignalized crossing with depressed curbs) that is aligned with the crosswalk.
  - Crosswalk delineator strips and/or beaconing APSs should be used to help people with vision disabilities maintain their heading while in the crosswalk.

**Channelized Turn Lanes and Roundabouts**

- Channelized turn lanes should be avoided.
- When incorporated into an intersection design, channelized turn lanes and roundabouts should comply with PROWAG and should comply with NCHRP 834.
- Since poorly designed channelized turn lanes and roundabouts can create significant navigational challenges for people with vision disabilities, people with a range of vision disabilities, Orientation and Mobility Specialists, and others with expertise on how people with different types of vision disabilities navigate should be actively engaged in the planning and design process.

\textsuperscript{28} According to the Montgomery County Complete Streets Design Guide, “Channelized right turn lanes (often called slip lanes) are designed to encourage the uncontrolled flow of right turns at fast speeds. This design is not recommended for Complete Street intersections and removal of existing channelized right turn lanes should be pursued during road reconstruction projects in locations where pedestrians are permitted.”(Bolding in original text.)
In addition, the following key features should be incorporated into the design (Figure 28):

- **Guidance strips** should be used to help people with vision disabilities find the crosswalk locations and align properly to cross.
- **Crosswalk delineator strips** should be used to help people with vision disabilities maintain their heading while in the crosswalk.
- Audible (textured) paving should be considered to make cars audible when exiting the circulatory roadway (roundabout) or entering the channelized turn lane.
- Measures to slow motor vehicle speeds should be included, such as raised crossings and roadway geometry that discourages high-speed turns.

![Illustration of key features of roundabout designs that are accessible to people with vision disabilities, including the use and placement of guidance strips, crosswalk delineator strips, audible paving, and traffic calming.](image)

Figure 36: Illustration of key features of roundabout designs that are accessible to people with vision disabilities, including the use and placement of guidance strips, crosswalk delineator strips, audible paving, and traffic calming.
Midblock Crosswalks

Concerns About Existing Approaches

People with vision disabilities report the following challenges at midblock crosswalks:

- Locating the crosswalk without cues such as cross traffic and curbs perpendicular to the path of travel
- Determining when it is safe to cross due to the lack of parallel traffic sounds
- Safety concerns associated with unsignalized midblock crossings, particularly those where there is more than one travel lane in same direction

Recommended Guidance

- The crosswalk should be designed so that it is straight and perpendicular to the street.
- A guidance strip should be installed to guide people with vision disabilities from the sidewalk to the crosswalk. The guidance strip should:
  - Be at least 2’ wide.
  - Be perpendicular to the pedestrian path of travel on the sidewalk.
  - Extend across the entire pedestrian access route.
  - Connect to the detectable warning surface at the crosswalk.
  - Have a detectable warning surface at the “wrong” end of the guide strip so there is no confusion about the intentional ending of the guide strip (and, in the case of the example in Figure 38, an obstacle/wall).
  - Be coordinated with the location of the APS pushbutton, so that people with vision disabilities can easily find it.
  - Be arranged to provide 3’ of pedestrian clear space to enable wheelchair users to access the crosswalk without having to roll one wheel on top of the guidance strip.
- For conventional streets, directional curb ramps should be installed at each end of the crossing.
- The crosswalk should be marked with high-visibility, ladder-style crosswalk markings.
- Crossing delineator strips should be installed on each side of the crosswalk to reduce the potential for a person with a vision disability to veer outside of the crosswalk.
- If the crossing is uncontrolled, it should be supported with midblock pedestrian crossing signs. Pedestrian crossing signs can improve motor vehicle yielding at midblock crossings and help pedestrians with low vision locate the crossing.
- The crosswalk should be well-lit so that drivers can see pedestrians and pedestrians, including those with disabilities, can see the crosswalk. A vertical illuminance level of 20 lux measured at a height of 1.5 meters (5 feet) from the roadway is recommended.29
- If there is a parking lane, curb extensions should be installed to minimize pedestrian crossing distance, improve visibility between pedestrians and drivers, and encourage driver yielding.

If the crossing involves more than two motor vehicle travel lanes in one direction, a pedestrian hybrid beacon should be installed. Pedestrian hybrid beacons should also be considered at midblock crossings with fewer lanes to improve safety and accessibility.

Bus Stops
Safe, comfortable, and convenient access to bus stops is extremely important for people with vision disabilities. Many people with vision disabilities depend on transit for travel to jobs, shopping, healthcare, education, and other personal needs.

Concerns About Existing Approaches
People with vision disabilities report the following challenges at bus stops:

- Finding stop locations, particularly when located midblock or in urban areas without continuous landscaped buffers between sidewalk and street
- Determining which bus lines are served by a stop
- Determining the correct bus if multiple buses pull up at the same time
- Signs that are difficult to read from a distance
- Lack of audio and tactile signage
- Inadequate lighting
- Vegetation impeding access
- Lack of direct access to nearby destinations via an accessible route
- Changes in bus service (e.g., due to construction)

Recommended Guidance

Key Dimensions and Characteristics

- Bus stops must comply with the 2006 DOT Standards and should comply with PROWAG R308.

Locations and Layouts

- Bus stops should be located at predictable locations near intersections and crosswalks.
- Bus stop layouts should be consistent, understanding that some variation will likely be required due to site specific conditions.

Pedestrian Access Route

- A pedestrian access route complying with the pedestrian access route guidance above must be provided between the bus stop landing pad, the adjacent sidewalk, bus stop amenities, such as shelters and benches, and the closest adjacent crosswalk and/or street crossing.
- Direct pedestrian access routes should also be provided between the bus stop and key destinations within 1/4 mile of the bus stop.

Figure 38: The Utah Transportation Authority new bus stop sign features a blue pole with the octagonal shape that makes it easier for people with vision disabilities to distinguish. (Source: Utah Transportation Authority)
Guidance Strips and Detectable Warning Surfaces

- A guidance strip should be installed perpendicular to the pedestrian path of travel on the sidewalk to alert people with vision disabilities to the presence of the bus stop (similar to those used to indicate midblock crossings). The guidance strip should:
  - Be at least 2’ wide.
  - Extend across the entire pedestrian access route, except for any space needed for detectable warning surface termini.
- The guidance strip should connect to detectable warning surfaces at both ends.
  - One detectable warning surface should indicate the location of the boarding area at the street edge. This detectable warning surface should be 24" wide and 48" long.
  - The other detectable warning surface should indicate the terminus of the guidance strip on the opposite side the pedestrian access route (furthest from the street). This detectable warning surface should be 32” square.
- The guidance strip and detectable warning surface should be installed in a way that minimizes impacts on pedestrians who use wheelchairs and other mobility devices. Specifically, the pedestrian access route between the sidewalk and bus landing should include a minimum width of 3’ that has a smooth surface and is unobstructed by guidance strips.

Bus Stop Signage

- Bus stop signage should comply with the guidance in the signage section and PROWAG R410 and should include a tactile information panel.
- Bus stop signage should be posted between 24” and 36” from the roadway edge. Signage should be posted at a location that can be easily accessed by person with a vision disability standing on the detectable warning surface at the boarding area.
- Bus stop signage should be mounted on a pole that has a distinctive shape and distinctive high-contrast color and is used consistently at all bus stops. The shape and color of the pole can be a helpful tactile cue for people with vision disabilities.
- Consider installing a Bluetooth beaconing system on bus stop sign poles or shelters to help guide people with vision disabilities to the stop and provide information on bus routes served and real time information about upcoming bus arrivals.

Shelters and Amenities

- Bus stop shelters should be considered at all bus stops. In addition to providing a place for transit users to be protected from the weather as they wait, shelters can make bus stops easier for people with vision disabilities to find. For people with low vision, they may be easier to see than bus stop signage. For people who are blind, they may echo sound in a way that helps them locate the stop.
- If the shelter is made of transparent glass, the glass should include high-contrast banding at eye level so that people with vision disabilities do not inadvertently walk into it.
- Glass panels should extend as close to the ground as possible to be cane-detectable and should be of a consistent width from top to bottom to prevent overhead or tripping hazards.
- Other elements of the shelter as well as amenities such as benches and trash receptacles should contrast visually with the walking surface at the stop location, e.g., black or dark green if the walking surface is a light gray concrete.
• Shelters should be well-lit and provide audible and tactile signage and tactile transit maps.
• Street furniture or other amenities located near the bus stop should be cane-detectable, of a visually contrasting color, and located so as not to obstruct accessible use of the stop.

Other Guidance
• Audible announcements should be provided from the transit vehicle for people with vision disabilities waiting on the bus stop landing pad to let them know the vehicle has arrived and the route name.

Floating Bus Stops
Montgomery County has begun installing floating bus stops. Floating bus stops are a bus stop design that is often installed along with separated bike lanes to improve bicyclist safety by reducing bus/bike conflicts and to reduce conflicts between pedestrians, bicyclists, and scooter riders on the sidewalk. The bike lane is routed behind the bus stop, requiring pedestrians to cross a bike lane when traveling to or from the platform where the bus stop is located.

Concerns About Existing Approaches
People with vision disabilities report the following challenges at floating bus stops:
• Additional challenges finding stops due to the location of the platform, which is unexpected and difficult to detect from the sidewalk
• The inconvenience of having to travel across a bike lane to the bus stop platform to determine what bus(es) it serves
• Distinguishing the bike lane from the sidewalk
• Determining when it is safe to cross the bike lane due to the relative silence of bicyclists and scooter riders, and uncertainty they will yield
• Guide dogs not trained to cross bike lanes or pay attention to bikes
• Cyclists coming from two directions (in the case of a two-way separated bike lane)
• Lack of consistency in floating bus stop design
• Lack of familiarity with using a floating bus stop
• Disorientation when disembarking at a floating bus stop
• Lack of shade on the bus platform

Recommended Guidance

Key Dimensions and Characteristics
• Floating bus stops must comply with the 2006 DOT Standards and should comply with PROWAG R308.
• The design of the floating bus stop must provide clear sight lines between pedestrians approaching the bike lane crossings and bicyclists.

Location and Layouts
• Wherever possible, floating bus stops should be integrated with signalized crosswalks supported by APSs.
• Floating bus stop layouts should be consistent, understanding that some variation will likely be required due to site specific conditions.
**One- or two-way separated bike lane?**

- On two-way streets, one-way separated bike lanes on each side of the street should be preferred over a two-way separated bike lane on one side of the street, recognizing that there may be circumstances under which a one-way configuration is not the best solution due to the location of existing bicycle facilities, right-of-way constraints, and other circumstances.

**Guidance Strips and Detectable Warning Surfaces**

- A guidance strip should be installed perpendicular to the pedestrian path of travel on the sidewalk to alert people with vision disabilities to the presence of the bus stop and direct them to the crosswalk optimized for their use (e.g., the signalized crosswalk in case of case of floating bus stop that is integrated with a signalized intersection). The guidance strip should:
  - Be at least 2’ wide.
  - Extend across the entire pedestrian access route, except for any space needed for detectable warning surface termini.
  - Be arranged to provide 3’ of pedestrian clear space to enable wheelchair users to access the crosswalk without having to roll one wheel on top of the guidance strip.
- The guidance strip should connect to detectable warning surfaces at both ends.
  - One detectable warning surface should be located at the edge of the ramp or blended transition per PROWAG.
  - The other detectable warning surface should indicate the terminus of the guidance strip on the opposite side of the pedestrian access route (furthest from the street) or a junction with another guidance strip. This detectable warning surface should be 32” square.
- There should be detectable warning surfaces at both ends of the bike lane crosswalk and at both ends of the street crossing, per PROWAG, if the floating bus stop is integrated with an intersection crossing.
- There should also be detectable warning surfaces at guidance strip junctions and termini as described in Detectable Guidance Surface (Guidance Strips) above.
- Crossing delineator strips should be used on either side of the crossing, across the bike lane and across the travel way.

**Bike Lane Design**

- The bike lane should be colored green for the length of the floating bus stop island to distinguish it from a motor vehicle lane or shared use path.
- Except at designated crosswalk locations, there must be a detectable edge or delineator strip between the sidewalk and bike lane to prevent people with vision disabilities from unintentionally crossing into the bike lane.
- Measures must be implemented on the crosswalk approaches to encourage more predictable bicyclist behavior and yielding. The following measures should be considered:
  - Vertical and horizontal deflection of the bike lane
  - Bike lane narrowing
  - Stop bars or yield markings
  - In-street pedestrian crossing signs
  - 6” solid yellow line positioned between opposing bike traffic (2-way separated bike lanes)
- Consideration should be given to how to make bicyclists more audible to pedestrians with vision disabilities crossing the bike lane, e.g., applying an audible surface to the bike lane on the bike
lane approaches or using passive detection linked to speaker at the crossing that produces a sound when bicyclists are coming.

Crosswalks and APSs

- All crosswalks connecting to a floating bus stop should be high-visibility, ladder-style crosswalks.
- If the floating bus stop is integrated with a crosswalk at a signalized intersection, APSs must be provided on the sidewalk at both ends of the crosswalk. These APSs should provide audible messaging indicating what street the crosswalk crosses and that a floating bus stop is integrated into it, e.g., “The WALK sign is on to cross Fenton Street. This crosswalk includes a floating bus stop serving bus(es) [list of buses served].”
- Depending on the width of the platform, either one or two APSs should be provided in the cut through on the platform. The APSs should be positioned in locations that can be easily reached when in the cut through.
- The APS next to the bike lane should provide audible messaging indicating that the crosswalk crosses a bike lane and what street the bike lane is on, e.g., “The WALK sign is on to cross the bike lane on Fenton Street.”
- The APS next to the street should provide audible messaging indicating what street the crosswalk crosses, e.g., “The WALK sign is on to cross Fenton Street.”
- Consideration should be given to making relatively quiet vehicles such as electric cars and bicycles more audible at unsignalized pedestrian crossing locations. Technologies such as textured/audible pavement or vehicle detection may be used to address this issue.

Platform Design

- The platform should be at least 10’ wide.
- People with vision disabilities should be guided between boarding and alighting locations and the crosswalk(s) optimized for their use by detectable edges, guidance strips, and/or other cues.
- If guidance strips are used, they should be arranged to provide 3’ of pedestrian clear space along the pedestrian access route to enable wheelchair users to follow it without having to roll one wheel on top of the guidance strip. A space measuring 4’ by 4’ that is free of guidance strips is required at locations where people in wheelchairs need to turn.
- The boarding location should be marked by a detectable warning surface located at the street edge. This detectable warning surface should be 24" wide and 48" long.
- Railings at the back of the platform (bike lane side) should be used to channelize pedestrians to designated crossing locations. Railings should be a maximum of 3 feet tall, cane-detectable, and colored to contrast visually with the background color.
- A shy distance of 6” should be provide between the edge of the bike lane and the railing/bus shelter to avoid catching the handlebars of cyclists.
- The height of the platform should generally not exceed 6”. In cases where the platform is higher than the 6” (standard sidewalk height), a detectable warning surface must be placed along the length of the street side of the platform that is not protected by screens or guards.
Shelters and Amenities

- Shelters and amenities associated with floating bus stops should comply with the guidance on [shelters and amenities](#) above.
- If a transit shelter is provided on the platform, the position of the shelter must be carefully considered to preserve site lines between pedestrians approaching the crosswalks serving the bus platform and bicyclists using the separated bike lane.

Signage

- Signage for floating bus stops should comply with the guidance on [bus stop signage](#) above.
- In addition, visual and tactile signage should be provided on the sidewalk to inform people with vision disabilities of the presence of a floating bus stop and the buses it serves. There should be one visual and tactile sign for each crosswalk connecting to the bus stop platform.
- If the floating bus stop is integrated with a signalized crossing, the visual and tactile signage should be co-located with the APSs serving the two crosswalks connecting to the bus platform (i.e., the crosswalk across the bike lane and the crosswalk across the street).
- Signage on the sidewalk should be positioned so that person with a vision disability who follows the guidance strip across the sidewalk can easily reach it from the top of the ramp, if a ramp is provided, or from the detectable warning surface at the crossing.

Figure 39: Preliminary design for a floating bus stop at the intersection of Fenton Street and Ellsworth Drive that illustrating several of the design elements discussed in this section, including guidance strips, detectable warning surfaces, and high-visibility ladder-style crosswalks. NOTE: THIS GRAPHIC WILL BE UPDATED FOR THE FINAL VERSION OF THE TOOLBOX.
Other Guidance

- Audible announcements should be provided from the transit vehicle for people with vision disabilities waiting on the platform to let them know the vehicle has arrived and the route name.
- Audible announcements should be provided for people with vision disabilities inside the bus to inform them of bus stops that are floating bus stops and generally how to navigate the stops, e.g., “Next stop, Ellsworth Drive. This stop is a floating bus stop. Exit right for signalized crossing.”
Appendices
Appendix A: Summary of Key National-Level Guidance Documents

Table 3 provides a list of key national-guidance documents with guidance on accessible design for people with vision disabilities.

*Table 3: Guidance Documents Reviewed—Full Title and Abbreviated Title*

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<thead>
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<tbody>
<tr>
<td><strong>Key Guidance Documents</strong></td>
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<tr>
<td>United States Department of Transportation, Americans with Disabilities Act (ADA) Standards for Transportation Facilities, 2006</td>
<td>DOT ADA Standards</td>
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<tr>
<td>United States Department of Justice, ADA Standards for Accessible Design, 2010</td>
<td>DOJ ADA Standards</td>
</tr>
<tr>
<td>Federal Highway Administration, Manual on Uniform Traffic Control Devices for Streets and Highways, 2009 (with 2012 revisions)</td>
<td>MUTCD</td>
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<tr>
<td><strong>Other National-Level Guidance Documents</strong></td>
<td></td>
</tr>
<tr>
<td>Federal Highway Administration, Accessible Shared Streets: Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities</td>
<td>FHWA Accessible Shared Streets</td>
</tr>
<tr>
<td>Federal Highway Administration, Separated Bike Lane Planning and Design Guide, 2015</td>
<td>FHWA Separated Bike Lane Guide</td>
</tr>
<tr>
<td>Federal Highway Administration, Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts, 2016</td>
<td>FHWA Achieving Multimodal Networks Guide</td>
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## Key Documents

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<tr>
<td>NCHRP Report 672--Roundabouts Informational Guide</td>
<td>NCHRP 672</td>
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<tr>
<td>NCHRP Report 674--Crossing Solutions at Roundabouts and CTLs for Pedestrians with Vision Disabilities</td>
<td>NCHRP 674</td>
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<tr>
<td>NCHRP Report 834--Guidelines for the Application of Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities</td>
<td>NCHRP 834</td>
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<tr>
<td>TCRP Report 175--Guidebook on Pedestrian Crossings of Public Transit Rail Services</td>
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Among the key documents, the *Proposed PROWAG* and *MUTCD* provide the most detailed design guidance on the navigational needs of pedestrians with vision disabilities.

- The *Proposed PROWAG* provides detailed guidance on accessible pedestrian signals, detectable warning surfaces, curb ramps, protruding objects, pedestrian crossing islands, sidewalks, shared use paths, and roundabouts.
- The *MUTCD* provides detailed regulations and recommendations regarding pedestrian signs, crosswalk markings, accessible pedestrian signals, and bicycle facility pavement markings, signs, and signals.

Among the other national-level guidance documents, *FWHA Accessible Shared Streets*, *FHWA Separated Bike Lane Guide*, *AASHTO Ped Guide*, *NACTO Urban Street Design Guide*, *NCHRP 672*, *NCHRP 834*, and *TCRP 175* provide the most relevant guidance.

- *FHWA Accessible Shared Streets* provides guidance on how to design shared spaces for people with vision disabilities. It also provides general guidance on the use of the detectable guidance surface, which is called a “directional indicator” in the text.
- The *FHWA Separated Bike Lane Guide* provides guidance regarding the design of separated bike lanes, including general considerations for pedestrians with vision disabilities.
- The *AASHTO Ped Guide* provides a general description of the characteristics and needs of pedestrians with vision disabilities and includes guidance on crosswalks, curb ramps, midblock crossings, and roundabouts.
- Among the reviewed guidance documents, the *NACTO Urban Street Design Guide* provides the only guidance that addresses streets where pedestrians, bicyclists, and motor vehicles are intended to share space, including general considerations for pedestrians with vision disabilities.
• *NCHRP 672* provides guidance about the design of bike ramps at roundabouts and recommendations related to pedestrian refuge island and median cut-through design, some of which have been further investigated and changed as a result of *NCHRP 834*.

• *NCHRP 834* addresses navigational issues for pedestrians who are blind at roundabouts and channelized turn lanes (CTLs) with a chapter discussing issues and photos of potential solutions. *NCHRP 834* also includes a chapter of design checks related to wayfinding, some of which is transferable to other types of complex intersections.

• *TCRP 175* includes a case study on how to accommodate pedestrians with vision disabilities when designing transit platforms that are in the middle of the street. This information may also be helpful in considering the design of floating bus islands.
Appendix B: Design Examples

To be provided in final document
Appendix C: Guidance for Temporary Changes
To be provided in final document
Appendix D: Engagement Best Practices
To be provided in final document
Appendix E: Meeting Materials and Transcript
To be provided in final document
Appendix F: Survey Results