



SUMMARY REPORT

September 2007



Sidewalks and Shared-Use Paths: Safety, Security, and Maintenance

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PREFACE AND ACKNOWLEDGMENTS

As director of the Insitute for Public Administration (IPA) at the University of Delaware, I am pleased to provide this report, Sidewalks and Shared-Use Paths: Safety, Security and Maintenance. This report has been a multi-stage process, including a literature review looking at best practices and interviews of professionals across the country, culminating in a policy forum. Based on the results from the three stages, this report seeks to provide answers to the current problems of safety, security, and maintenance associated with multi-modal facilities and to add the exisiting discussion of improving multi-modal facilities.

I would like to take this opportunity to acknowledge the many people who helped with the policy forum and the production of this report. Project manager Ed O'Donnell coordinated the entire process and was involved with the planning, research, and writing. Consultant Lorene Athey and research assistant Drew Knab spearheaded the literature review, identified professionals across the country to interview regarding their policies on these topics, coordinated the policy forum, and wrote the document. Mark Deshon designed the graphics and handouts for the policy forum, aided in its coordination, and managed the podcasting of the policy forum. Lisa Moreland provided excellent editorial support. Richard Nietubicz typed the edits for the report.

In addition to the project team's efforts, IPA staff member Wanda Moore provided invaluable logistical support; without her, the policy forum would not have been such a success. Staff member Nelcenia Downer provided additional support. Research assistants, Megan Lehman, Shelley Cook, Ezra Temko, Nick Walls, Melissa Zechiel, Cori Burbach, and Emily Poag also assisted at the policy forum.

Finally, I would like thank our keynote speaker Robert Searns, AICP, who not only gave an excellent keynote address, but also gave valuable input into the process. Also deserving are the 13 interviewees who sacrificed their time to provide the project team with professional advice, innovative ideas, and past policies.

Dr. Jerome R. Lewis, Director
Insitute for Public Administration

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EXECUTIVE SUMMARY

The results of Delaware's Statewide Comprehensive Outdoor Plan (SCORP) 2003-2008 telephone survey revealed Delawareans' commitment to outdoor facilities, especially sidewalks and shared-use paths. Eighty-eight percent of households surveyed indicated that walking or jogging are activities in which they will participate in the next twelve months, and sixty-four percent of households listed bicycling (Ehemen 3-2). Moreover, demand analysis of the state's needs and public's preferences rated the increasing of the number of linear facilities such as sidewalks and shared-use paths as the top priority (Ehemen 5-2). As these facilities continue to be built and become increasingly utilized as a transportation mode, the issues of safety, security, and maintenance are emerging as major issues.

The unfolding of Governor Minner's Livable Delaware Initiative has focused on mitigating the effects of sprawl and encouraging pedestrian-friendly design, which has also increased the demand for multi-modal facilities. Moreover, the expansion of multi-modal facilities has fostered the concept of seeing these facilities in the dual roles of transportation and recreational purposes. In the article *Bicyclists and Pedestrians Belong!*, Edward T. McMahon on page 13 notes that in the sprawling Chicago metropolitan area, the U.S. Department of Transportation found that "census zones, where five linear trails exist averaged almost 16% of commuter trips by bicycle, compared to only 1% for the region as a whole" (McMahon 13).

This project was undertaken with the support of the Delaware Department of Transportation, to analyze the safety, security, and maintenance of multi-modal facilities—both on- and off-road. Specific attention was directed toward accessibility issues and snow removal. In order to adequately examine these issues, the project proceeded in three stages. First, an extensive literature review was conducted. Second, 13 experts and professionals were identified and interviewed on these topics from a total of eight states across the country. Following the completion of the literature reviews and interviews, a policy forum was held on March 21, 2007, on the University of Delaware's campus at Clayton Hall. Approximately 60 invitees attended, including state and local police, city managers, and agency staff responsible for sidewalks and shared-use paths throughout the state. Three breakout sessions on safety, security, and maintenance were utilized to provide the project team with an "events on the ground" perspective and identify solutions. A nationally recognized expert on greenways and trails, Robert Searns, AICP, presented the keynote address. This executive summary seeks to provide a brief synopsis of the key findings and recommendations from the literature review, interviews, and policy forum. More extensive information can be found in the full report and appendices.

After completing the literature search and the interviews, the project team sought to clarify the definitions of safety, security, and maintenance as they relate to sidewalks and shared-use paths. However, for the purpose of this report it is necessary to first define sidewalks and shared-use paths:

Sidewalks: paved walkways typically running parallel to a roadway. This report considers crosswalks as part of the sidewalk system.

Shared-Use Paths: paved or unpaved facility used by a range of non-motorized travelers. Generally these paths are most frequently used by bicyclists, but are also by runners, joggers, and roller-skaters (Hummer 1). It is important to note that throughout this report the terms “trails” and “shared-use paths” are used interchangeably.

Three major definitions were developed in order to define safety, security, and maintenance:

Part I of this report examines the issue of security by analyzing common security incidents on trail or sidewalk facilities, problems with perceptions of security among users and the public, and vandalism-related facilities. As two interviewees noted, there is no way to ensure total security on trail facilities, but governments and agencies can enhance security (Bustos; G. Smith). Secure facilities are those that reduce the risk of security incidents and the fear of potential incidents through educational efforts directed at users, design, and management policies that increase the number of users on the facility and provide adequate visibility.

The issue of safety is explored through several different viewpoints in this report. Safe sidewalks and shared-use paths are designed and managed to reduce the risk of injury to pedestrians and other users of the facility. This means safe facilities are constructed and maintained to provide a safe environment for all ages and skill levels. Part II of this report, the safety section, examines common problems plaguing the current sidewalk and shared-use path system: facilities that are not compliant with the Americans with Disabilities Act of 1990 and are difficult for older and disabled individuals to travel on; design flaws or policies (or lack thereof) that increase the chances of user conflicts (i.e., bicycle-on-bicycle collisions or bicycle and pedestrian collisions); and conflicts between vehicles and pedestrians.

The issue of maintenance is related to both the security and safety of facilities. Maintained facilities are in good repair, accessible, and regularly inspected. Part III of the paper explores routine maintenance tasks and the use of volunteers and equipment and also specifically addresses the problem of snow removal on sidewalks and shared-use paths. Additional attention is given to the problem of sidewalk repairs and long-term maintenance needs. Unsurprisingly, both the interviews and literature review revealed that the higher the quality of initial design and construction, the less maintenance the facility will require.

PRIMARY FINDINGS AND ISSUES

This section will discuss the major issues facing sidewalks and shared-use paths based on the interviews and literature review.

SAFETY

1. Accessibility Issues Exist on Both Sidewalks and Shared-Use Paths

According to the 2000 U.S. Census, 49 million or 19.3 percent Americans have a disability, and the population of citizens 65 and older is also growing. Interviewees picked up on this trend, as they commented that there is an increasing demand for ADA-accessible facilities. They also noted that changes to address ADA issues have been well received among users of their facilities (Beaver; G. Smith). ADA issues related to sidewalks include proper design with handicapped ramps, correct slopes, and detectable warnings. For the most part, jurisdictions are improving accessible sidewalk design, but improvements tend to be completed within the context of other maintenance projects and/or in response to complaints. As a result, most jurisdictions still have many sidewalks that are not up to current standards, especially in residential areas.

Facilities should be designed with safety and accessibility in mind. ADA is concerned about safety for disabled users, but too frequently agencies design to the minimum standards. Facilities should be designed to be safe and useable for all users including children and elderly people, not just ADA users (Horton).

2. Pedestrian Safety Conflicts

The most common and deadly user conflict related to sidewalks and pedestrian networks involves motor vehicles. Pedestrian crash statistics reveal some important insights into current problems. Page 20 of this report contains a summary of many important national statistics, however the primary findings are: (1) September through January is the time period in which the highest amount of pedestrian fatalities occur due to less daylight and more dangerous weather conditions; (2) a pedestrian hit by a car traveling 40 miles per hour has a 85 percent chance of being killed, a 45 percent chance at 30 mph, and a 5 percent chance at 20 mph; and (3) five to nine year-olds have the highest crash involvement rates, and over 20 percent of accidents involving older pedestrians result in death (Harkey and Zegeer 7-10). Also, vehicle speed is more dangerous to pedestrians than traffic volume, therefore speed should be addressed first (Zegeer et al. 66). Faster speeds increase the chances of a pedestrian being hit and pedestrian injuries are less frequent and less severe on lower speed roadways (Zegeer et al. 65). Please refer to page 23 for specific findings on pedestrian crossing treatments.

3. User Conflicts

According to a Federal Highway Administration (FHWA) report, user conflicts on trails are the result of differences in skill, movement patterns, and speed. The greater the differences, the more likely an accident will occur. Different user groups have dissimilar movement patterns (i.e., rollerbladers need more space for their movements than bicyclists and walkers). User conflicts on trails are often the result of crowded conditions as well as different user groups with different speeds and skills such as bicyclists, walkers, joggers, and other user groups (Moore 1). Issues related to shared-use paths and safety incidents include: (1) collisions or users attempting to avoid potential collisions, (2) unsafe user behavior, (3) low-level user skill or poor user

judgment, (4) dangerous conditions on the trail such as rain, snow, or physical obstacles (5) poor trail design, construction, or maintenance, and (6) speed of road bike users (Woodcock; Moore 1). Furthermore, user conflicts often go unreported, which leads to managers being unaware of situations creating conflicts until a serious incident occurs (Collins).

4. Signage

Signs provide us with directions and needed information. Edward McMahon states that too often signs are oversized, poorly planned, badly located, and altogether too numerous. A profusion of signs is as confusing as an absence of them. A good sign communicates its message clearly and quickly, is compatible with its surroundings, and enhances the visual image of the community. When the streetscape or trail becomes overloaded with signs, the cumulative effect is negative; the viewer actually sees less, not more (McMahon et al.). Visual clutter impairs wayfinding ability (Zelinka and Brennan 33). Signage or other means should be used to provide trail information related to slopes, grades, potential obstacles, cross-slope, and surface type. This enables users to select the most appropriate route for their user level. This information needs to be posted at the beginning of the trail, before a disabled person enters and has to turn back (Horton). Frequently, trails only provide basic information on destinations along the route and usage guidelines, which leaves disabled, elderly, or less skilled users with insufficient information over the appropriate route (Kirschbaum et al. 83; Kirschbaum et al. 6-2).

5. Uniform Guidelines and Consistency: Sidewalks and Trails

Many county and municipal codes are not in full compliance with ADA, therefore new facilities are still being built that do not comply (Waterland). Moreover, since there is no master design guide for sidewalks, many municipalities and states have adopted their own design standards. They have relied upon the Institute of Transportation Engineers, Americans with Disabilities Act Accessibility Guidelines (ADAAG) Public Right-of-Way Guidelines, and the American Association of State Highway and Transportation Officials (AASHTO) Green Book as sources for design standards. When agencies select or develop design standards for shared-use paths, they should create design standards with flexibility as shared-use paths often cross unique topographical and natural areas. When developing design standards, agencies should avoid rigid standards without exceptions as this may cause trail managers to ignore all guidelines or standards where their trails cannot meet standards in any conceivable manner (Kirschbaum et al. 75-77). Most sources recommend using the *AASHTO Guide for the Development of Bicycle Facilities* (Pedestrian and Bicycle Information Center; Ross). Also, it was recommended that private developers and other institutions be required to build to the same standards, especially ADA, because they can be considered public-right-of-ways with inherent liability (Reitmayer et al. 22).

SECURITY

1. Fear of Crime and Appearance

Even when reported data indicate that a facility has experienced almost no incidents of criminal activity, public perception of crime may lead to the avoidance of the facility. Research has shown that fear of crime is higher for women than men, and women are more likely to avoid walking after dark. Physical factors such as litter, poorly maintained buildings, and graffiti as well as social influences like publicly intoxicated individuals, homeless people, and groups of youth all affect an individual's perception of risk. Studies have also found that a lack of

familiarity with an area and dark areas create an increased fear of crime (Loukaitou-Sideris 222-24).

2. *Misconceptions over Trail Security*

In their article, *Rail-Trails and Safe Communities: The Experience on 372 Trails* (1998), Tammy Tracy and Hugh Morris address many misconceptions concerning trail security. Their research revealed that crime rates are lower on trail networks than the overall crime rate for the region in which they are located, whether urban, suburban, or rural. The authors also discovered that in many cases the trail networks reduced minor crimes such as graffiti and vandalism. Worth noting, however, was that although there were differences among urban, suburban, and rural trails in terms of graffiti (26 percent reported in urban areas compared to 17 percent in suburban and 12 percent in rural areas) there was virtually no difference between urban, suburban, and rural related to incidents of littering and sign damage (Tracy and Morris 5).

3. *Trailheads Most Common Places of Criminal Activity*

In his article “Community Greenways,” Joseph Murray has investigated security issues linked to trails. He notes that trailhead parking lots are well-known as the most common locations for criminal activity within trail systems according to surveys of law enforcement officials (Murray 1). State and local police officers present at the security breakout session seconded Murray’s observation that trailheads were the most common areas for criminal activity.

4. *Facilities with More Users Have Fewer Security Issues*

Another important component of security is “eyes,” in other words, the more people present, the less likelihood of criminal activity. To that end, the design of sidewalks and multi-use paths should create a pleasant environment where people want to spend time. Interviewees found that heavily used facilities experience less crime (Woodcock).

5. *Technology Not Always the Answer to Security Issues*

Although some experts recommend the use of cameras, emergency phones, and call boxes, most of our interviewees (Ross; Woodcock; Bustos; G. Smith; Pauley) did not consider them to be especially helpful in most cases. Emergency phones can provide peace of mind to users, although they are rarely used. (Bustos). Two interviewees noted the difficulty in installing phones in remote areas and the proliferation of cell phones as reasons for not using emergency phones (G. Smith; Beaver). Another interviewee (Saltreli) noted that his jurisdiction had some call boxes, but they had to be removed due to graffiti problems. Cameras may have some limited uses, but are very costly to install, maintain, and operate. One interviewee (Saltreli) believed that cameras can create a false sense of security, for example, if a camera is broken. In addition, someone needs to monitor the cameras and respond to problems, or be exposed to legal liability.

MAINTENANCE

1. *Deficient Maintenance Practices Negatively Affect Safety and Security*

Without appropriate maintenance practices, the safety and security of users is at a higher level of risk. Poor maintenance practices that allow graffiti, trash, and general disrepair sends the signal that nobody cares or is watching (Zelinka and Brennan). In addition, quality maintenance practices will reduce incidents of litter, graffiti, and vandalism (Tracy and Morris 10). The most

common ADA complaints relate to sidewalk maintenance: cracks, holes, loose gravel (Hodges). Poor sidewalk surfaces such as swelling, cracking, and other repair issues are ADA problems (United States Access Board 51). Also, poor maintenance practices can lead to dangerous conditions on the trail such as rain, snow, or physical obstacles, which have been linked to causing user conflicts (Moore 24)

2. Responsibility and Coordination

Confusion over which entity (agency, private business, or homeowner) and which level of government (local or state) are responsible for the maintenance of sidewalks and shared-use paths exists in many jurisdictions. This problem was expressed in the safety breakout session, specifically in regard to the maintenance of sidewalks and curb ramps. However, the literature review also revealed that frequently there are issues with shared-use paths managed by multiple jurisdictions. Determining who is responsible for maintenance issues like vegetation management, snow removal, and sign replacement is critical for providing a safe and secure facility. Memorandums of understanding between governmental entities should be drafted, followed, and updated as necessary to ensure there is clear responsibility for specific facilities and, if necessary, coordination between governmental entities. In Delaware, determining responsibility for sidewalks and trails can be very difficult, and government entities may need to be educated regarding their specific responsibilities. Through our interviews with several state officials it became apparent there is a serious confusion over specific responsibilities:

- Often, no one really knows who is responsible for a particular facility, such as around DART bus stops. Responsibility depends on the location and circumstances. In addition, the party responsible for enforcement may not be the party responsible for design (Hodges).
- Questions over responsibility for mixed-use facilities and residential areas are inherently difficult because they may be private facilities that are not covered by ADA. However, the right-of-way (trails, paths, sidewalks) is public and therefore covered (Horton).
- Questions regularly arise over who is legally responsible for sidewalk maintenance and repair. Most ADA complaints are the result of non-compliant design, incorrect implementation, or lack of maintenance (Waterland).
- It is very confusing to determine who is legally responsible for trails and paths (Hodges).
- In Delaware there is a lack of awareness on the part of governments regarding their responsibilities and the design and maintenance standards required by ADA. There is a great need for the people who write regulations and review and inspect development to be trained or educated so that they understand the standards and specifications that are applicable (Waterland).

3. Snow Removal

An article by Andy Briscoe in the spring issue of the *Salt and Highway Newsletter* provides evidence that agencies that ignore snow maintenance related to sidewalks and pedestrian facilities can face potentially serious litigation. According to a Salt Institute survey, some municipalities and cities designate agencies responsible for snow maintenance of sidewalks but most require homeowners to clear sidewalks:

- Eighty-three percent of the agencies surveyed have a written policy requiring homeowners to remove snow within 24 hours after the end of a snowstorm.

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- Seventy percent of the agencies surveyed do not issue tickets to property owners who fail to remove ice and snow from their sidewalks.
- Fifty-eight percent of the agencies surveyed have been sued for a sidewalk incident (Briscoe 1).

According to Cottrell in *Evaluating and Improving Pedestrian Safety in Utah*, the failure to remove snow on sidewalks and shoulders creates multiple safety hazards for pedestrians. Sidewalks that have not been cleared force pedestrians to either use the facility in unsafe conditions (frequent slips and falls) or to walk in the street. Crosswalks and curb ramps are frequently blocked by snow either because it is dumped by plows or because neither the homeowner nor the snow crews clear it (Cottrell 23).

How a jurisdiction handles snow removal from sidewalks and paved shared-use paths is also an ADA issue. Snow removal is treated differently because of its temporary nature and because responsibility for clearing the snow is diffused. However, there is a legal obligation to remove snow within a reasonable period of time (Horton). Most jurisdictions need to have a plan in place to do it, and snow removal programs must include clearing curb ramps (United States Access Board 51). Snow-blocked curb ramps due to plowing are an ADA issue (Horton). ADA complaints and issues related to snow removal involve response times and proper clearing:

- Many complaints are received when snow is plowed into handicapped parking spaces for storage (Horton).
- Many snow removal complaints come from residential areas, such as apartment buildings. If management does not clear sidewalks or parking lots, disabled individuals may be imprisoned in their apartments. Many more do not complain because they are afraid of possible negative repercussions (Waterland).
- Snow-blocked curb cuts due to plowing are an ADA issue (Horton).

4. Pavement

The most common ADA complaints relate to sidewalk maintenance: cracks, holes, loose gravel (Hodges). Frequent sidewalk problems include step separation (vertical displacement of 0.5 inches or greater), badly cracked concrete (holes and rough spots wider than 0.5 inches), spalled areas (crumbling or flaking concrete), depressions that trap water (depressions, reverse cross-slopes, indentations), and tree root damage (Kirschbaum et al. 66-68). Typical shared-use path maintenance issues are virtually identical to sidewalks including step separation, badly cracked pavement, settled areas that trap water, tree root damage, and vegetation overgrowth (Kirschbaum et al. 66-68).

RECOMMENDATIONS

After an intensive literature search, interviews with over 13 professionals in the field, and a policy forum featuring breakout sessions on safety, security, and maintenance, a list of critical and important recommendations have been compiled. The recommendations have been broken down into four key areas: design, safety, security and maintenance. As noted at the policy forum and in the paper, safety, security, and maintenance are all interconnected; neglecting one area affects all three. It is important to realize how strategies toward one area affect others. For example, increased trail patrols for security purposes can also increase the level of maintenance and assist in safety incidents. Conversely, a lack of maintenance can create security and safety issues. Although this paper contains many recommendations throughout, this section seeks to highlight the recommendations that are the most critical. The following recommendations are not comprehensive nor are they a substitute for reading the report. However, they provide a list of recommendations that agencies can implement to improve the safety, security, and maintenance of their facilities. More specific details on the recommendations can be found in the relevant sections of the report.

DESIGN

Tight budgets and timelines can lead to lower quality design and construction. However, the difficulty of finding and receiving additional funding for issues is well-noted and thus the likelihood that facilities will receive additional funding to correct or improve their facilities in the near future is unlikely. Therefore, managing agencies and governments who are designing constructing sidewalks or shared-use paths should subscribe to several principles.

- ***Building Quality Facilities***
 1. Treat sidewalks and shared-use paths as the transportation facilities they are.
 2. Design and construct facilities to the highest standards and correctly the first time.
 3. Ensure designers are trained in bicycle and pedestrian design.
 4. Adopt uniform statewide standards that incorporate ADA guidelines and requirements.
 5. Incorporate quality control into the construction process to ensure that the facility designed is the facility that is built. Particular attention should be given to accessibility issues such as grades and slopes.
- ***Well-Designed Facilities for All Users***
 1. Design for safety first. (Keep safety in mind throughout facility design.)
 2. Design for all users. Assume a range of skill levels and different groups of users will be utilizing the facility.
- ***Shared-Use Path Design***
 1. Design for visibility—design so users can see the environment around them, and so users can be seen by others. Also, carefully select vegetation for design and maintenance characteristics (Murray). (In other words, avoid dense brush alongside trails.)
 2. Minimize the number of street crossings on a shared-use paths facilities—paying special attention to path and intersection crossings, especially sight distances approaching intersections
 3. Provide markings that separate user groups on crowded facilities or facilities that are expected to attract a range of users (see Picture 1, Appendix C).
 4. Apply highway design standards and techniques such as sight and stopping distances

SAFETY

The importance of providing facilities that are safe for all user groups—from young children to the elderly and disabled—provides benefits not only to the aforementioned groups but all users as facilities built to higher standards benefit all types of users. The safety recommendations are divided into three categories: sidewalk and pedestrian safety, shared-use path safety, and ADA.

Sidewalk and Pedestrian Safety

- ***Management and Policy Priorities***
 1. Direct efforts toward speed reduction as speed, not traffic volume, is correlated with higher numbers of pedestrian fatalities and injuries.
 2. Improve pedestrian safety with a triangulation of efforts directed at decreasing vehicle speed and increase pedestrian visibility. This means taking a comprehensive approach to pedestrian safety: education, enforcement (i.e., speeding drivers), and design.
 3. Reevaluate and improve existing signage throughout your jurisdiction from the pedestrian and motorist viewpoint. Check to make sure signs are correctly located, easy to understand, and not cluttered by other signs or obscured by other objects.
- ***Education Efforts***
 1. Pedestrian education efforts on such issues as safe crossing practices should increase before summer months and once again before September since pedestrian crashes increase during summer and winter (see page 16).
 2. Specific education efforts should be targeted towards transit users as they are frequent pedestrians (i.e., safety warnings and signage near transit stops or on transit vehicles).
 3. Create a safety committee comprised of local officials that holds workshops and distributes literature on proper pedestrian safety movements.

Shared-Use Path Safety

- ***Education and Signage***
 1. Provide signage and information regarding surface material, grade, obstacles, and known safety issues at trailheads and connection points to different networks. This will allow individuals to select facilities that are best suited to their abilities.
 2. Ensure all forms of signage meet the Manual on Uniform Traffic Control Devices (MUTCD) standards and are uniform throughout systems.
 3. Types of signage should include directional, safety, informational, and trail etiquettes.
- ***Policy Responses to Safety Issues on Shared-Use Paths***
 1. Employ design changes—separate users using different surface materials or provide medians—if user conflicts become a problems.
 2. Use signage and educational efforts to direct users to the appropriate facilities for their particular use.

SECURITY

Once again, there is no way to “ensure” security on any transportation facility. However, there are many strategies agencies can utilize to enhance it. The following list of recommendations involves three overarching principles: communication, coordination, and education. The literature search and interviews revealed that security problems frequently can be solved by employing strategies based on these principles. For example, when both police agencies and the responsible trail agencies are involved cooperative approaches can increase the likelihood of reducing the threat or increasing the effectiveness of the response (i.e., police increasing patrols and the responsible agency making design changes). Communication also involves sharing important data regarding different facilities. The principle of education reflects the need to educate and reinforce important security precautions that can help enhance security on the trail (i.e., encouraging and reminding individuals not to travel alone in remote areas). The following recommendations reflect these principles and can produce immediate benefits in security-related issues:

- ***Programming Efforts***
 1. Encourage police patrols or establish volunteer trail patrols to increase “eyes on the facility.”
 2. Program and hold events at the facility to increase users and demonstrate security of the facility.
 3. Direct education efforts towards trail and exercise groups to reinforce security practices (such as using facilities during daylight hours or hiding valuables).
- ***Management Practices***
 1. Implement anti-vandalism techniques such as quick removal (i.e. removing graffiti three times within 72 hours) and follow target-hardening techniques (page 7 of this report).
 2. Improve lighting and patrols of trailhead areas.
 3. Provide general orientation signage that indicates distances to exits and entrances.
 4. Only install cameras and other technologies when other methods fail to reduce a problem and if appropriate resources are available to staff and repair them.
 5. Encourage police to complete paperwork in between responses or duties at trailheads and parking lot areas. This presence will deter illegal activity.
 6. Identify an individual as a police liaison to share data and information with police and coordinate efforts.

MAINTENANCE

The issue of maintenance on pedestrian facilities is developing into a significant issue. Moreover, maintenance impacts both safety and security of users on the facility. Poor maintenance practices involving vegetation removal can create security issues, and poorly maintained surfaces can lead to serious injuries or collisions. In addition, maintenance also affects perception of these facilities and their use. The lower the level of maintenance, the higher the likelihood the facility will be underutilized. Snow removal is also a critical maintenance concern in many communities. These recommendations seek to guide agencies and municipalities on different practices for improving their maintenance operations. In our interviews and literature review, our project team became aware of the cost and personnel time required to accomplish quality maintenance. One major recommendation that was included in

multiple sources was the need to institute regular inspections of facilities and implement an easy system for users to report problems and complaints. For example, the Municipality of Anchorage has an online reporting system for users that can report maintenance issues such as downed trees, burned-out lighting, or security problems such as vandalism or suspicious behavior (Municipality of Anchorage, Trail Watch Program, Submittal Form). The level of financial investment required for quality maintenance should not be overlooked. The following recommendations are divided by snow removal and routine maintenance:

- ***Snow Removal***
 1. Develop a snow removal plan for pedestrian facilities and prioritize responses by: pedestrian traffic, high densities of elderly or disabled, schools, transit areas, and other highly trafficked routes.
 2. Develop a cost-share program with local businesses to have sidewalks in central business districts uniformly cleared.
 3. Construct new and retrofitted sidewalks with buffers or planter zones of at least 2 to 5 feet that can accommodate snow storage during the winter.
 4. Adopt and annually review memorandums of understanding between agencies before winter months to clarify who is responsible for specific areas.
- ***Routine Maintenance—Shared-Use Paths***
 1. Provide agencies with management and maintenance manuals on their regular inspections and maintenance operations with maintenance standards specified (i.e., vegetation shall not encroach within 5 feet of either side of the trail).
 2. Provide ample number of litter containers and empty on a regular schedule.
 3. Create a volunteer maintenance patrol trained by appropriate staff if funding is an issue.
 4. Include an overall maintenance policy should include the following six aspects: trail inspections, vegetation maintenance, tread maintenance, drainage maintenance, structure maintenance, and sign maintenance (Parson Bartholomew and Associates, Inc.)
- ***Routine Maintenance—Sidewalk Systems***
 1. Conduct regular inspections to identify trip hazards, cracks, and other surface problems.
 2. Use GIS or other technology systems to efficiently conduct annual inspections and repairs.
 3. Identify areas that are frequented with litter and debris.

CONCLUSION

In addition to these findings and recommendations, please review the summaries of the breakout sessions and specific sections of the paper to examine them in further depth. Through examining these issues it became quite apparent that in order to continue to improve multimodal facilities and the walkability of our communities, more funding for these areas will need to be provided. As with any set of recommendations, there are costs associated with them. However, improvements can also be made without the large costs. For example, employing volunteer groups and calling upon the community to assist with the complex issues of safety, security, and maintenance cannot only solve simple issues like vegetation overgrowth, but also more complex issues such as pedestrian fatalities on shared-use path and roadway crossings. Moreover, engaging the community on issues like safety and security is a major component of a comprehensive response. Regardless, responsible agencies and governments building these facilities should construct the facilities to the best possible standard and have appropriate safety,

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security, and maintenance plans formulated before construction begins. We hope this report provides answers to subjects that have frequently been overlooked or ignored, and we also hope it sparks communities, agencies, and governments to reexamine existing policies.

INTRODUCTION

Edward T. McMahon, in *Better Models for Development in Delaware: Ideas for Creating More Livable and Prosperous Communities*, notes that many studies demonstrate that walking trails and bicycle paths increase nearby property values. In turn, increased property values can increase local tax revenues. Greenways often provide new business opportunities and locations for commercial activities such as bed and breakfasts, recreation equipment rentals and sales, and other related businesses.

In the article *Bicyclists and Pedestrians Belong!*, Edward T. McMahon on page 13 notes that in the sprawling Chicago metropolitan area, the U.S. Department of Transportation found that “census zones, where five linear trails exist averaged almost 16% of commuter trips by bicycle, compared to only 1% for the region as a whole.” (McMahon 13).

Tim Bustos, former bike/pedestrian coordinator for the City of Davis, California, noted that bicycle and multi-use facilities can be a real boon to a community. One advantage is reducing crime rates. As more people use the facility, there are fewer problems with crime. Another advantage is economic development opportunities. These facilities are also a nice community amenity that improves property values because people want to live near them. Bob Searns, AICP, noted in his presentation at the Sidewalks and Shared-Use Paths: Safety, Security and Maintenance Policy Forum at the University of Delaware that trails are in higher demand than golf courses, parks, exercise rooms, and pools as the number one outdoor amenity according to a 2006 National Homebuilders Association Survey.

Like other modes of travel, as sidewalks and shared-use paths continue to be built questions arise over the safety, security, and maintenance of the facilities. This paper takes an in-depth examination of these three issues. Before discussing these three principle issues in more depth, it is important to clarify their definitions. In this paper, safety is defined as protection from the risk of injury, design hazards, and conflicts. This primarily involves such issues as conflicts between users and automobiles, pedestrian crossing issues, emergency response issues, and the provision of a safe environment for all users. Security is defined as freedom from the occurrence or fear of criminal activity. Security issues explored in this issue are security-related design issues, strategies to enhance the security of users, and appearance-related problems such as vandalism. Maintenance is defined as keeping facilities in good repair and up to proper standards in order to provide dependable access, safety, and security. As result of exploring these methods we also spent considerable effort examining issues related to the Americans with Disabilities Act of 1990 (ADA) and the issue of snow removal on these facilities.

This project was initiated with the support of the Delaware Department of Transportation to analyze the safety, security, and maintenance of multi-modal facilities—both on- and off-road. In order to adequately examine these issues the project unfolded in three principal stages. First, an extensive literature review was conducted. Simultaneously, 13 experts and professionals were identified and interviewed on these topics from a total of eight states. Following the completion of the literature reviews and interviews, a policy forum was held on March 21, 2007, on the University of Delaware’s campus at Clayton Hall. Over 60 invitees attended, including state and local police, city managers, and staff from agencies that manage sidewalks and shared-use paths

throughout the state. Three breakout sessions on safety, security, and maintenance were held to identify solutions to existing issues and provide the project team with a idea of “events on the ground” perspective. A nationally recognized expert on greenways and trails, Robert Searns, AICP, presented the keynote address. This report combines information from the literature review, interview results, and policy forum to present a list of findings on the safety, security, and maintenance of sidewalks and shared-use paths.

Robert Searns uses the “daughter test method” as a concrete way of determining whether a facility is safe, secure, and well-maintained. This test requires a planner or manager to feel comfortable enough with the condition of the facility to allow his or her daughter to travel on the facility in order to open or permit access to the facility. As more sidewalks and shared-use paths continue to be built and progress into dual transportation and recreational roles, appropriate design methods and policy responses to the issues surrounding safety, security, and maintenance must be developed. The paper is divided into five principal parts accompanied with appendices. Part I discusses security-related issues, then Part II discusses safety and ADA-related issues. Part III focuses on key maintenance issues, including routine maintenance, snow removal, and other problems, and Part IV includes a section on management actions that can enhance safety, security, and maintenance of these facilities. Part V provides key recommendations. Two appendices supplement the report; one provides additional information on pedestrian crash issues, and the other provides summaries of the breakout sessions.

PART 1: SECURITY, CRIME, AND EMERGENCY RESPONSE

Recent rail-to-trail conversions have heightened concern over security issues on trail networks. In their article, *Rail-Trails and Safe Communities: The Experience on 372 Trails*, Tammy Tracy and Hugh Morris address many misconceptions concerning trail security, examining urban, suburban, and rural rail-trails across the country. They interviewed trail managers and law enforcement personnel to understand the extent of criminal issues as well as effective techniques in combating criminal activity. Their research revealed that crime rates are lower on trail networks than the overall crime rate for the region in which they are located, whether urban, suburban, or rural. The authors also discovered that in many cases the trail networks reduced minor crimes such as graffiti and vandalism. Worth noting, however, was that although there were differences among urban, suburban, and rural trails in terms of graffiti (26 percent reported in urban areas compared to 17 percent in suburban and 12 percent in rural areas) there was virtually no difference between urban, suburban, and rural related to incidents of littering and sign damage (Tracy and Morris 5).

In her article, *Is it Safe to Walk? Neighborhood Safety and Security Considerations and Their Effects on Walking*, Anastasia Loukaitou-Sideris (222) notes that several studies have revealed a correlation between fear of crime and reductions in walking. Even when reported data indicate that a facility has experienced almost no incidents of criminal activity, public perception of crime may lead to avoidance of the facility. Research has shown that fear of crime is higher for women than men, and women are more likely to avoid walking after dark. This is especially true for minority women living in poor neighborhoods. However, research should not be assumed to hold true for all women as there are many differences. Physical factors such as litter, poorly maintained buildings, and graffiti as well as social influences like publicly intoxicated individuals, homeless people, and groups of youth all affect an individual's perception of risk. Studies have also found that a lack of familiarity with an area and dark areas create an increased fear of crime (Loukaitou-Sideris 224-225). Loukaitou-Sideris's research illustrates why trail managers should pay close attention to the appearance and signage of their facilities regardless of the number of security incidents on it (Loukaitou-Sideris 222-24).

In his article *Community Greenways*, Joseph Murray has investigated security issues linked to trails. He notes that trailhead parking lots are well-known as the most common locations for criminal activity within trail systems according to surveys of law enforcement officials (Murray 1). State and local police officers present at the security breakout session at the policy forum seconded Murray's observation that trailheads were the most common areas for criminal activity. In fact, the officers recommended some solutions to this problem (see Security Breakout Summary).

Several interviewees (G. Smith; Bustos) noted that they cannot "ensure" the security of users, and that there is always some user risk associated with using any transportation facility. However, designers and management can "enhance" safety, and it is important to factor security into the design of the facility. For the most part, interviewees felt that crime and vandalism were minimal issues within their sidewalk and trail systems, especially those that are well used. In

general, the more users and workers on the sidewalk or trail, the less likely that crime will be an issue. However, Tim Bustos felt that security issues were sometimes overemphasized on trails and paths, and that security issues on trails are no different than for any other urban area. He also stressed the importance of not allowing security concerns to be used as a reason to not build more pedestrian facilities (Bustos). Just outside Denver, Bill Woodcock has also found that crime on the trail system is not really an issue due to the heavy usage (Woodcock). As more research has become available on the design of bicycle and pedestrian facilities, security has been incorporated into the state and federal design guidelines.

Location and Alignment of Trail

In *SafeScape: Creating Safer, More Livable Communities through Planning and Design*, Zelinka and Brennan recommend that trails be located where they will be visible from neighboring buildings or the street as much as possible. Dan Burden and Michael Wallwork, P.E., in *Handbook for Walkable Communities* agree, and recommend that walkways should either be part of the street system, within sight of the street or along a popular trail, park, or other active corridor. In his article, *Community Greenways*, Joseph Murray cites research that argues against placement of urban trails, paths, or greenways in depressed areas such as near streams. He notes that users are less inclined to use these facilities, and local governments frequently fail to maintain these facilities. Moreover, these facilities are more likely to have security issues (Murray 1-3).

A number of interviewees also stated their preference for trails located close to roadways (Huber; Saltrelli; Bustos), specifically for security reasons. However, Tim Bustos pointed out that these facilities can have major problems related to intersection design as well as increased conflicts with driveways (Bustos). Therefore, placement of shared-use paths should be dictated by both safety and security concerns.

Design Trails for Visibility and Access and to Increase Use

The experts agree that designing for visibility is essential to safety and security in trails and sidewalks. Visibility means that users can see the environment around them and can be seen by others. To that end:

- In general, design paths to be in visible locations (Ross; Collins).
- Focus on maintaining long sight lines (Tracy and Morris, Loukaitou-Sideris 224-225). The City of Rochester, New York, eliminated berms along its trail network in order to increase visibility (Saltrelli).
- Eliminate hiding places created by vegetation, walls, buildings, and fences (Zelinka and Brennan). Avoid blind spots and eliminate hiding places (Bustos). Focus on eliminating hiding areas (Tracy and Morris).
- Design streets adjacent to trails and sidewalks for slower traffic speeds to increase “eyes on the street,” which enhances safety because criminals do not want to be seen, and reduces the ease of escape for criminals (Zelinka and Brennan).
- Avoid pedestrian tunnels and bridges where possible. Use them as a last resort after attempting traffic calming measures and pedestrian-activated signs (Zegeer et al. 49). When necessary, Wisconsin prefers using overpasses rather than underpasses wherever possible, because they are more visible and easier to patrol and access in an emergency (Huber). When necessary, they should be as short as possible, straight, wide, and well lighted. Bridges

should allow for full visibility from within and without (Zelenka and Brennan 134). Underpasses should be designed to be open and accessible. Construct the roadbed above the tunnel entrance such that one can see all the way through the tunnel from a distance (Bustos). Lighting, security, and drainage must be factored into the design process (Zegeer et al. 42-50).

- Use the national standards, but be aware of unique situations and make adjustments (Ross).

Because it changes over time, vegetation (trees, shrubs, flowers, and ground covers) need to be carefully located, selected, and maintained. A few key points (see more on maintaining vegetation in Part 3: Key Maintenance Issues) include:

- Carefully select plants for design and maintenance characteristics (Murray 1). Plantings near the trail should be designed for security concerns (Olka, Searns and Flink 106-107). Vegetation should be carefully located, specified, and maintained to prevent blocking the trail or sight distances (Bustos; Huber).
- Avoid dense brush or thickets alongside the trail (Olka, Searns and Flink 106-107). Eliminate overgrown vegetation and tall shrubbery (Tracy and Morris). Remove brush from trail entrances and along the sides of the trail to eliminate the “tunnel effect” on users’ vision. (Pauley; Beaver; G. Smith; Ross; Saltrelli).
- Shrubs and trees should be cropped 10 feet from the ground (Olka, Searns and Flink 106-107). Vegetation should be trimmed to 10 feet from the trail edge (Birk et al. 100).

Tim Bustos noted that there is not always a linear relationship between landscaping and crime. He stated that there needs to be a balance between incorporating security principles and creating an enjoyable experience. He gave an example where a large park was developed and landscaped with berms, trees, and hills. The police complained about the lack of visibility into the park and surrounding areas from their patrol cars. However, cutting back landscaping to incorporate environmental design principles such as “eyes on the trail” could ruin the experience of biking through the natural, peaceful setting. Eliminating the landscaping and the “outdoor feel” of these facilities can decrease the number of total users on the trail facility, potentially damaging the number of users (Bustos).

LIGHTING

Appropriate lighting is also important for visibility and security. Loukaitou-Sideris refers to studies that have found that dark areas can increase the fear of crime, and conversely, increased lighting has been found to reduce assaults and other criminal activity. A number of experts provide recommendations regarding lighting:

- Pedestrian lighting should be placed on the sidewalk instead of the street and be about 12 to 15 feet above the sidewalk. Lighting that is obstructed by tree canopies is not effective, and local businesses should also factor in the growth of younger trees. Deciduous trees are better than evergreens in terms of allowing lighting (Barreras et al. 23). Lighting should be evenly distributed, focused on sidewalks, and shine down, not out. Reflective paints and markings can amplify the benefits of lighting (Kirschbaum et al. 53).
- Provide uniform/consistent levels of lighting along both sides of a roadway. Mercury vapor, incandescent, or less-expensive sodium lights are low energy but have a high level of color

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distortion, which can be a problem for people who are elderly and others with poor vision (Zegeer et al. 48).

- Provide lighting at trailheads, parking lots, and trail entrances to improve patrols and ease of surveillance (Olka, Searns and Flink 94-95; Tracy and Morris).
- Provide lighting at roadway and train crossings, tunnels, and overpasses (Zegeer et al. 48; Olka, Searns and Flink 82, 87; G. Smith).
- Provide lighting in extremely dark or problem prone areas of the trail (Birk et al. 90; Olka, Searns and Flink 146). Facilities in remote locations or high crime areas should have more lighting designed into the network (Huber).
- Consider the use of motion-activated lighting to reduce costs at night (Birk et al. 90).

Not all of the experts agree as to whether the trail itself should be lighted. Designers should consider the type of user and uses anticipated when making a decision. In general, any facility intended for transportation purposes needs to be adequately lighted for safe nighttime use. Lighting may be less important on recreational trails. Alternatively, agencies can encourage residents to stay off trails after sunset.

- Trails in urban and suburban areas often serve travel needs both day and night and need to be adequately lighted (Pedestrian and Bicycle Information Center). All pedestrian facilities should be adequately lighted for safe nighttime use. (Zelenka and Brennan). Provide overhead lighting throughout the system (Ross). Provide a lot of lighting on bike paths (Ross).
- Avoid providing lighting throughout the trail network as this encourages individuals to use the facilities at night (Olka, Searns and Flink 146).
- Lighting throughout the trail may be optional, however, consider whether the trail is a commuter route (Birk et al. 90).

Finally, when considering the location and design of lighting, agencies also have to be mindful of light pollution when lighting trails and trail facilities (Huber).

The Seattle Energy Code standards stipulate lighting requirements for sidewalks and surface parking lots. The City Light Program provides extra lighting beyond these standards to help increase the amount of security lighting placed throughout the city, 0.05 watts per square foot (e.g., a 5,000 square-foot-parking lot requires a 250-watt bulb, installation height depends on area covered and bulb strength). Lighting near sides of buildings should be 7.5 watts per linear foot (Barreras et. al 53). Having lighting standards throughout geographic regions or trails creates a uniform level of lighting throughout.

The experts also agree that it is important to design trails to allow access for emergency and maintenance vehicles:

- Access points must accommodate emergency vehicles; also, some trails may need to be designed to accommodate police cars (Birk et al. 99). Provide trail access for emergency vehicles (Tracy and Morris; Bustos).
- Ensure emergency accessways can withstand up to 6.5 tons of weight (Searns).

Another important component of security is “eyes,” in other words, the more people present, the less likelihood of criminal activity. To that end, the design of sidewalks and multi-use paths should create a pleasant environment where people want to spend time. Several interviewees found that heavily used facilities experience less crime. In one example, a recent trail project connected a trail through underpasses that were previously occupied by the homeless. Due to the increased usage, the homeless moved out of the underpass (Woodcock).

- Provide shade in summer with shade trees.
- Provide pleasant places to sit (Zelinka and Brennan 142) and include tables and benches to encourage informal social control (Loukaitou-Sideris 224).
- Provide a buffer between the sidewalk and traffic with medians, street trees, landscaping, etc. (Zelinka and Brennan).
- Remember that positive looking areas discourage criminal activity (Tracy and Morris).
- Program events on the facility and encourage vendors and other positive groups on the facility (Birk et al. 99). Focus on increasing trail usage (Tracy and Morris). Hold community events on the trails (Murray).

If vandalism and graffiti are a problem, several sources recommend “target hardening” strategies:

- Make the target more visible with lighting, cameras, or security patrols (Barker and Bridgeman 14-17).
- Use graffiti-resistant paint or grooved or exposed rock walls instead of smooth walls to lessen the attractiveness of the target (Barker and Bridgeman 14).
- Landscape around the target. Vandals are less likely to smash flowers or bushes to damage a target (Barker and Bridgeman 15).
- Use materials that are strong and vandal-resistant whenever possible (Birk et al. 69).

A number of interviewees stated that their jurisdictions have aggressive policies to remove graffiti as quickly as possible, both to discourage future incidents and to help users feel secure.

INFORMATION, ORIENTATION, AND SIGNAGE

Loukaitou-Sideris notes that studies have found that a lack of familiarity with an area increases the fear of crime (Loukaitou-Sideris 220). In *SafeScape: Creating Safer, More Livable Communities through Planning and Design*, Zelinka and Brennan note that important principles for safety and security are information and orientation. To feel safe, people want to know where they are and how to get to their destinations safely and efficiently, irrespective of their modes of travel. These recommendations include:

- Clearly articulate rules and directions and provide appropriate street signage: directional and locational signage to help people find their destinations.
- Provide schedules and other route information at all bus stops.
- Provide kiosks and community message boards with community information in areas of high pedestrian activity.
- Business and building signage should be orderly and located to help users find their destinations and bearings. Visual clutter impairs wayfinding ability.
- Create and preserve landmarks that help to identify a place, provide orientation, and create unique community character.

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- Provide clear boundaries and borders to enhance pedestrian corridors, define ownership, and encourage appropriate behavior. Boundaries must be carefully designed and maintained so as not to obstruct pedestrian visibility and sightlines.
- Provide transitions between public and public and private space. Provide neighborhood identification where appropriate. Neighborhood gateways should create identity and assist visitors in finding their way. Examples of boundaries, borders, and transitions include knee walls, plazas, porches, awnings, colonnades, and doors.
- Use different and special paving materials to define boundaries and right-of-way, as well as to channel pedestrian flows.

A few additional recommendations specifically related to trails and multi-use paths include:

- Position mile markers or cross-street signage regularly along the routes (Searns; Birk, et al. 100; Olka, Searns and Flink 88-93).
- Provide signage at call boxes with directions to the closest street or exit (Olka, Searns and Flink 88).

Several interviewees also noted the importance of signage and other wayfinding tools:

- Colorado's South Suburban Parks and Recreation (SSPR) places half-mile and mile markers along their trails that also indicate the block or street name where it is situated. This allows people to more easily identify their location and also enables emergency personnel in responding to incidents (Woodcock).
- The City of Rochester keeps the trails well signed. The city also distributes brochures indicating where exits are located on the trail system. Quality signage is considered important to security—knowing your location and how to exit (Saltreli).

TECHNOLOGY: CAMERAS, EMERGENCY PHONES, AND CALL BOXES

- Provide emergency phones and call boxes on certain trails (Tracy and Morris), and cameras (Loukaitou-Sideris 226-227).
- Install call boxes or emergency phones only with direct connections to emergency operators (Olka, Searns and Flink 146).
- Place call boxes at regular intervals throughout the trail or remote areas (Olka, Searns and Flink 146).

Although some experts recommend the use of cameras, emergency phones, and call boxes, most of our interviewees (Ross; Woodcock; Bustos; G. Smith; Pauley) did not consider them to be especially helpful in most cases. Emergency phones can provide peace of mind to users, although they are rarely used (Bustos). Two interviewees noted the difficulty in installing phones in remote areas and the proliferation of cell phones as reasons for not using emergency phones (G. Smith; Beaver). Another interviewee (Saltreli) noted that his jurisdiction had some call boxes, but they had to be removed due to graffiti problems.

Cameras may have some limited uses, but are very costly to install, maintain, and operate. One interviewee (Saltreli) believed that cameras can create a false sense of security, for example, if a camera is broken. In addition, someone needs to monitor the cameras and respond to problems, or be exposed to legal liability. There are also concerns that cameras reduce users' awareness of

their surroundings. With those cautions, Tim Bustos (Bustos) described a large-scale tunnel project in Seattle that successfully incorporated security cameras. Due to vehicle exhaust and the length of the tunnel, a separate bicycle and pedestrian tunnel was constructed that incorporated cameras. He noted that the limited length of the tunnel (0.25 miles) and the fact that it gets a high degree of use contributed to the success of the cameras. However, he also noted that this project had a large budget. Other interviewees noted having success with cameras on underpasses (Huber) and to successfully combat illegal activity like dumping and renegade ATV use in areas where they are banned (Beaver). After conducting interviews and reviewing literature, cameras and other technologies should only be installed as a response to a reoccurring problem that cannot be solved by other potential security responses. The scarcity of funding, the likelihood of these technological structures will be the target of vandalism, and their tendency to go unused provide ample reasons on why they should only be used in a very limited set of circumstances.

Maintenance Practices Also Affect Security

Many sources and interviewees discussed the connection between maintenance and security. Maintenance is discussed more thoroughly in Part 3 of this report.

- Keep sidewalks in good repair and free of obstructions. Graffiti, trash, and general disrepair are signs that nobody cares or is watching (Zelinka and Brennan).
- Quality maintenance reduces incidents of litter, graffiti, and vandalism (Tracy and Morris).
- Maintenance is a key component of security (Murray).
- Remove graffiti and other litter from public areas as quickly as possible (Loukaitou-Sideris 225).
- In difficult areas, the city sweeps paths more frequently (Ross).

PART 2: FACILITIES THAT ARE SAFE TO USE

One interviewee defined safety as “safety of movement” (Ross). Another correctly stressed that transportation engineers have an obligation to move all travelers safely (Bustos).

Design for the Safety of Everyone

Title II, Subpart A of the Americans with Disabilities Act explicitly prohibits state and local governments from discriminating against people with disabilities with respect to public transportation. Shared-use paths, sidewalks, and street crossings in the public right-of-way are considered programs (provided by local or state governments) and therefore covered under the program accessibility section in the ADA and Department of Justice (DOJ) Title II regulations. Program accessibility requires that individuals with disabilities not be denied access to public programs (U.S. Access Board 12-15).

New construction requires the highest level of accessibility as there are different technical specifications for new construction than there are for alterations. Alterations are defined as “a change that affects or could affect access to or usability of a facility or part of a facility.” The technical requirements for alterations are not as rigorous as the requirements for newly constructed facilities. Examples of alterations include downtown sidewalk improvements or roadway realignments, but also may include resurfacing projects (U.S. Access Board 15).

Facilities should be designed with safety and accessibility in mind. ADA is about safety for disabled users, but too frequently agencies design to the minimum standards without considering safety concerns. It is especially important in areas where there are no standards, only guidelines (such as trails), that agencies understand the safety issues and how to address them: “figure out what accessibility looks like” for the specific situation. A design approach focused on safety can prevent lawsuits and future liability problems in the future. If any user—handicapped or not—gets injured on your facility, an ADA violation is the least of your worries. All facilities should be designed to be safe and useable for all users, including children and elderly people, not just ADA users (Horton).

According to the 2000 U.S. Census 49 million or 19.3 percent of Americans have a disability, and the number of citizens 65 and older is also growing. Interviewees picked up on this trend, as they commented that there is an increasing demand for ADA accessible facilities, and changes to address ADA issues have been well received among users (G. Smith; Beaver). There are more people than ever with wheelchairs, and the chairs are getting better, allowing those who use them more mobility and opportunities to use facilities (Bustos).

Agencies or governments responsible for sidewalks and trails should cast aside the concept of the “standard pedestrian.” The standard pedestrian does not exist, as there wide differences in walking abilities, speed, and balance among pedestrians. Agencies should focus on designing trails and sidewalks beyond the minimum specifications laid out in the Americans with Disabilities Act Accessibility Guidelines (ADAAG) wherever possible. This makes walking easier not only for individuals with disabilities, but also for those carrying objects or pushing strollers, children, and senior citizens (U.S. Access Board 23-25).

Disabled individuals are more likely to be pedestrians because their physical limitations may preclude them from driving or leave them in a financial position unable to own a vehicle (U.S. Access Board 6, 19, 30). Older individuals and children are the largest users of public transit and walking facilities. Past research has indicated that older citizens are more likely to experience safety and security incidents as a result of poorly lit sidewalks, sidewalks only on one side, and areas with no sidewalks (U.S. Access Board 44). In addition these facts should be considered:

- Older individuals need longer crossing times.
- Changes in level and high curbs create difficulties and hazards for older individuals.
- Reduced or impaired vision is common among older folks and children have one-third less peripheral vision than adults, so minimize glare, distances, and the need for peripheral vision
- Children are less able to judge speed and distance.
- Signage should be simplified to the maximum extent possible.
- Children may not be able to read traffic signs or warnings (Harkey and Zeeger 7-10; U.S. Access Board 93).

The article *What Is Universal Design?* presents seven principles of universal design. Although these principles have been developed to address people with disabilities, following them makes mobility easier for many people without disabilities, including children, the elderly, parents of small children, and people carrying bulky or heavy items. While ADA requires facilities to be designed to certain standards and dimensions, additional attention beyond the requirements enhances mobility for all users (The Center for Universal Design, North Carolina University 1). The seven principles developed by the Center for Universal Design include:

Equitable Use: The design is useful and marketable to people with diverse abilities.

- Provides the same means of use for all users and avoids segregating any users.
- Gives provisions for privacy and safety.
- Appeals to users of all abilities.

Flexibility in Use: The design accommodates a wide range of individual preferences and abilities.

- Provides choice in methods of use.
- Facilitates the user's accuracy and precision.
- Provides adaptability to the user's pace.

Simple and Intuitive Use: The design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

- Is consistent with user expectations and intuition and eliminates unnecessary complexity.
- Accommodates a wide range of literacy and language skills.
- Arranges information consistent with its importance.
- Provides effective prompting and feedback during and after task completion.

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Perceptible Information: The design effectively communicates necessary information to the user, regardless of ambient conditions or the user's sensory abilities.

- Uses different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
- Maximizes legibility of essential information and provides adequate contrast between essential information and its surroundings.

Tolerance for Error: The design minimizes hazards and the adverse consequences of accidental or unintended actions.

- Arranges elements to minimize hazards and errors; frequently used elements should be the most accessible; hazardous elements must be eliminated, isolated, or shielded.
- Provides warnings of hazards and errors and provides fail-safe features.

Low Physical Effort: The design can be used efficiently and comfortably and with a minimum of fatigue.

- Allows user to maintain a neutral body position.
- Uses reasonable operating forces and minimizes sustained physical effort.
- Minimizes repetitive actions.

Size and Space for Approach and Use: The design provides appropriate size and space for approach, reach, manipulation, and use, regardless of user's body size, posture, or mobility.

- Provides a clear line of sight to important elements for any seated or standing user.
- Makes reach to all components comfortable to any seated or standing user.
- Accommodates variations in hand and grip size.
- Provides adequate space for the use of assistive devices or personal assistance.

Individuals with mobility impairments are frequently use wheelchairs, scooters, prosthetic limbs, canes, and other devices. The following design considerations should be incorporated to assist wheelchair users (U.S. Access Board 31-35):

- Firm, stable surfaces.
- Turning radius of 60 inches by 60 inches.
- Maximum high side reach of 54 inches (ADAAG).
- Maximum low side reach of 9 inches (ADAAG).
- Eye level for wheelchair users should be assumed to be between 35 and 52 inches.
- Rapid changes in cross-slopes must be avoided particularly in situations of 2 feet or less.

Design considerations for walking aids such as canes, crutches, and walkers include:

- Grates and cracks larger than a cane tip should be repaired or fixed.
- Icy or uneven surfaces are very dangerous.
- Frequent rest areas should be incorporated into the design because these individuals expend greater amounts of energy.

However, planners and designers should also remember many individuals with mobility issues may not have assistive devices. As many as 40 percent of adults have some level of hearing

disability, and it is common to have pedestrians with partial hearing or vision as well as total blindness or deafness. Design considerations for people with visual impairments include:

- Users may be unable to detect obstacles.
- Information is acquired through sound and texture.
- Dog guides will direct the visually impaired to the shortest route, not necessarily within the crosswalk or pedestrian areas. Therefore, crosswalks should be designed as much as possible in a straight line.
- Painted crosswalks are helpful to those who are classified as legally blind, but still retain some vision capability. (They also have safety benefits.)
- Longer sight distances and fewer visual obstructions increase safety, especially near intersections.

Pedestrians with cognitive disabilities are among the most difficult to predict as their physical and mental capabilities vary widely. However, signage should be simplified where possible.

- Universal symbols are understood by a broader range of individuals.
- Symbols for DON'T WALK should be placed above the WALK symbol.

Locating Facilities, Right-of-Way

Dan Burden and Michael Wallwork, P.E., in *Handbook for Walkable Communities*, recommend that walkways should either be part of the street system, within sight of the street, or along a popular trail, park, or other active corridor. Walkways should offer a direct route, connect streets commercial areas and parks, and have frequent, safe road crossings. Although numerous intersections should be avoided, shared-use paths should be connected to other transportation options (Pedestrian and Bicycle Information Center 2).

In listing the best practices for improving pedestrian safety, FHWA recommends that along high-speed, high-volume roads, off-road multi-use paths are better than bike lanes (Zegeer et al. 49). However, the Pedestrian and Bicycle Information Center (PBIC) asserts that shared use paths function best when they are in their own right-of-way. It also recommends using bicycle lanes or shared roadways instead of multi-use paths when there would be more than eight crossings per mile. The PBIC contends that shared-use paths should not be installed next to highways, and that sidewalks should not be included as part of shared-use paths. Avoiding both of these practices reduces conflicts between users and with automobile traffic (PBIC). These two recommendations are also included in the AASHTO Guide for the Development of Bicycle Facilities and most state design guides. The New Jersey Department of Transportation lists some reasons *not* to locate sidewalks next to highways:

- Causes users to move in the opposite direction of automobile traffic.
- Increases vehicle-user collisions.
- Increases the potential for accidents due to vehicles exiting or stopped at driveways and smaller streets.
- The minimum recommended separation is 5 feet horizontally or 42 inches vertically, by barrier or railing (PBIC 2).

SAFE SIDEWALKS

In 1994, *Prevention* magazine published *Blueprint for a Walkable Community: Florida's 12-Step Program*, which makes several suggestions, the most relevant of which are:

- Step 2: “Pedestrianize” intersections. Use design features that cause cars to slow down when turning. Use design elements that reduce the amount of time a walker spends crossing traffic. Channel intersections so that a pedestrian only has to cross two lanes of traffic at a time.
- Step 3: Design for Americans with Disabilities (ADA). Install corner ramps and raised crosswalks to facilitate mobility. Design and standardize signals to be more accessible and help the visually impaired.
- Step 4: Place signals properly. Place signals for optimum visibility for both pedestrians and drivers. Be careful not to place signals too high.
- Step 5: Illuminate. All intersections should be well lit, including the crosswalks and waiting areas.
- Step 6: Simplify median crossings. Build landscaped medians into existing roads to allow pedestrians to cross wide roadways more securely. Focus on high-volume pedestrian areas around schools, entertainment areas, malls, and residential neighborhoods.
- Step 7: Make walking to schools safer. Identify specific places for buses and cars to drop off children, away from pedestrian areas. Designate areas for children to cross streets safely with as little vehicular contact as possible. Design all roadways around schools to automatically slow traffic.
- Step 8: Eliminate backing up. Design parking areas with walkways for pedestrians, eliminating the need for walkers to be behind any car that may be backing up.
- Step 10: Create auto-restricted zones. Restrict vehicles to specific spaces and/or times in busy commercial activity centers.

There are a lot of general recommendations related to sidewalks and pedestrian systems; to reduce user conflicts, vehicular traffic should be separated as much as possible from bicycle traffic, and both should be separated from pedestrians (Robinette). Provide sidewalks along all arterials and streets in and around commercial centers and surrounding housing (Hess et al. 3). Provide sidewalks on both sides of all streets (Pucher and Dijkstra). Sidewalks along a roadway must be ADA accessible; therefore roadway engineers must also consider how roadway placement and design affects the sidewalk (U.S. Access Board). When construction blocks an accessible route, an alternative route must be provided (U.S. Access Board 23, 34).

Design communities so that kids can walk to school (Smart Growth Network 33). Encourage safe pedestrian routes to transit (Smart Growth Network 34). Planners must provide an accessible route from public transit, accessible parking, public streets, and passenger loading zones to the entrance they serve (United States Access Board 34). Pedestrian routes should be short with key destinations located within a 400- to 600-meter [1300- to 1950-foot] radius of the bus stop. Pedestrian facilities should be continuous, easy to find and follow, and accessible to people with mobility aids. Sidewalks throughout a site should provide a clear, direct route through the site (Robinette 16). Make pedestrian routes convenient by minimizing stairs and grade changes, driveways, and parking lot crossings (City of Calgary).

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Narrow sidewalks create safety liabilities for wheelchair users as they require a minimum of 60 inches to change direction. Crowds, rain, snow, or ice all increase the chances for falls or slips into the road, especially where sidewalks have little or no separation from the road. Other disabilities also require minimum widths including individuals on crutches (42 inches) and individuals with service animals or guides (48 inches). Sidewalks should be at least 5 feet wide with 2-foot planting strips (U.S. Access Board 35). The minimum widths stated in ADAAG are the minimum for passage and not recommendations.

A essential feature for pedestrian- and transit-friendly design is sidewalks that are wide enough for couples: A 5-foot sidewalk is wide enough for two people to walk comfortably abreast, where pedestrian traffic is light, street furniture is limited, and buildings are set back from the sidewalk. Wider sidewalks are warranted when the conditions are not met. At peak times, sidewalks must provide at least 25 sq. ft. per pedestrian, 40 sq. ft. is better, but 100 to 150 sq. ft. is ideal (Ewing).

When determining the appropriate width of a sidewalk, account for (Kirshbaum et al. 37-39):

- The shy distance (2 feet next to buildings and streets which are avoided by pedestrians).
- The “effective design width”—pedestrians travel in the middle of the sidewalk.
- Passing space—if a sidewalk width must be narrow, a 5-foot passing space should be provided at least every 200 feet. A turning space requires a 5- by 5-foot space.

The most comprehensive guidelines for determining an adequate sidewalk width are in *Designing Sidewalks and Trails for Access Part II of II: Best Practices Design Guide* (Kirschbaum et al. 4-4-4-7). The sidewalk corridor is divided into a number of zones with suggested minimum standards in the table below:

Sidewalk Corridor Minimum Dimensions (Kirschbaum et al. 4-4)

Zone	Minimum Width
Curb Zone	6 inches
Planter/Furniture Zone	24 inches (48 inches for trees)
Pedestrian Zone	60 inches
Frontage Zone*	30 inches
Total Sidewalk Corridor	10 feet

**If 2.5 feet of open space is available between the sidewalk corridor and the property line no frontage zone is needed, the minimum resulting sidewalk corridor width is 7.5 feet.*

The *curb zone* is immediately adjacent to roadway.

The *planter/furniture zone* is the area between the curb and the pedestrian zone:

- Many cities with on-street parking allow for 36 inches.
- Locations with transit stops may require additional space (a boarding pad is typically 60 by 96 inches), wheelchair lifts may extend to 48 inches beyond the side of the vehicle, and a bus shelter may require a 96- by 156-inch space.
- Areas with snow may need additional space: minimum recommended width of 72 inches to allow for clearing.

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- Furniture, where it can be placed on adjacent property (such as residential lawns), should have recommended minimum width of 24 inches (not eliminated completely).
- Extra space is needed at pedestrian crossings between the curb and the pedestrian zone for two perpendicular curb ramps.

The *pedestrian zone* is the area of the sidewalk corridor specifically reserved for pedestrian travel:

- Commercial and urban areas may require larger pedestrian zones based on the anticipated number of users, according to the Highway Capacity Manual.
- Paths or sidewalks less than 60 inches wide should have periodic passing spaces of at least 60 by 60 inches no greater than 200 feet apart.
- Pedestrian zone should never be less than 36 inches wide for accessibility reasons.
- Obstacles should be eliminated in the pedestrian zone, including mailboxes, telephone poles, and water fountains, which decrease the clear width of the sidewalk and make walks inaccessible for the disabled.

The *frontage zone* is the area between the pedestrian zone and the property line:

- Zone should be a minimum of 12 inches.
- Zone can be eliminated if it is adjacent to a wide open or landscaped area (lawns).
- Individuals who are visually impaired use this zone for orientation from building noise and tend to travel between 12 and 48 inches away from the buildings (Kirschbaum et al. 4-4-4-7).

ADA Issues

ADA issues related to sidewalks include proper design with handicapped ramps, correct slopes, and detectable warning pavement. For the most part, jurisdictions are improving accessible sidewalk design, but improvements tend to be completed within the context of other maintenance projects and/or in response to complaints. As a result, most jurisdictions still have many sidewalks that are not up to current standards, especially in residential areas.

- Faulty design of curb cuts can lead to pooling of water that, in some instances, prevents ADA access and can also damage the facility (Waterland).
- Although retrofitting curbs with accessible curb cuts is helpful, the adjacent sidewalks also need to be accessible. While curb cuts provide access to cross the street, obstacles and deteriorated sidewalks may still prevent people from using sidewalks (Waterland).
- A very big ADA problem in Delaware is access to fixed-route transit, primarily sidewalks. Although the public transportation system is accessible, often there is simply no accessible route to the bus stop, either as a result of lack of facilities or because the existing sidewalk is in a state of disrepair (Waterland).
- Consider issues like sight distance for wheelchair users in order to avoid future problems (Horton).

Some additional technical recommendations (above and beyond ADA) were developed by the Public Rights-of-Way Access Advisory Committee of the U.S. Access Board. The guidelines for well-designed new sidewalks, documented in *Building a True Community: Final Report*, include:

- Sidewalks shall contain a pedestrian access route and reduced vibration zone. The minimum clear width for the reduced vibration zone shall be 48 inches.

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- Pedestrian access routes should have a minimum clear width of 60 inches. The clear width of the pedestrian access route may be reduced to 48 inches at driveways and alley crossings, constrained building entrances, and at street fixtures.
- Grades shall be consistent with the adjacent roadway.
- Stairs shall not be a part of the pedestrian access route.
- Visual contrast, where present, is required at the leading edges of stairways.
- Pedestrian access routes should have a maximum cross-slope of 1:48.

A U.S. Access Board guide cites grade or slope and surface type as the “access characteristics” or the two factors that influence accessibility the most. Changes in level can occur due to buckling, roots, drainage issues, tree grates, drainage grates, railroad tracks, and uneven transitions. Vertical changes in level greater than 0.25 inch limit accessibility. Changes in level between 0.25 to 0.50 inches must have a maximum bevel of 50 percent. A ramp is required in all cases above 0.50 inches (U.S. Access Board 65-67).

The U.S. Access Board states that running grade or slope should be calculated along the length of the facility; however, running grade only will not always reveal impassable or steeply graded sections. Therefore, maximum grade should be determined in 24-inch intervals (wheelchair base and common walking pace) to detect steep sections. The rate of change grade should not exceed 13 percent especially between curb ramps and gutters to prevent wheelchairs from tipping over or other individuals from falling (U.S. Access Board 23-25).

If a new facility is being constructed, it is easier to meet the running slope requirement of 5 percent and the 8.33 percent requirement for ramps. However, this is frequently impossible due to the close proximity of sidewalks to roadways that exceed these grades. Therefore, the design guide stipulates that running slope should be kept to the minimum level permitted by the natural environment. Some treatment options include level runouts, ramps, and wider sidewalks which create more room for the installation of these treatments (U.S. Access Board 23-25).

The U.S. Access Board also addresses requirements related to cross-slopes. Cross-slopes with high grades can prevent wheelchair users from balancing and can cause them to swing into the street or downhill. They are also an enormous energy obstacle for many users. However, since the AASHTO Green Book requires that sidewalks have a 1.5 percent cross-slope to provide drainage off the curb and the ADAAG guidelines do not permit cross-slopes over two percent, there is little room for error. Without providing an appropriate cross-slope, puddles and ice can occur, creating accessibility problems. Rapid changes in cross-slopes must be avoided particularly in sections of two feet or less (the width of a wheelchair base). Non-planar surfaces are common on driveway crossings and curb ramps without landings (U.S. Access Board 46-47).

The cross-slopes of driveway aprons are frequently in violation of cross-slope standards and cause wheelchair users to tip (U.S. Access Board 44-45):

According to the 1973 Rehabilitation Act, curb ramps must be installed at all intersections and mid-block locations where pedestrian crossings exist. Separate curb ramps at each crosswalk should be built as this helps visually impaired pedestrians (Zegeer et al. 44). Counter slopes on curb ramps should not exceed five percent. When designing curb ramps factor in the different

equipment the disabled depend on to traverse pedestrian routes (i.e., manual wheelchairs, walkers, powered wheelchairs, etc.) Also, factor in drainage issues. In some cases the street drainage system may need to be modified to prevent pooling and freezing at the bottom of the ramp (U.S. Access Board 47-48).

Finally, be sure to provide a minimum vertical clearance of 80 inches. If objects extend into pedestrian space, a barrier must be provided to alert the visually impaired and blind. Wall- and post-mounted objects in the pedestrian access route are discouraged. Utility poles, newspaper boxes, signage, hydrants, etc. must not be allowed to infringe on the clear width of the walkway (U.S. Access Board 52-55).

Drainage: Accessibility and Safety

Poor drainage creates serious safety issues. The Access Board design guide specifically recommends, “In extremes of climate, where wet or freezing conditions occur frequently, surface water must be carefully controlled and maintenance must be emphasized in the vehicular and pedestrian way” (U.S. Access Board 47).

In some cases the street drainage system may need to be modified to prevent pooling and freezing at the bottom of a curb ramp. Faulty design of curb cuts can lead to pooling of water that in some instances prevents ADA access and can also damage the facility (Waterland). When possible, avoid placing curb ramps in areas where catch basins and storm drains are placed. However, when this is not possible, regrading can reduce pooling at curb ramps. There are some additional points related to sidewalk drainage (Kirschbaum et al. 46-48, 65-66):

- Areas with heavy rainfall or frequent drainage issues need more inlets as well as more strategically placed inlets.
- High curbs can limit sidewalk pooling in flood-prone areas, however higher curbs increase issues with curb ramp installations on narrow sidewalks.
- Inlets should be installed uphill from crossings and curb ramps to decrease water issues in these areas.
- ADAAG specifies gutters not exceed a maximum slope of five percent to prevent wheelchair crashes.
- Wider gutters can handle more water volume without increasing the slope.

Drainage structures should be avoided within sidewalks, but when they occur, they should be placed flush with the surface in which they occur. Never locate a grate between a curb ramp and the corner of the street, or immediately downgrade from a curb ramp. Always locate drains perpendicular to the direction of vehicular and pedestrian traffic (Robinette 26). Do not place grates with perpendicular bars at ramps as wheelchair wheels could get caught, also be sure drainage grates are level with bike lanes or pavement (Reitmayer et.al.). Gaps in gratings should never exceed ½ inch in the direction of travel. Use slip-resistant finishes or nonmetallic surfaces on exposed gratings (U.S. Access Board 50).

PEDESTRIAN SAFETY: VEHICLES AND PEDESTRIANS

Although there are some crashes related to bicycles on sidewalks, the most common and deadly user conflict related to sidewalks and pedestrian networks is motor vehicles. Pedestrian crash statistics reveal at-risk populations and dangerous situations (Harkey and Zegeer 7-10):

- Five- to nine-year-old males have the highest crash involvement rates.
- In 2003, 69 percent of pedestrian fatalities were male, and the injury rate for males was 58 percent higher than for females.
- Pedestrians 65 and older have lower crash involvement rates, but are more susceptible to serious injury or death when involved in an accident. Over 20 percent of accidents involving older pedestrians result in death.
- Eighty-five percent of all non-fatal crashes happen in urban areas, and 72 percent of all fatal crashes happen in urban areas.
- Sixty-five percent of all crashes do not occur at intersections, however for pedestrians aged 45 to 65 crashes are split 50-50 between intersections and non-intersections.
- Older pedestrians are more likely to be injured or killed at intersections.
- Pedestrian crashes are more frequent during commuting times, morning and afternoon.
- Fatal crashes are more frequent between 5 and 11 p.m.—indicating the relationship that darkness and alcohol play during this time period.
- The time period between September and January has the highest amount of pedestrian fatalities due to less daylight and more dangerous weather conditions.
- A pedestrian hit by a car traveling 40 miles per hour has an 85 percent chance of being killed, a 45 percent chance at 30 mph, and a 5 percent chance at 20 mph.

Also, vehicle speed is more dangerous to pedestrians than traffic volume; therefore, speed should be addressed first. Faster speeds increase the chances of a pedestrian being hit and pedestrian injuries are less frequent and severe on lower speed roadways (Zegeer et al. 66).

The National Highway Traffic Safety Administration and the Federal Highway Administration have identified 12 major pedestrian crash types based upon analysis and studies (Harkey and Zegeer 13-26). The complete list of crash types, along with their corresponding counter-measures can be found in the Appendix. The crash types most relevant to this study include:

- *Dart/dash*: this accident type comprises 24 percent of all pedestrian accidents. This involves a pedestrian entering the roadway at an intersection or mid-block location and is hit by a vehicle.
- *Multiple threat/trapped*: these accidents occur when a pedestrian begins crossing in front of a stopped vehicle and gets struck by a vehicle traveling in the next lane. Common causes are the stopped vehicle blocked the visibility of the pedestrian for the traveling car and the speed of the car traveling in the next lane.
- *Unique mid-block accidents*: these accidents involve pedestrians exiting or entering parked vehicle or getting mail.
- *Accidents involving pedestrians crossing at unsignalized intersections*: in these cases, either the pedestrian or motorist may have failed to yield.
- *Bus related*: passengers accessing or exiting a bus.

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- *Turning vehicle accidents:* these conflicts happen when a right or left turning vehicle strikes a pedestrian.
- *Through vehicle at signalized intersection:* these conflicts occur at an intersection or mid-block crossing between cars traveling straight ahead and pedestrians.
- *Pedestrian walking along the roadway incidents:* these accidents involve pedestrians who run or walk alongside a roadway and are struck.
- *Non-roadway sidewalk, driveway, parking lot, or other:* These conflicts occur when pedestrians are struck by vehicles in a parking lot, alley or on a sidewalk crossing a driveway.
- *Vehicle backing-up conflicts.*

Some of the suggested countermeasures include:

- Provide or improve lighting.
- Install or re-time traffic signals to more pedestrian responsive, add a pedestrian signal, and provide quick-response pedestrian push-buttons or automatic detectors.
- Install overhead warning signage, pedestrian actuated flashers, or other warning signage.
- Apply traffic-calming measures such as: intersection curb extensions, raised pedestrian crossings, raised intersections, pedestrian crossing islands, speed humps, speed tables, chokers, narrow travel lanes, or at spots with busy mid-block crossings.
- Remove or restrict parking areas that block pedestrian and motorist sight lines, prohibit left turns, and prohibit right turn on red.
- Increase motorist and pedestrian education and enforce speed limits and pedestrian ordinances.
- Provide a bus pull-off area or relocate bus stop to the far side of the intersection.
- Install or improve crosswalk markings, stagger crosswalks through a median to force pedestrians to walk and look to the right, recess stop lines 30 feet in front of crosswalks, and reduce curb radii.
- Remove obstacles in sidewalks and objects blocking visibility near driveways. Remove intersection snow at corners to improve visibility and allow for the pedestrians to stand in a visible location.
- Provide sidewalks or walkways on both sides of the street, add bike lanes, and provide a pedestrian underpass or overpass.
- Add a planting strip or some form of sidewalk separation.
- Construct and maintain sidewalks and curb ramps, and maintain a level sidewalk across driveways.

Traffic-calming techniques have been successfully used to reduce the frequency and severity of pedestrian/vehicle conflicts. The 2002 report titled *Pedestrian Facilities User Guide—Providing Safety and Mobility* offers some traffic-calming best practices. When applying traffic-calming procedures, one should apply treatments that serve multiple purposes such as a raised crosswalk rather than a speed hump. Devices should be placed between 300 to 500 feet apart. In some areas it may be better to test out traffic calming practices first by using temporary, removable devices. Visibility should always be factored into the design. They also discuss some of the advantages of specific devices:

- Curb extensions reduce the crossing distance for pedestrians, increase the visibility of pedestrians, and eliminate visibility issues with parked vehicles close to intersections. They also decrease turning speeds and can be used on mid-block crossings as well.
- Chokers are useful in alerting drivers that they are moving from a commercial area to a residential area.
- Crossing islands allow pedestrians to look in one direction at a time and shorten pedestrian crossing distances. Installing these can significantly reduce pedestrian crashes.
- Mini-circles have been found to reduce pedestrian crashes by 90 percent in Seattle.
- Raised pedestrian crossings increase pedestrian visibility and motorist awareness. One study of raised crosswalks found an increase in the motorist yield rate from 10 percent to 55 percent (Zegeer et al. 67-75)

PEDESTRIAN CROSSINGS

Pedestrian crossing opportunities should occur at short (500 feet), regular intervals along streets and arterials serving concentrations of multi-family housing, commercial development, and schools. Crosswalks must be accompanied by appropriate signage and signals to make drivers aware of pedestrians (Hess et al.1). Walkways should have frequent and safe road crossings (Burden and Wallwork). Recent research has found most pedestrians walk at a pace of 3.5 feet per second, however, the AASHTO Green Book recommends 39 inches per second for older pedestrians. Disabled persons crossing the street may take longer. Transportation agencies should extend their crosswalk timing for pedestrians to reflect these slower crossing paces (Kirschbaum et al. 59-62). A number of factors should be considered when designing crossing facilities (U.S. Access Board 55-56):

- Disabled individuals are often difficult to see.
- Curb radii should be decreased to allow disabled individuals to cross in time and to increase their visibility.
- Vehicles who violate stop lines create issues for the visually impaired.
- Shorter crosswalk distances make it easier for visually impaired pedestrians to determine perpendicular and parallel traffic.

In 2005, The Institute of Transportation Engineers produced a report describing different methods to improve the pedestrian experience. The City of Boulder studied compliance related to different crossing treatments, conducting before and after tests from 1997 to 2003. The tests were performed at unsignalized intersection crossings, mid-block crossings areas and at some signalized intersections with right-turn slip lanes. On average, for all the locations tested and all safety treatments, motorist compliance (yielding to pedestrians) increased from 34 percent to 77 percent (Boroski et al. 6-7). The study found the following treatments to be the most effective:

- Pedestrian-activated flashing lights installed on roadside poles and in the median.
- Alternative signing mounted curbside and in the median stating: STATE LAW—YIELD TO PEDESTRIANS IN CROSSWALK.
- Raised pedestrian crossing consisting of 6-inch, elevated, flat “speed tables” with marked crosswalks. These were found to be very effective on intersections with right-turn bypass lanes (Boroski et al. 6-7).

Small radius corners, raised pedestrian islands, and curb extensions on wide streets also improve crossing safety for pedestrians (Reitmayer et al.). Intersections and crossings should be designed with clearly marked crosswalks, and traffic islands with pass-throughs at all legs of the intersection (Robinette). Some other recommendations for crossing design:

- Design crosswalks in a straight line as much as possible since dog guides will direct the visually impaired to the shortest route, not necessarily within the crosswalk or pedestrian areas (U.S. Access Board 21).
- Force pedestrians to look to the right with staggered crosswalks. Raise the crosswalks (Zegeer et al. 26).
- Include accessible ramps within the crosswalk treatment to allow a wheelchair user to access the ramp without leaving the crosswalk (Zegeer et al. 44).
- Provide painted crosswalks to help those who are classified as legally blind, but still retain some vision capability (Kirschbaum et al. 22). Ladder paint patterns are more visible to motorists and require less maintenance if painted such that motor vehicles tires track between the painted lines (Zegeer et al. 46).
- Place stop lines 30 feet before the crosswalk (Zegeer et al. 96).
- Provide brighter lighting near heavily trafficked crosswalks, intersections and approaches to crosswalks (Zegeer et al. 151).
- Make crosswalk markings more effective by using other measures like curb extensions. They should not be the only measure taken to improve pedestrian safety (Zegeer et al. 45).

Crosswalks must be clear of debris and tripping hazards. Granite or cobblestone should not be used on crosswalks. One of the best materials for marking crosswalks is inlay tape, which can be installed on new or repaved streets. It is slip resistant, long-lasting, and does not require extensive maintenance. Thermoplastic should be used on rougher pavement surfaces. Both of these materials are more visible and less slippery than paint when wet (Zegeer et al. 45).

The literature also provides suggestions for pedestrian signals. Locate large crosswalk buttons less than 42 inches from the ground to allow for greater usability by disabled individuals (U.S. Access Board 93). Use modern technology to increase pedestrian safety such as countdown signals on crosswalk signs, infrared or microwave pedestrian sensors, and audible pedestrian signals (Smart Growth Network). Program longer pedestrian signals at multi-lane roads, and if pedestrians ignore signals, re-time them to be more responsive (Zegeer et al. 92). Forethought should go into the placement of pedestrian warning signs so they do not get lost in “visual clutter” (Zegeer et al. 97).

Jaywalking

Researchers have found that pedestrians in areas with suburban characteristics (large blocks with fragmented or no pedestrian facilities) were more likely to jaywalk. “The very high incidence of jaywalking in suburban sites suggests that pedestrians take risks because they lack options in their walking routes.” (Hess et al. 4) As a result, it has been recommended that mid-block crossings should be used in pedestrian areas where block lengths are long (Robinette). FHWA makes recommendations for mid-block crossings (Kirschbaum et al. 60-62):

- Provide curb ramps for access.

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- Consider how multiple traffic lanes can prevent pedestrians and handicapped individuals from crossing.
- Consider bulb outs or medians.

Dan Burden and Michael Wallwork, in their *Handbook for Walkable Communities*, also provide guidelines for safe mid-block crossing design:

- Provide an at-grade cut-through at the crossing point, and ensure that the cut-through is appropriately sloped for drainage.
- Angle the cut-through 45 degrees towards advancing vehicles to force pedestrians to look for vehicles.
- Keep all landscaping at least two feet behind the median curb.
- Create a pedestrian refuge in the median if possible (also at 45° angle).
- Provide signalized crossings for pedestrians where traffic is heavy or people have special needs.

New Strategies

Transportation agencies across the country have been trying new markings and other techniques to improve pedestrian safety:

- Salt Lake City developed a double ladder crosswalk after receiving numerous complaints about conventional ladder crosswalks being slippery on wet and icy days. The design eliminates markings in the middle third of the crosswalk so pedestrians can walk on the paved surface instead of the slippery markings. This process is less expensive and easy to install (Harkey and Zegeer 199).
- Salt Lake City also installs triangle-shaped advance warning pavement markings before all crosswalks to alert motorists. Since the introduction of their safety program and design treatments in 2001, Salt Lake City's pedestrian incidents dropped by 31 percent at the end of 2003 (City of Salt Lake Pedestrian Safety Committee 6).
- Beverly Hills changed traffic signals to a 60-second cycle with a 20- to 22-second pedestrian phase. Signage and pavement markings were added to encourage diagonal crossings. The cost ranged from \$500 to \$700 at each intersection. These changes resulted in a 66 percent drop in pedestrian/auto accidents at those intersections (Harkey and Zegeer 169-171).
- The New Jersey Department of Transportation (NJDOT) identified poor crosswalk visibility as a primary cause of many pedestrian crashes. In order to improve visibility, NJDOT tried an in-pavement illuminated crosswalk. This has ultrasonic passive actuation, automatically lighting when a pedestrian approaches. Lights directed toward motorists stay on for ten seconds, flash four pulses per second, and are easy to see even on bright days. Other states have calculated that flashing crosswalk installations increased vehicle yielding by 13 to 35 percent (Harkey and Zegeer 174).
- The New York Department of Transportation developed a 4-foot pedestrian safety cone that could be placed in the centerline of the road right in front of a crosswalk called a Supplementary Pedestrian Crossing Channelization Device (SPCCD). These devices cost around \$200 to \$300, are portable, and designed to take occasional hits without becoming projectiles. A FHWA study revealed that motorists yielded to pedestrians more frequently where SPCCDs are present (Harkey and Zegeer 181-182).

Vertical and horizontal separation of the sidewalk from the street is encouraged (Public Rights-of-Way Access Advisory Committee). Provide buffers between the street and sidewalk wherever the speed of traffic constitutes a perceived danger to pedestrians (Hess et al 1).

Planting strips and streets trees serve a number of functions:

- Planting strips offer a place to store snow during the winter, and they decrease overall runoff requirements as they absorb water. Wide planting strips increase turning radii. Driveways should be built into planting strips (Reitmayer et al.).
- Use trees and other green infrastructure to provide shelter, beauty, urban heat reduction, and separation from automobile traffic (Smart Growth Network).
- Provide appropriate buffering from traffic with greenstrips between the walk and the curb, and street trees. Closely spaced shade trees located between the street and sidewalk form a physical and psychological buffer (Ewing). Select trees needing little maintenance or watering and root systems that do not damage sidewalks (Reitmayer et al.).
- Many jurisdictions require a minimum distance between the curb and the sidewalk specifically to accommodate snow storage. In Wisconsin, the minimum recommended setback for a median is five feet from back of curb, which is just adequate for snow storage in most parts of the state (Huber).

An essential feature for pedestrian- and transit-friendly design is comfortable and safe places to wait (Ewing).

- Rest areas should be provided adjacent to the sidewalk (but not infringing on the clear width of the walkway) where pedestrians must walk long distances or up slopes (Robinette).
- Bus stops create special sidewalk issues, and they must have maneuvering space for wheelchair users. Also, do not place the stop too close to planting strips (United States Access Board).
- Drop-off zones should be located as close to building entrances as possible, with no grade change (curb) between the roadway and sidewalk. Provide a waiting area with lighting and protection from weather (Robinette).

Other issues to consider in designing sidewalks include:

- Signal loop detectors should be adjusted to aid pedestrians (Reitmayer et al.).
- Parking, landscaping, bus shelters, and signage affect sight distances for all pedestrians including wheelchair users (Kirschbaum et al. 61).
- Curb extensions can prevent parking from blocking pedestrian facilities (Kirschbaum et al. 61).
- Asphalt repairs to the roadway should be milled from gutter to gutter to prevent crowning and steep grades (Kirschbaum et al. 63-64).
- Street identification signs shall meet readability criteria (Public Rights-of-Way Access Advisory Committee, X02.3.8.1 - X02.3.8.6).
- Railroad tracks (Reitmayer et al.).
- Sidewalk ramps on bridges (Reitmayer et al.).

SAFE SHARED-USE PATHS

Accessibility and Shared-Use Paths

Accessibility standards and specifications are not limited to sidewalks, as the Access Board has been working to develop consensus on technical requirements for outdoor trail facilities and accessibility. A final report was submitted to the Access Board in September of 1999, but a Notice of Proposed Rule has not yet been introduced. As of this writing, the Regulatory Negotiation Committee's *Final Report: Recommendations for Accessibility Guidelines for Outdoor Developed Areas* provides the most up-to-date recommendations for trail accessibility (National Center on Accessibility).

The Regulatory Negotiation Committee's Outdoor Developed Areas Report only requires newly constructed or altered trails to be retrofitted to ADA standards, not routine maintenance. An alteration is defined as transforming the trail's original character, whereas maintenance returns the trail to its initial form. The following distinction is laid out on page 4 of the National Center on Accessibility's summary of the report: *Repairing a trail surface caused by use or weather would be maintenance and not require the installation of accessible features, but replacing the surface with a new form of surface would be considered an alteration and require the accessibility guidelines to be contained.*

The natural environment creates challenges and can require compromises. Sometimes there is a misunderstanding by ADA-covered entities—especially public entities—that because there is no technical standard formally adopted by the Access Board or the Justice Department, that an outdoor facility is not covered. They still have an obligation to do *something*. They must make their best effort to resolve the issue and keep a record in case of future complaints. Even with rules, not everybody will be happy, even if a facility is in full compliance. According to Nancy Horton, one should “never make assumptions about what disabled people can or want to do- plan for disabled people to do everything” (Horton).

Trail accessibility should depend on the purpose of the trail. If the trail is built for mountain biking or as a difficult hiking trail, accessibility is less of a concern. However, if the trail or path is built for routine pedestrian use, it should adhere to the proposed accessible guidelines. It is also important for trail planners to remember that a trail can meet accessible standards, but fail to meet the appropriate standards laid out for shared-use paths in the AASHTO guide for bicycle and shared-use facilities. In other words, meeting accessibility guidelines does not mean that the facility meets safety guidelines for all user groups (National Center on Accessibility).

On trails, interviewees talked about the importance of signage and doing as much as possible to make trails safe and accessible for a wide variety of users.

- Lack of information for users is a big ADA problem. Signage and information help people decide which trails match their abilities and limitations best. Trail conditions such as surface material, grade, obstacles, and known safety issues should be posted at the beginning of the trail, before a disabled person enters and has to turn back (Horton).
- There is little to be done about naturally occurring grades, but one is obligated to do as much as possible. There are options for dealing with areas that naturally exceed the five percent

requirement, for example providing passing places and rest stops at regular intervals. Rest stops allow the physically challenged and disabled to utilize the structure (Bustos).

- The Pennsylvania Bureau of Forestry is actively enhancing trails and looking for new opportunities for experiences for ADA users. However, most trails in the Bureau's system are unpaved trails providing a more rustic experience than a typical park trail. New structures (such as latrines) are all ADA accessible, but they are not systematically retrofitting older structures. In 1977, the Bureau of Forestry started to provide motorized access for disabled persons, primarily to allow hunting. In recent years, access roads are being used for a wider variety of activities, and they have some roads solely for the use of disabled persons (Beaver).

In general, the rule of thumb seems to be that if it is paved it needs to be fully ADA compliant using the most current standards. There are also ADA issues related to changing standards for rural, recreational trails over the years and with new federal rules pending. Due to the sometimes rustic nature of recreational trails, it is difficult to decide how far ADA accommodations should go. In many situations, providing ADA accommodations is impossible or cost prohibitive and/or would seriously change the natural experience for everyone. Moreover, because ADA regulations have changed over the years, facilities that were in compliance when constructed may not be in compliance now. Without permanent guidelines, managers of trails may be unsure how to proceed. Moreover, there are issues with the guidelines changing—ten years from now the guidelines could change again requiring new improvements (G. Smith). However, many of the interviews provided insight into how local governments or agencies handled this problem:

- In terms of off-road facilities: "Provide for one, provide for all" (D. Smith).
- In Colorado, all trails that are paved must be ADA accessible (Collins).
- It is very unusual for a bicycle facility to be truly single-use, and therefore all facilities need to be ADA compliant (Bustos).

USER CONFLICTS

User conflicts on trails are often the result of crowded conditions as well as different user groups with different speeds and skills such as bicyclists, walkers, joggers, and other user groups (Moore 1). Issues related to shared-use paths and safety incidents include:

- Collisions or users attempting to avoid potential collisions.
- Unsafe user behavior.
- Low-level user skill or poor user judgment.
- Dangerous conditions on the trail such as rain, snow, or physical obstacles.
- Poor trail design, construction, or maintenance.
- Criminal activity.

Interviewees also noted that crashes on urban and suburban off-road and multi-use paths are most often related to user conflicts:

- The primary safety issue is user conflict due to the speed of road bike users on the trail network (Woodcock).
- The main safety issue in Colorado tends to be user conflicts (bicycle/pedestrian, equestrian/pedestrian, etc.). Most user conflicts go unreported (Collins).

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- User conflict issues between bikers and other user groups such as rollerbladers or walkers are the primary safety issue. A specific trail was utilized by a number of user groups of varying skill levels, and significant time was spent negotiating between users groups over their access to the facilities. For example, he worked with bicycle racing teams to find a parallel route that was better suited for their high speeds (Bustos).
- Most problems occur where a trail intersects with a road (Huber).
- One interviewee noted that each user group would like to have its own dedicated, single-use trails, but that this is simply not possible. It is hard enough to maintain what they have now (Beaver).

According to an FHWA report, user conflicts on trails are the result of differences in skill, movement patterns, and speed. The greater the differences the more likely an accident will occur. Different user groups have dissimilar movement patterns. For example, bicyclists and rollerbladers use different amounts of the trail due to their different physical requirements, and certain users require different amounts of room to turn. Additionally, fast-moving bicycles approaching walkers is a very frequent problem (Kirschbaum et al. 83). Trail users, especially cyclists, have a low tolerance for delay. Bicyclists have a strong desire to maintain momentum and may feel as if traffic regulations do not apply to them; while younger trail users may not be experienced dealing with traffic (Pedestrian and Bicycle Information Center).

Another report by the Federal Highway Administration and the National Recreation Trails Advisory Committee combines the abundance of literature related to user conflicts on shared-use trails into one helpful source. Trail conflicts between users are not limited to one type of trail, so this report evaluated all types of trails including concrete urban greenways and unpaved rural trails. It is important to remember that shared-use paths are not limited to conflicts solely between bicyclists, rollerbladers, and joggers, but may also include conflicts between hikers, snowmobiles, and equestrians (Moore 1).

They found many factors that influence user conflicts and accidents, of which trail designers and managers need to be aware (Moore 1):

- Users passing each other without warning.
- Masses of users or vehicles.
- Congestion (number of users per mile).
- Sight distances.
- Trail width.
- Trail surface.
- Trail hazards or difficulty.
- Users expectation of their environment and awareness of possible conflicts or hazards.
- Personnel presence on the trail and emergency protocols.

The authors divide actions aimed at reducing user conflicts into physical and management responses. Physical responses include trail design, maintenance, and layout. Management responses include information and education, user involvement, and enforcement. More information related to management measures can be found in Section 4: Managing to Enhance Safety, Security, and Maintenance. This report cautions against waiting until accidents or incidents occur. It is much easier to prevent conflict with quality planning than attempt to change

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existing policies, structures, and design to reduce conflicts. Several physical strategies can be used to reduce conflicts (Moore 22-27):

- Provide separate trails in areas experiencing frequent problems.
- Diversify the number of trails with various activities in mind (providing different terrain or levels of difficulty will cause some users to move to an alternate facility).
- Tim Bustos noted that in his experience, about one to two percent of bicycle riders would rather ride in the street than on a separate bicycle facility (Bustos).

The authors also refer to the system suggested by Robert Searns and Charles Flink where trails are designed with different facilities in mind:

- Single-tread multiple-use: open to all user groups on a paved surface.
- Single-tread time of use: allows different uses at specific time periods. For example, some trails in close proximity to crowded beaches in California have time restrictions on when bicycling is permitted. A red traffic light indicates that bicyclists must walk their bikes, and conversely when it is green they can ride.
- Single-tread zoned for multiple-use: certain geographic sections divided by striping or materials for different uses. The Platte River Greenway in Denver has different surfaces to distinguish different sections for separate uses. Urban areas are paved and rural, less-traveled areas have a crusher fine surfacing.
- Multiple-tread, multiple-use trails: have different surfaces, but usually run parallel to each other. The Ojai Trail in California is a good example. This facility has a 10-foot wide paved trail for most pedestrian users and a woodchip-surfaced equestrian trail alongside. The two surfaces are separated by a fence. Another example in California is the Venice Beach trail that divides two-way bicycle traffic and two-way pedestrian traffic using a yellow center line and pavement markings to identify them to user groups.

However, providing separate facilities is not always recommended by the report due to cost and enforceability (Moore 22-27).

Some additional practices can also be used to reduce user conflict (Kirschbaum et al. 87-91):

- Use signage to divert different skill level users to alternate trails.
- Regulate the intensity of certain activities, for example with speed limits and rules.
- Provide multiple trailheads for different users to reduce congestion between groups.
- Provide etiquette standards on trail signage.
- Hold meetings between user groups and clubs to facilitate a better understanding of user activities and trail etiquette.
- Shorten sight distances and include curves and turns to reduce speed.

Interviewees shared their experiences related to shared-use and parallel paths:

- All of Madison, Wisconsin's paths are multi-use and paved and do not use side (parallel) paths to separate users (Ross).
- The concrete, multi-use Platte River Greenway has 500,000 users a year (including road bikes, mountain bikes, hikers, roller-bladers, and strollers). Because of the constant usage, a secondary granite sand (crusher fines) trail was built along side to handle overflow and separate users. However, some individuals think the new secondary trail is a maintenance trail and do not use it (Woodcock).

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- Because of the diversity of users on the trail, ranging from fast-moving road bikes to five year-olds learning how to bike, there needs to be a focus on designing multi-use trails. Chris Pauley recommended a separation of users on the trail and cited his desire to build a secondary pedestrian trail next to the current paved trail, especially in more urban areas (Pauley).
- The use of separate bicycle facilities is only recommended where it can have its own dedicated right-of-way (Bustos).

The Pedestrian and Bicycle Information Center (PBIC), states that shared-use paths have become increasingly common and differ in size, location, and function. Some are long paths stretching over 20 miles; others are short 1-mile routes in urban areas. Some may be used by commuters and others for recreational use (PBIC). Researchers and interviewees provide a number of considerations for designing these facilities:

- Designers should expect and plan for bike paths to be used as multi-use paths. Therefore, the needs of different user groups and the number of users should be accounted for in designing the facility and determining the width of the path (Bustos). Paths are used by a wide variety of users including pedestrians, joggers, in-line skaters, fitness walkers, and people with dogs or strollers, bicyclists, and equestrians moving in both directions. The more types of users expected on the trail, the wider the path should be. (PBIC). Trails are seldom used in one direction of travel (PBIC). Assume both pedestrians and bicyclists will use the trail, and remember that pedestrians travel at low speeds compared to other users, usually between three and seven miles per hour (Olka, Searns and Flink 52).
- Shared-use paths should be designed using the same engineering standards as highways. Issues that are considered in highway design such as sight distances, surface quality, and stopping distance should be factored in shared-use planning (Pedestrian and Bicycle Information Center). Also incorporate design speeds, super-elevation, and curve radii, which affect the safety and security of users (Bustos).
- Facilities should be designed for safety first, and designing to the minimum ADA standard may not address all safety issues. Too frequently, agencies design to the minimum ADA standards without considering all the safety concerns. It is especially important in areas where there are no adopted standards that agencies understand the safety issues and how to address them –“figure out what accessibility looks like.” All facilities should be designed to be safe and useable for all users (such as children and elderly people), not just ADA users (Horton).
- Tim Bustos recommended that trail and path facilities be built to the same construction standards as roadways. Inevitably, maintenance or emergency vehicles will use the trail, so better to construct for those vehicles from the start. On busier trails, he stated that it was also important to make sure facilities are wide enough and tunnels high enough to allow these vehicles to pass through (Bustos).
- Several interviewees recommended that facilities be designed at the outset to reduce future maintenance costs and invest in durable materials that will last the longest (Pauley; Huber; Bustos). For example, develop strategies to limit the damage weeds have on breaking up (asphalt) trails and compare options such as concrete versus asphalt to reduce future maintenance costs.
- SSPR had roundabouts on the trail network designed to accommodate snow removal equipment. The design of the roundabouts has allowed snow vehicles to clear effectively,

however, he also noted that some cyclists still go too fast through the roundabout. (Woodcock).

- It is strongly recommended that facilities for bicycles be designed by individuals with experience in bicycle transportation design. Frequently, traffic engineers are only schooled in one type of road users: automotive users (Bustos).
- Trails are an addition to, not a substitute for, the roadway network. Trail users will still need to use roads and sidewalks traveling to and from the trail, (PBIC).

In general, shared-use paths (trails) should be a minimum of 10 feet wide to accommodate multiple users traveling in both directions (Kirschbaum et al. 14-3; Olka, Searns and Flink 60; Pedestrian and Bicycle Information Center; Reitmajer et al.; U.S. Access Board). Urban trails may require 12 feet or more, and trails with heavy use or large numbers of in-line skaters may need to be at least 14 feet (PBIC 1). In rural areas with no walkers or joggers, trails may be reduced to 8 feet wide. Two feet of clear space on either side of the trail is recommended so users can avoid signs, shrubs, walls, etc. (Kirschbaum et al. 18-1-18-4; Olka, Searns and Flink 106; PBIC 1). This total width should be maintained through bridges, tunnels, etc. In addition provide (Olka, Searns and Flink 54, 87):

- Eight-foot vertical clearance along the trail and a 10-foot clearance in overpasses and tunnels.
- A safe design speed of 20 miles per hour on level ground and a 30 miles per hour on grades above four percent.
- Stopping sight distance of 150 feet for both paved and unpaved trails.
- Design speed should be set at 20 mph minimum, 30 mph where downgrades exceed four percent, and 15 mph on unpaved paths (Pedestrian and Bicycle Information Center).

Interviewees offered their experiences related to path width:

- Bill Woodcock stated that all of their trails are 10 feet wide, but they would like to expand to 12 feet to accommodate 2-foot rumble strips throughout the trail network (Woodcock).
- The paths range in size from 8 feet to 12 feet (preferred), depending on location and age (Ross).
- TimHuber recommended that all trails be a minimum of 10 feet wide to allow for emergency and maintenance vehicles to access the trail network effectively. The edges of 8-foot paths break off because they cannot support the width and weight of maintenance vehicles (Huber).

Intersections are where the majority of bicycle/motorists collisions occur (Bustos 22). Therefore, planners and other public officials should attempt to minimize the number of street intersections crossing shared-use paths. Shared-use paths that cross through more than eight street intersections should not be installed. The Idaho manual suggests using on-street bike lanes when there are five to eight intersections per mile. On shared-use paths that have one to four intersections, planners should incorporate special treatments to minimize the risk to users (Pedestrian and Bicycle Information Center).

As trails age and become more popular, there will be increasing numbers of trail users at the crossings, which may require additional crossing improvements. A number of traffic calming measures have been recommended to address user conflict due to the speed of road bike users on trails. Curves in the trail, rumble strips, and centerline striping have all been successfully used to

slow cyclist speeds. Additionally, some jurisdictions have experimented with roundabouts on trails. Some additional recommendations:

- The best trails avoid sudden or sharp turns, but are not completely straight either (Pedestrian or Bicycle Information Center). Design or add speed control features such as frequent turns (Moore 27). Design more curves into the trail system to slow down bicyclists on multi-use trails (Collins).
- On a recently built concrete trail, Bill Woodcock stated they placed a 2-foot rumble strip along the sides of the trail where it runs close to creek and lacks railings. These have been so effective that he hopes to place rumble strips throughout the trail system (Woodcock).
- SSPR has centerline striped a greenway in response to a fatal collision between a northbound bicyclist and southbound bicyclist. The line is solid through underpasses and dashed in all other areas. This striping has significantly increased user safety. In particular, cyclists no longer ride three or more abreast across the full width of the trail (Woodcock).
- They also constructed bicycle roundabouts were constructed to slow down road bikes at congested trail intersections. Roundabouts have been effective in reducing the speed of most user groups, although road bikes can still maintain considerable speed in the roundabout (Woodcock).

In congested areas where providing a separate facility is not possible, some additional treatments are recommended to reduce the potential for conflicts (Moore 23):

- Separate trailheads and crowded areas of the trail (such as at the beginning).
- Maximize sight distances.
- Increase trail width.
- Provide pullover or passing areas by increasing width in congested areas.

Finally, bicycle speeds can cause problems for trail workers too. Due to cyclist speeds, SSPR often uses flaggers in work areas—this has led to some altercations with road cyclists (Woodcock).

Slopes on Trails

Steep grades (or slopes) present problems for a number of reasons. Pedestrians and cyclists may seek an unsafe crossing if the upcoming slope is too high, and/or cyclists may increase speed to unsafe levels to manage the upcoming hills. Additionally, steep grades become even more dangerous with inclement weather and debris (Bustos 19). Another major reason is accessibility. According to the 2000 U.S. Census, 49 million or 19.3 percent of Americans have a disability, and the number of citizens 65 and older is also growing. It makes sense to minimize slopes as much as possible.

Sources agree that running slopes (across the length of the trail) should be kept to less than five percent as much as possible. Cross-slopes (across the width of the trail) are important for drainage, but can present an enormous energy obstacle for many users, including those with wheelchairs and walkers and individuals with balance and stamina issues (U.S. Access Board). As a result, cross-slopes should be less than 1:20 or two percent (National Center for Accessibility). Cross-slopes above two percent increase the difficulty for disabled users in normal weather conditions much less when rain or snow storms occur.

It is not always possible to meet the running slope requirements due to natural or existing conditions. In that case, it is important to do as much as possible to allow all users to navigate the grade. Therefore, the design guide stipulates that the running slope should be kept to the minimum level permitted by the natural environment (Kirschbaum et al. 10-11, 75-76).

Some treatment options include level runouts, ramps, and wider sidewalks which create more room for the installation of these treatments (U.S. Access Board, 37), as well as regular resting places. The National Center for Accessibility provides some additional guidelines for slopes where resting places are included at regular intervals:

- Running slope must have no more than 30 percent of the trail length exceeding 1:12 and comply with one or more of four requirements: running slope cannot exceed 1:20; if resting intervals are installed every 200 feet, the running slope may be a maximum of 1:12; if resting intervals are provided every 30 feet, the running slope may be a maximum of 1:10; if resting intervals are provided every 10 feet, the running slope may be 1:8 (National Center For Accessibility).

Some recommend that rest stops with benches be provided every 200 to 300 feet (Olka, Searns and Flink 59), and that these areas must be 60 inches in length, as wide as the greatest width of the portion of the trail segment leading to the rest area, and slope must not exceed 1:20 in any direction (National Center For Accessibility).

Some other recommendations include:

- In places where it is impossible to stay below a five percent grade, a slip-resistant ramp should be installed (Olka, Searns and Flink 52).
- The maximum slope for ramps is 8.33 percent (U.S. Access Board 75).
- Ramps should have a landing for every 30 inches of vertical rise and 32-inch hand railings.

Steps are a major barrier for individuals in wheelchairs and should not be included in new construction. Where steps already exist, alternate routes should be created. Signage should be installed at the trailhead indicating the presence of steps, and barriers should be installed around the steps to ensure appropriate use. Wheel tracks along the stairs may encourage bicyclists to use the stairs. Flights of stairs should be set apart from one another and the height should be minimal if steps must be used. Wheelchair users, however, will still require assistance (Kirschbaum et al. 64-66).

There are options for dealing with areas that naturally exceed the five percent requirement. For example, when a pedestrian crossing above a freeway exceeded a five percent grade because it had to cross over six lanes of traffic, rest stops were included every few feet to compensate for the grade. These rest stops allowed the physically challenged and disabled to utilize the structure and created an attractive serpentine rolling look. Tim Bustos, former Bicycle and Pedestrian Coordinator for City of Davis, California, mentioned two other alternatives for steep slopes that he deemed to be much less successful. First, the design could include switchbacks; however, these create problems for cyclists. Second, California has tried using bike stairs, but no longer uses this approach and does not recommend them (Bustos).

If switchbacks are used, they should have less than a five-percent slope, follow natural drainage patterns to ensure a constant, firm, and stable surface, and include natural or other barriers at the edges of the path (Kirschbaum et al. 78).

Drainage on Trails

Drainage systems can be used to reduce the maintenance costs associated with drainage issues (Olka, Searns and Flink 64):

- An inexpensive option is an open drainage system that uses drainage channels alongside the trail, ditches, detention ponds, and sheet flow to collect water throughout the system.
- A closed system includes underground structures such as catch basins, inlets, culverts, or underground piping to move water away from the trail.
- A combination system employs both methods depending on the different circumstances.
- French drains, trenches with permeable, and absorptive material can be used to address subsurface water.

The crusher fines trails need good drainage or they will wash away. The crushed limestone must be very fine or it will not have a good surface. Due to freeze/thaw cycles, sometimes crushed limestone trails need to be top-dressed and rolled/compacted, especially where there are drainage issues (G. Smith).

Surface and Materials

According to the National Center on Accessibility, the following questions should be posed when selecting a trail surface:

- What are future maintenance costs?
- Who will be the primary users of the facility?
- What is the goal of the trail experience?
- What are the geographical characteristics of the trail sites (areas with high rainfall or other weather issues will require stronger surfaces)?

An accessible trail includes a route from accessible parking to the trailhead. This surface must be firm and stable (National Center on Accessibility). Sidewalks and shared-use paths must adhere to the “stable, firm, and slip-resistant” accessibility requirements (U.S. Access Board,). The greater distance the accessible trail route runs, the more firm and stable the surface should be and vice versa. Firmness and stability can be measured by a rotational penetrometer (National Center on Accessibility). Some additional considerations for surfaces of trails and shared-use facilities for universal accessibility include (Kirschbaum et al. 12-15, 12-18):

- Surface materials should be consistent with the intended use of the trail and the surrounding area. A rustic backwoods trail through the wilderness, for example, should not be designed as a paved shared-use path.
- Surface materials should be consistent throughout the trail (i.e., a wide paved trail should not come to a half-log crossing over a stream or require wading through the stream).
- Soft or unstable surfaces should be avoided, but never allowed for more than 45 feet in accessible areas, and should be avoided around elements that would be used by the disabled.
- Signage describing the trail surfaces should be provided at the trailhead.

The choice of trail surface also has implications for the level of maintenance and durability of the multi-use trail. Harder surfaces withstand environmental elements much better than softer surfaces and therefore have fewer maintenance issues. In addition, the higher the quality of the sub-grade and sub-base, the longer the trail will last without major, costly maintenance concerns (Olka, Searns and Flink 62, 65). Two interviewees noted that it would be worth investing more in the design and materials at the beginning to avoid maintenance costs later, especially since maintenance money is harder to get (Huber; Pauley). Additionally, materials that are strong and vandal-resistant should be used whenever possible.

A number of surfaces have been identified as inaccessible through legal actions and research, including: sand, pea gravel, mulch, wood chips, and large gravel (greater than 3/8 inch in diameter). These surfaces do not meet the requirements for firm and stable. When selecting an accessible surface, the NCA reminds trail managers and other agencies not to assume a surface will meet standards just because it is labeled as accessible. Bare soil, for example, may be considered as accessible, but weather conditions or maintenance can quickly change this. An accessible trail that is in a condition that does not meet standards is no longer considered accessible (National Center on Accessibility).

Soil stabilizers are frequently referred to as a source that binds different materials together to provide a more firm and stable surface. They can be mixed with the surface, but it may be more cost-effective to use soil stabilizers on the base surface instead. Errors in mixing or compacting can lead this surface to be determined as inaccessible (National Center on Accessibility).

Concrete and asphalt meet the firm and stable ADA requirement (National Center on Accessibility). One design guide recommends using broom-finished concrete to provide slip resistance and for surface water control (U.S. Access Board). The state of Oregon recommends Portland cement sidewalk surfaces because it has a smooth, durable finish that is easy to grade and repair. They also note that it has a 40-year life expectancy compared to 15-20 for asphalt (Reitmayer et al.). The PBIC also prefers asphalt or concrete surfaces for heavily used trails and trails with in-line skaters. However, paved trails will raise the speed of bicyclists, which may be an issue in areas with heavy pedestrian use. Crushed limestone is adequate for low-use facilities, but is more prone to flood damage. Some hard surface trails have a parallel soft surface for jogging or equestrian use (PBIC). Tim Bustos pointed out that concrete, although initially more costly to construct, saves a lot in maintenance costs due to its durability compared to other surfaces such as asphalt (Bustos).

Others also discuss the advantages and disadvantages of trail surfaces. Granular stone such as crusher fines, asphalt, and concrete hold up the best with minimal maintenance and are accessible to all user groups, although softer surfaces such as crushed rock or mulch are usually preferred by pedestrians (Olka, Searns and Flink 68). They go on to state that granular stone surfaces provide stability and are deemed accessible if the stones are smaller than 3/8 inch in diameter and properly packed. However:

- Replace stones every 7-10 years. Spot repairs and grading will be necessary.
- Avoid snow-plowing this type of surface.
- Spread four inches thick over the sub-grade.
- Use geotextiles on top of the sub-grade to prevent weeds from emerging.

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For asphalt trails:

- Layer two inches thick over the sub-grade.
- Consider that asphalt lasts longer with regular use (7-15 years).
- Patch cracks.
- Build a soft-surface, off-trail path for equestrians to avoid the damage they can cause to asphalt in the summer.

They conclude that the strongest, but most expensive trail surface is concrete, which requires practically no maintenance:

- Reinforce it to prevent cracking.
- Place wire or fabric mesh over sub-base and 4-6 inches of concrete.
- Finish with a stiff broom to reduce slipperiness when wet.

They also provide a few additional considerations:

- Asphalt and concrete are the best surfaces for the disabled, however crushed stone with a diameter less than 3/8 inch can also work.
- If the multi-use path uses concrete or asphalt as the surface, then a smooth 2.5- to 5-foot shoulder free of hazards and obstructions should also be included.
- A separate, pedestrian-only path that runs beside the multi-use path can minimize conflicts between user groups and may be constructed of bare earth or crushed stone.

Interviewees also weighed in on surface materials:

- Asphalt trails built since 1990 have not required much maintenance yet, but Tom Huber believes these trails will become a problem in the future as facilities are used and age. Resurfacing will be an issue with these trails in the future (Huber).
- Crusher fine is considered to be ADA accessible and Bill Woodcock stated he had personally witnessed wheelchairs successfully using crusher fines trails. Furthermore, he stated that wood chips and bark are also considered accessible (Woodcock).
- SSPR has been using more of the crusher fines, especially in floodways. Bill Woodcock reports that it drains well and hardens to a consistency almost like concrete (Woodcock).
- Crushed limestone must be very fine or it will not have a good surface. Due to freeze/thaw cycles, sometimes crushed limestone trails need to be top-dressed and rolled/compacted, especially where there are drainage issues (G. Smith).
- Motorized access for disabled persons has been provided by the Bureau of Forestry, primarily to allow hunting. They now have 62 miles of astro #10 surface, rolled pavers placed in aggregate and compacted (Beaver).

Trail managers who avoid using asphalt and concrete due to the appearance should be aware that they can now be stained, stenciled, and colored to create the appearance of a natural surface (National Center on Accessibility).

The sub-grade, sub-base, and trail surface also factor into a trail's maintenance costs. The sub-grade is the natural environment on which the trail will be built. When designing the trail, consider the following practices based on sub-grade conditions (Olka, Searns and Flink 62):

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- Replace fine soil with graded aggregate stone to prevent frost heaving.
- Replace heavy clay soils or finely grained soils with coarse soils that allow better drainage
- Replace saturated soils with soils that drain efficiently to prevent ruts or other damage due to heavy usage or loads.
- Replace “expansive soils”—soils that expand more often than other soils due to temperature and water—with coarser materials that drain better to avoid cracking.

Above the sub-grade is the sub-base that serves as the foundation for the trail surface. The sub-base is comprised of a graded aggregate stone; selecting the specific type is dependent on trail location, soil type, and drainage issues. The following design specifications should be followed to reduce maintenance costs:

- The sub-base should be at least 4-8 inches thick. Increase the thickness if the sub-grade is in poor shape.
- The design load—maximum weight the trail can sustain without damage—should be at least 12,000 pounds to accommodate emergency and maintenance vehicles.
- The maximum design speed should be 15 miles per hour.

General Issues: Sidewalks and Shared-Use Paths

Grade versus At-Grade

The majority of bicycle/motorists collisions occur at intersections (Bustos 21). Therefore, planners and other public officials should attempt to minimize the number of street intersections crossing shared-use paths. Shared-use paths that cross through more than eight street intersections should not be installed. The Idaho manual suggests using on-street bike lanes when there are five to eight intersections per mile. On shared-use paths that have one to four intersections, planners should incorporate special treatments to minimize the risk to users (Pedestrian and Bicycle Information Center).

There is also an obligation to provide safe and attractive pedestrian and bicyclist crossings when there are obstacles such as highways, railroads, or rivers (Pucher and Dijkstra). First, it must be determined if the intersection will be at-grade or grade-separated. Deciding between keeping an existing bridge or removing it usually leads to conflict between trail users and the agency responsible for maintaining the structure. Trail users contend that trail user safety is usually sacrificed in the name of motorist user safety, and removing grade-separated crossings reduces the trail corridor’s value as a commuter trail since trail users must stop at at-grade crossings. PennDOT analyzes a number of factors in determining whether a grade-separated structure should be retained (Gittings et al. 105):

- Type of trail user.
- Average daily traffic (ADT) of both roadway and trail.
- Type of vehicular traffic.
- Type of roadway.
- Number of lanes.
- Speed of roadway.

- Sight distance.
- Grade.
- Drainage.

There was a lack of comprehensive engineering guidelines in deciding between at-grade and grade-separated trail crossings. Of note is the fact that California developed guidelines for trail/highway crossings based on peak-hour motor vehicle traffic and peak-hour bicycle volume. The state used these criteria to determine if traffic signals, other marked treatments, or grade separations are warranted. Minnesota is considering adopting Finland's guidelines used to decide between marked crosswalks, traffic islands, signalization, and grade separation. The Finland guidelines incorporate a quantitative formula that considers motor vehicle ADT, speed limit, type of trail user, and trip purposes (Gittings, et al. 105-106).

A major consideration is railroad track crossings. These crossings have been studied by numerous state and federal agencies to improve safety. At-grade crossings are being increasingly replaced with more costly grade-separated crossing for safety and liability issues. This report recommends against building at-grade crossings with railroad tracks whenever possible (Birk et al. 53-54). However, many pedestrian and trail experts recommend avoiding pedestrian tunnels and bridges (grade-separated treatments) where possible for security reasons. Use them as a last resort after attempting traffic-calming measures and pedestrian-activated signs (Zegeer et al. 49; Zelenka and Brennan).

The following design recommendations are for grade-separated crossings (Birk et al. 70-74):

- These facilities are highly expensive to retrofit and should be designed with both current and future use in mind.
- If an underpass is selected it should be designed to the shortest possible distance to maximize natural lighting and reduce the potential for hiding areas.
- Future maintenance needs and costs should be considered when planning the facility.
- Width should match the approach path with a 2-foot clear area on either side (an 8-foot path should have a 12-foot-wide tunnel or bridge).
- Vertical clearance should be at least 8 feet and allow for access by emergency and maintenance vehicles.

Wisconsin prefers using overpasses rather than underpasses where grade-separation is necessary because they are more visible and easier to patrol and access in an emergency (Huber). Bridges and tunnels (overpasses and underpasses) should be as short as possible, straight, wide, and well lighted. Bridges should allow for full visibility from within and without (Zelenka and Brennan). Underpasses should be designed to be open and accessible. If possible, construct the roadbed above the tunnel entrance so that users can see all the way through the tunnel from a distance (Bustos). Lighting, security, and drainage must be factored into the design process (Zegeer et al. 49). At-grade intersections between a path and roadway must be carefully and consistently designed. The objective is to make trail users as visible and predictable as possible to motorists and each other (Pedestrian and Bicycle Information Center). Poorly designed trail crossings can lead to frequent safety incidents. If there are no traffic signals or lights present, an agency should speak with a traffic engineer to evaluate the crossing. As a general rule, trail crossings should cross streets as close to intersections and crosswalks as possible. However, if this is not

possible, a traffic engineer should conduct a gap analysis to ascertain traffic peak times. The traffic engineer will determine whether a crosswalk and pedestrian crossing signs will suffice or whether a pedestrian signal light is needed. Usually, traffic lights will not be installed unless pedestrian accidents become a common problem. Also, if a trail crossing involves more than three lanes, a median refuge should be installed (Olka, Searns and Flink 22, 84).

Trails should adhere to the same system roads and streets do, with higher-volume streets having priority over lower-volume streets. For example, if a street has higher volume than the trail, the street retains the right-of-way. If, however, the trail has a larger volume than a residential street, the trail users should have the right-of-way (Olka, Searns and Flink 84).

Sight Distances

Sight distances are extremely important to allow users sufficient time to stop before the intersection (see the AASHTO guide for specific sight distances). Sight distance should be determined by the approach speed of vehicles, roadway width, and acceleration ability of users (Gittings et al. 106). Specifically, designers need to allow for sufficient:

- Sight distance for users to come to a controlled stop before the intersection.
- Intersection sight distance for trail users from the stopped position before crossing.
- Motorist sight distance to allow for adequate stopping time.

Additionally, sight distance should be measured from a stopping point 15 feet in front of railroad tracks. Also design for the approach sight distance, sight distance across the tracks in both directions while crossing and clearing (Birk et al. 71-72).

A number of sources include design recommendations for street crossings:

- Provide curb cuts that are the same width as the trail (Olka, Searns and Flink 52).
- Place crosswalks at all trail crossings. However, rural districts have discouraged this due to the high speed of motorists on rural roads (Gittings, et al. 106).
- Design the crossing at a 90-degree angle to the street or railroad tracks (Pedestrian and Bicycle Information Center; Birk et. al. 70-74).
- Design crossings to be consistent throughout the trail corridor (Pedestrian and Bicycle Information Center).
- Use sound engineering (Pedestrian and Bicycle Information Center).
- Do not allow approach grades to exceed five percent (Birk et al. 73).
- Provide a smooth, well-maintained crossing surface (Birk et al. 73-74).

At intersections with roadways, some paths may be mistaken for roads. Therefore paths need to be clearly marked and signed in both directions to discourage unauthorized motorized access (Pedestrian and Bicycle Information Center):

- Provide signage at access points from the roadway to the trail and at all intersections (Pedestrian and Bicycle Information Center).
- Provide stop signs placed 5 feet from intersection (Olka, Searns and Flink 84-86).
- Provide passive advanced warning treatments at railroad tracks such as signage or pavement markings (compliant with the Manual on Uniform Traffic Control Devices, MUTCD) (Birk et al. 75-77).
- Provide active advanced warning treatments at railroad tracks such as gates, bells, and flashing lights (MUTCD; Birk et al. 78-79).

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- Provide markings using MUCTD standards (Pedestrian and Bicycle Information Center).
- Provide an 18-inch concrete strip across the trail on asphalt trails to indicate upcoming intersection, placed 30 feet from the intersection. This creates a change in surface and color to alert users (Olka, Searns and Flink 84-86).
- Provide a detectable surface across entire width of the trail for two feet from the roadway (Olka, Searns and Flink 52).
- Provide pedestrian-activated crossing signals at intersections and at mid-block crosswalks. Also consider adding bicyclist-activated traffic signals at key intersections, and special traffic lights for bicyclists at intersections with priority signaling for bicycles (Pucher and Dijkstra).
- Provide reflectorized panels or vertical bars at all four corners of crossing and bicycle crossing signs (Gittings et al. 106-107).

Interviewees also discussed the importance of signage and markings at crossings:

- They use the same traffic control devices and signage as would normally be used at a regular street intersection. Madison, Wisconsin, also began marking crosswalks where the multi-use paths intersect with roads. Paths have detectable warnings at street intersections and ADA ramps designed to specifications. Intersection treatments are critical, especially visibility and warnings. Intersections must be clear and safe for all users (Ross).
- All trail crossings are marked according to MUTCD standards for warning signs (Huber).

Other options for protecting users at intersections include using carefully located bollards and medians or splitting the trail into two approaches with a planted triangle in between (Pedestrian and Bicycle Information Center). Barriers can be used at trail openings to prevent vehicular access, however, they should be designed to allow for emergency and maintenance access (Burden and Wallwork).

- Barriers, if used on a shared-use path or recreational trail where bicycles are permitted, should be spaced 60 inches apart. This will accommodate all types of bicycles, wheelchairs, scooters, and walkers. If the trail is restricted to pedestrians, then the minimum passage space between barriers should be 36 inches (Kirschbaum et al. 12-26, 12-27).
- Bollards can cause problems for emergency vehicles. Bollards can also be problematic for bicycles (pedals can nick the bollard). However, bollards are an effective method to prevent unauthorized motor vehicles on bike trails (especially at intersections with roads). Minimize the use of bollards to only those locations where they are absolutely necessary. Where present, use break-away bollards or removable/lockable bollards. Make sure that staff replace and relock the bollards back into place after gaining trail access (Bustos).
- Carsonite Posts installed with optional anchor on the bottom should be used to prevent vandals from removing. The added cost is minimal [National Park Service (NPS) 88].

SIGNAGE AND PAVEMENT MARKINGS

Signs provide directions and needed information. Edward McMahon states that too often signs are oversized, poorly planned, badly located, and altogether too numerous. The careful design and placement of traffic signs and other public signs can improve community appearance and aid travelers. A profusion of signs is as confusing as a lack of them. A good sign communicates its message clearly and quickly, is compatible with its surroundings, and enhances the visual image of the community. When the streetscape or trail becomes overloaded with signs, the cumulative

effect is negative; the viewer actually sees less, not more (McMahon et al.). Visual clutter impairs wayfinding ability (Zelinka and Brennan).

Provide uniform signing and marking on all bicycle and pedestrian walkways (Reitmayer et al.). Signage and striping should be used to provide information relating to location, warnings, upcoming intersections, and expected behavior (Pedestrian and Bicycle Information Center). Develop pedestrian-oriented signage such as warnings for steep grades, as well as other safety and informational signage. Signage placement must focus on pedestrians too—almost all current signage is focused on drivers (Kirschbaum 69). Also, all signage should adhere to MUTCD standards (Birk et al. 75).

Place signage and information at the beginning of the trail. Conflicts frequently occur in congested areas on the trailhead, during the first mile or two. Placement of information in these areas not only guarantees high visibility, but also places the information close to the problem (Moore 22-25, 26-28). Do not place regulatory signs too close together. Signs should be at least 75 feet apart throughout the trail. Information signs can be placed together at trail facilities such as kiosks, trail headquarters, access points, or rest areas. Avoid placing signs where they block scenic views or views of upcoming obstacles or hazards (Olka, Searns and Flink 88-93).

Provide signage and information as well as warning signs throughout trails (Olka, Searns and Flink 88-93). Provide signage and markings related to intersection warnings and crossing rules as discussed in the previous section. Providing railings, curbs, or rope along the edge of trails to help define the trail and warn of danger areas, to provide a barrier-free environment for the visually impaired (Robinette). Bill Woodcock, SSPD Manager of Planning and Construction, stated they placed a 2-foot rumble strip along the sides of a recently built concrete trail where it runs close to creek and lacks railings. These have been so effective that Bill Woodcock hopes to place rumble strips throughout the trail system (Woodcock).

Use signage or other means to provide trail information related to slopes, grades, potential obstacles, cross-slope, and surface type. This enables users to select the most appropriate route for their user level. This information needs to be posted at the beginning of the trail, before a disabled person enters and has to turn back (Horton). Frequently, trails only provide basic information on destinations along the route and usage guidelines, which leaves disabled, elderly or less skilled users with insufficient information over the appropriate route (Kirschbaum et al. 69). Other important information includes:

- The trail's length, location of special areas (such as rest rooms), location and height of signs along the route (to accommodate the blind), meaning of special signals such as textural changes, and dangerous areas (Robinette).
- Known safety issues or hazards.
- Total distance of accessible portion and first area of departure from accessible trail guidelines (National Center for Accessibility).
- Trail difficulty.

Zelinka and Brennan provide recommendations for designing and locating sidewalks and trails to enhance user safety. An important principle is information and orientation. To feel safe, people

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want to know where they are and how to get to their destinations safely and efficiently, irrespective of their modes of travel. These recommendations include (Zelinka and Brennan):

- Clearly articulate rules and directions and provide appropriate street signage (directional and locational) to help people find their destinations.
- Provide kiosks and community message boards with information in areas of high pedestrian activity.
- Provide clear boundaries and borders to enhance pedestrian corridors, define ownership, and encourage appropriate behavior. Boundaries must be carefully designed and maintained so as not to obstruct pedestrian visibility and sightlines. Examples of boundaries, borders, and transitions include knee walls, plazas, porches, awnings, colonnades, and doors.
- Different and special paving materials to define boundaries and right-of-way, and channel pedestrian flows.

Additional recommendations related to wayfinding include:

- Place half-mile and mile markers along trails that indicate the block/street name for each mile marker. This allows people to more easily identify their location and enables emergency personnel to locate individuals and respond to incidents faster (Woodcock).
- Develop a comprehensive wayfinding system in town centers (The Smart Growth Network).

Trail rules and etiquette are also important information to convey. Important information and rules that should be posted include (Birk et. al. 100):

- Hours of use.
- Users should stay on trail; trespassing is illegal.
- Users should keep to the right, unless passing.
- Users should yield to oncoming traffic.
- Bicycle users should yield to pedestrians.
- Users should not travel more than two abreast.
- Users should not stand or stop in middle of the trail.
- Users should obey speed limits.

In addition (Moore 12):

- Convey that the trail is shared with other types of users.
- Give an audible warning when passing.
- Encourage bicyclists to walk bicycles through underpasses (Olka, Searns and Flink 52, 147).

Use visual cues and design elements to indicate pedestrian rights-of-way and minimize conflicts (The Smart Growth Network). Special pavement can clearly delineate pedestrian, bicycle, and vehicular rights-of-way. It can contribute human scale, linkage, complexity, and coherence to the streetscape (Ewing 20).

Sign Specifics

Signage is an important safety feature on all trails. *Trails for the Twenty-First Century 2nd ed.* identifies four types of trail signs: regulatory, warning, informational, and educational. All signs should align with the Manual on Uniform Traffic Control Devices (MUTCD). According to the authors, the following sign shapes should be uniformly be used throughout trails (Olka, Searns and Flink 89-93):

- Octagon for stop signs.
- Equilateral triangle for yield signs.
- Circle for railroad crossings.
- Diamond shape for existing or potential hazards.
- Rectangle for regulatory signs such as speed limits and right-of-way.
- Rectangle for directions.

The authors also list these colors to be used for the following purposes (Olka, Searns and Flink 90):

- Red should be used for the background color for stop signs, do-not-enter, and parking prohibition.
- Black should be used for the message on white, yellow, or orange signs.
- White should be used as the background for all regulatory signs.
- Orange should be reserved for construction and maintenance signs.
- Yellow should be used on warning and school signs.
- Fluorescent yellow-green should be used as the background for pedestrian, bicycle, and school warnings.
- Blue background should be used on signs indicating services information.
- Green background should be used on signs giving directions and permitted movements.
- Brown background should be used on recreational and historical or cultural information signage.

It is recommended that the Sign Symbol system created by the American Institute for Graphic Arts for the Department of Transportation (Olka, Searns and Flink 88-90) be adopted. Some additional signage guidelines include:

- The viewing distance for multi-use trail signs is 20-150 feet.
- Text height should be 3-6 inches tall.
- Text and symbols should be used together for maximum effectiveness.
- Dark backgrounds with light colors should be used to increase readability.

Sign size, placement, and mounting are also important (Olka, Searns and Flink 88-93):

- Stop signs should be 18 by 24 inches.
- Regulatory signs 12 by 18 inches.
- Signs should be placed in clear areas.
- Post-mounted signs should be built 3 feet off the trail.
- Signs should be raised 4-5 feet off the surface.
- Informational or educational signs should be at least 4 feet off the trail.

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Make sure regulatory and warning signs are placed within sight-distance limits (Olka, Searns and Flink 88-90). Assuming a design speed limit of 20 miles per hour, the following important requirements regarding viewing distances and sign placement should be highlighted:

- Stop signs should be viewable from 100-125 feet.
- Warning signs should be viewable from 125-150 feet.
- Stop signs for roads intersecting with trails should be viewable from 200 feet.
- Warning signs for intersections should be 400 feet.

The following should be considered when selecting a material: budget, durability, aesthetics, and maintenance costs (Olka, Searns and Flink 92). Materials considerations include:

- Plastics expand and contract with temperature changes.
- Fiberglass is durable, impact resistant and malleable.
- Wood signs are the easiest to damage.
- Aluminum signs do not rust and can also be laminated.
- Steel is fairly inexpensive, but rusts unless stainless is selected.
- Stone is very durable, but difficult to use and costly.
- Fabrics suffer wind damage and fade from the sun.
- Recycled materials can be sturdy and economical dependent on the particular composition.

Pavement markings are another method of communicating warnings or safety precautions. However, pavement markings should be used infrequently and should not be viewed as a replacement for signs. If pavement markings are used, use white for all markings except when marking a centerline (yellow). Letters should be 3-4 feet high. Acceptable pavement markings include: “Stop,” “Yield,” “Slow,” “Bike Lane,” or “Pedestrian Lane” (Olka, Searns and Flink 91). Avoid using pavement markings in the following situations:

- Critical turning or stopping points: pavement marking make it more difficult to stop in inclement weather.
- In areas where snow, sand, gravel, or leaves accumulate frequently or remain for long periods.
- In places of high use: markings wear away quickly.

DEVELOP AND ADOPT UNIFORM GUIDELINES

Since there is no master design guide for sidewalks, many municipalities and states have adopted their own design standards. They have relied upon the Institute of Transportation Engineers, ADAAG Public Right-of-Way Guidelines, and AASHTO’s Green Book as sources for design standards. When agencies select or develop design standards, they should create design standards with flexibility as trails and shared-use paths often cross unique topographical and natural areas. When developing design standards, agencies should avoid rigid standards without exceptions as this may cause trail managers to ignore all guidelines or standards where their trails cannot meet standards in any conceivable manner (Kirschbaum et al. 87).

Most sources recommend using the American Association of State Highway and Transportation Officials (AASHTO) *Guide for the Development of Bicycle Facilities* (Olka, Searns and Flink), Pedestrian and Bicycle Information Center; Ross). Also, it was recommended that private developers and other private institutions be required to build to the same standards, especially

ADA, because they can be considered public right-of-ways with inherent liability (Reitmayer et al.). The state of Oregon also recommends:

- Adopt design standards for safe and convenient facilities.
- Adopt AASHTO and MUTCD design standards, and in some cases, exceed them.
- Design standards and minimums should allow flexibility for geographic and environmental exceptions.

The United States Access Board, in its *Public-Right-of-Way Design Guide*, warns against designing to the maximum or minimum standards because it leaves little room for error in construction or different construction practices. If the final installation does not meet ADAAG standards, the agency must undertake expensive renovations or be exposed to potential liability issues. Designing beyond minimum standards also increases the ability to handle weather-related events. This concern was also expressed in one of our interviews:

- Although the range of acceptable slopes is set at two to seven percent, facilities are being designed at seven percent, usually to avoid right of way issues, but not allowing any flexibility in the event of a construction issue (D. Smith).

All levels of government should follow the same uniform ADA design standards. This reduces confusion and creates consistency throughout the particular system. Many county and municipal codes are not in full compliance with ADA, therefore new facilities are still being built that do not comply (Waterland). Other interviewees mentioned using ADAAG (Huber), Forest Service and Federal Highways Guidelines (Collins), and Draft Federal Guidelines on Public Right-of-Ways (Woodcock). In addition, Wisconsin Department of Transportation publishes and disseminates to communities a *Bike Guide* and a *Pedestrian Handbook*, both of which include design guidelines to meet ADA standards (Huber).

Special Situations

Although the Washington and Old Dominion Trail in Northern Virginia itself is compliant, many access points may fall short of ADA standards. In most areas, disabled people do regularly use the trail. So far, they have not experienced any issues. Despite not following all ADA standards, the trail does follow slope ratings on bridges and tunnels. The fact that the trail is a paved surface also accommodates a wide range of users (Pauley).

Since the trail is accessible from thousands of locations in a variety of environments, Chris Pauley underscored the difficulty of universal system-wide changes. Because the right-of-way is already established, changing the trail location or alignment is not an option in these situations (Pauley). Rail/trails may also have pre-existing railroad tunnels. Gary mentioned a new rail-trail where it was decided to light the tunnel facility located on the trail (G. Smith).

PART 3: KEY MAINTENANCE ISSUES

FHWA points out that poorly maintained sidewalk networks decrease the amount of walking. At the same time, those who must walk, (especially wheelchair users and the elderly) may be forced to walk in the street (Zegeer et al.).

In *SafeScape: Creating Safer, More Livable Communities through Planning and Design* Zelinka and Brennan point out that how facilities are maintained can maximize (or erode) the users' perceptions of safety. In the book *Trails for the Twentieth Century*, 2nd ed., Kristine Olka, Robert Searns and Charles Flink, as well as many other sources, (U.S. Department of the Interior) note that a well-maintained multi-use trail will increase the number of users, reduce liability concerns, and reduce safety incidents on the trail. Moreover, since both the elderly and disabled are often without personal means of transportation, maintaining facilities in good repair allows them a safe, alternative means of travel. They note that the best way to avoid costly and lengthy maintenance is through appropriate design. In addition to design, appropriate maintenance practices can preserve facilities and save money in the long term (Reitmayer et al.).

Both the literature (Kirschbaum et al.) and our interviewees pointed out that maintenance is required under ADA to keep trails in compliance. The Department of Justice regulations [Titles II (government) and III (business)] also require maintenance of accessible features—routes that are not maintained are no longer considered accessible. Maintenance of pedestrian sidewalks and facilities are considered a program under Title II of the ADA (U.S. Access Board, 15; Horton).

MANAGEMENT AND RESPONSIBILITY

The most recent litigation determined that municipalities are responsible for the maintenance of sidewalks. Although the municipality can decide on the mechanism to use for maintenance (i.e., raise taxes to pay for annual repairs or require homeowners to repair them at their own expense), they are still the jurisdiction's sidewalks. Sidewalks are considered to be a facility, just like a bridge or a building, and, therefore, are protected by the full force of ADA. As a result, the local jurisdiction would most likely be held liable if a person were hurt on a residential sidewalk even where maintenance responsibility is deferred to the homeowner (Horton). At a minimum, the jurisdiction is responsible for enforcement, and therefore local government inspectors should review and approve all repairs (Kirschbaum et al., 8-9).

Robert Searns' article "Trail Maintenance and Management: Operations, Maintenance, and Stewardship 101" states that an agency or managing organization needs to develop quality standards and a maintenance manual that lays out specific tasks. If necessary, they should develop an interagency maintenance agreement such as a memorandum of understanding (MOU) to outline which agency is responsible for particular areas, equipment, performance standards, and cost-sharing information (Searns, 2).

To avoid lawsuits, agencies must inspect and maintain trails and other facilities. Virginia developed maintenance standards to ensure the safety of their facilities and users covering six areas (Parsons HBA, 5-5):

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- Trail inspections.
- Vegetation maintenance.
- Tread maintenance.
- Drainage maintenance.
- Structure maintenance.
- Sign maintenance.

It is usually preferred that a trail or facility be the responsibility of only one jurisdiction or agency. In *Trails for the Twenty-First Century*, 2nd ed. according to Flink, Olka, and Searns, trails managed by one agency have:

- A uniform look (signage, policies, etc.).
- A comprehensive design.
- One uniform trail surface.
- One set of trail rules.
- A consistent maintenance level that users can expect.
- Consistent reporting procedures for concerns or issues (Flink, Olka, Searns 140).

A factor in deciding which agency or governmental organization should be responsible is size. Smaller agencies commonly lack the funds, manpower, and influence to manage longer distance trails. However, local agencies may have a better relationship with local citizens and groups. Moreover, it is not always the case that larger agencies have funding for maintenance; local agencies may have the capacity to devote larger portions of their budgets to maintenance.

When a trail is encompassed by one community, a local agency is the most appropriate governing agency. For example, trails within city limits can be managed by the city's department of parks or recreation. However, if a trail crosses through several municipalities within a county, the county's parks agency, transportation agency, or even utility agency should manage the trail.

In some cases, having a single agency in charge is not always possible. When this is the case, communication and cooperation between agencies and/or governmental levels is critical. An MOU detailing responsibilities and a shared-design manual should be developed. In addition:

- Develop a design, management, and maintenance manual for all managing organizations to follow.
- Agree on a consistent name throughout the facility. If local areas want to include their names, place it after trail name (e.g., Sparkling Creek Trail, Sussex County Section).
- Jointly develop a comprehensive trail map.
- Develop a "Friends of the Trail" organization for the entire trail network. This helps develop relationships between bureaucracies.

Trails that run through more than one county should be managed by a state agency or converted into a state park, providing advantages such as economy of scale, planning staff, and a dependable source of funding, as well as uniform signage and consistent maintenance. In some instances, state agencies are in poor financial shape and cannot undertake the responsibility of maintaining a trail. In these situations, regional authorities have been formed to effectively

manage the trail. Regional authorities can emerge from metropolitan planning organizations, councils of government, or special districts. They have the same advantages as state trails with the additional advantage of having a larger base of public support.

If the public sector is incapable or unwilling to manage the trail, private sector organizations can be considered such as homeowner's associations, local businesses, community groups such as trail groups or civic groups, Adopt-a-Trail programs, and summer youth programs.

SPECIFIC MAINTENANCE TASKS

Maintenance tasks can be categorized into routine maintenance, long-term maintenance, and emergency maintenance, which tend to be weather-related tasks. Routine maintenance includes pavement condition, vegetation management, signage and striping, lighting, trash, sweeping and debris removal, graffiti removal, drainage issues, cleaning facilities such as toilets, and taking care of furniture and security equipment.

Pavement Condition/Surface Condition

The most common ADA complaints relate to sidewalk maintenance—cracks, holes, and loose gravel. (Hodges). Poor sidewalk surfaces such as swelling, cracking, and other repair issues are ADA problems (Kirschbaum et al. 39). The following actions should be undertaken in order to mitigate the effects of time and the elements trails and address these concerns:

- Regular inspections should be conducted (Parsons HBA 5-5). Check surfaces for irregularities and structural deterioration such as major cracks. Damaged surfaces must be replaced so disabled individuals are not forced onto inaccessible alternate paths (U.S. Access Board 51).
- Frequent sidewalk problems include step separation (vertical displacement of 0.5 inches or greater), badly cracked concrete (holes and rough spots wider than 0.5 inches), spalled areas (crumbling or flaking concrete), depressions that trap water (depressions, reverse cross-slopes, indentations), and tree-root damage (Kirschbaum et al 66-67).
- Typical shared use path maintenance issues are similar to sidewalks including step separation, badly cracked pavement, spalled areas, settled areas that trap water, tree-root damage, and vegetation overgrowth (Kirschbaum et al. 18-3).
- Differences in pavement height must not exceed 0.25 inch or 0.5 inch on beveled surfaces (U.S. Access Board 51).
- When sidewalk problems are found, it is important to replace them or alert responsible property owners to initiate repairs. Patch and grade where needed, and conduct spot surfacing, fix depressions or dips to prevent water damage, and return surface to original condition as needed (NPS 83).

Vegetation Management

Overhanging vegetation can be an ADA issue by obstructing sight lines and creating obstacles for users (Kirschbaum et al. 67). The Virginia Trails Handbook (Parsons HBA 5-5, 5-9) specifically lists the following vegetation management practices:

- Maintain vistas (windows) with trimming and pruning.
- Provide 10 feet of vertical clearance (8 feet if no equestrians) and 2 feet of horizontal clearance beyond the pavement width on multi-use trails.

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- Cut branches at the body of the tree, leaving no protruding points.
- Cut trees and brush as close to the ground as possible. Use approved herbicides to prevent regrowth.
- Remove small weeds and trees from the trail surface and properly fill holes.

A few additional practices include:

- Trim and remove vegetation that interferes with sight distances, clearance and lighting (Flink, Olka, and Searns 106-107; Kirschbaum et al. 18-3, Barreras et al. 51).
- Look for and remove potentially dangerous trees or branches (NPS 83; Pauley)
- Remove and maintain vegetation more extensively at trailheads due to the higher frequencies of assaults and robberies at these locations (Murray).
- Selectively thin tree branches to prevent developing canopies over trails that can significantly reduce the amount of light on the trail (Huber).
- Remove brush from trail entrances and along the sides of the trail to eliminate the “tunnel effect” on users’ vision (Pauley).
- Cut back intrusive tree roots and keep drains in operating condition-sweep after repairs (Reitmayer et al.).

When conducting vegetation management, be mindful that excessive trimming of vegetation for security purposes can reduce the aesthetic appeal of the trail or path (Murray). Joseph Murray argues against over trimming to the point where vegetation looks like “isolated military outposts in the jungle.” An overemphasis on vegetation reduction can decrease the number of users on the trail, thereby creating the opposite goal of vegetation reduction. Murray proposes concept of vista pruning—maintaining cleared areas or “windows” in certain places to allow attractive views and surveillance. According to Murray, this practice satisfies security concerns without eliminating the original appeal to users.

Maintenance and construction vehicles operating on shared-use paths can cause expensive maintenance costs. Overwatering around the paths increases the level of damage as it weakens the maximum load weight of the facility. Managers should examine watering practices near paths (Bustos 13).

Signage and Striping

Periodically review all signs, traffic, and pavement markings for usefulness, degradation, etc. (Flink, Olka and Searns 143; Kirschbaum et al. 18-5).

- Signs should be cleaned to maintain visibility and all damaged signs should be replaced (Parsons HBA 5-10).
- Replace, repair and clean signage as needed. Worn and faded signs no longer serve their purpose (NPS 57, 60).
- Replace damaged or vandalized signage (Flink, Olka, and Searns 143).
- Repaint crosswalks and pavement markings as needed (Barreras et al. 59).

Lighting

Clean and/or replace lighting structures and bulbs to keep light levels adequate for safety and security (Flink, Olka and Searns 143).

Trash, Sweeping, and Debris Removal

It is important for safety and security to keep debris, trash, materials, and other potential obstructions clear from bicycle and pedestrian facilities. Methods that can be employed to accomplish this include:

- Sweep and clear trails and trail edges of debris such as glass, gravel, and branches. Pay close attention when nearby roads are swept because the road debris frequently ends up on the parallel trail (Flink, Olka and Searns 144).
- Provide litter containers to reduce trash and debris on trails and remove garbage and litter regularly (Saltreli).
- Increase the level of maintenance if a sidewalk or trail area routinely has excess trash such as scattered broken glass (Ross).
- Keep debris, materials, and other potential obstructions clear from bicycle and pedestrian facilities. Bill Woodcock mentioned an accident where a bicycle rider snagged the pedal on some nearby construction fencing (Woodcock).

The City of Rochester provides their residents with the option of petitioning for [city] trash cans in areas of high pedestrian activity (Saltreli). Providing additional trash cans, posting etiquette rules on littering, and encouraging community organizations to adopt a path, sidewalk, or street can all curb a “trash” problem.

Graffiti Removal

There is unanimous agreement among security experts agree that graffiti needs to be removed as quickly as possible in order to discourage new graffiti. Furthermore, this practice helps users feel safe (Zelenka and Brennan; Murray; Flink, Olka and Searns 146-147). The City of Seattle encourages businesses and public areas to follow the “3 Times 72 Rule.” If graffiti is removed three times within 72 hours, the chance of repeated vandalism drops significantly (Barreras et al. 36-37). Please refer to security section for information on anti-graffiti efforts.

Drainage Issues

In the book *Trails for the Twentieth Century*, 2nd ed., Kristine Olka, Robert Searns, and Charles Flink cite drainage issues as the most costly repairs. However, drainage maintenance saves money in the long run by preventing more costly water damage and washouts (NPS 83). The following drainage practices should be followed:

- Clear debris from any and all drainage devices to keep drainage features functioning as intended and minimize trail erosion and environmental damage (NPS 82; Flink, Olka and Searns 144). Drainage structures include: drainage channels, drainage dips or water bars, parallel ditches, culverts through or the beneath trail and drains, culverts, and other existing structures (Parsons HBA 4-16-4-20.). Clearing may need to be enacted on a routine basis as well as after storms and at specific times of the year, such as in the fall during and after leaf drop.
- Maintain drainage structures and features, check for damage to drainage components (Flink, Olka, and Searns 144), and maintain cross-slopes on the trail bed, (Kirschbaum et al. 18-4).
- Check and repair any damage to trails as a result of drainage issues (Flink, Olka, and Searns 144). Add surface water control structures in problem areas (Parsons HBA 4-16.). Also, due to freeze/thaw cycles, sometimes crushed limestone the trails need to be top-dressed and

rolled/compacted, especially where there are drainage issues (G. Smith). These trails need good drainage or they will wash away.

Trail Facilities, Furniture, and Security Equipment

Clean trail stations and toilets daily to ensure sanitary facilities for users (Parsons HBA 5-3), (Murray). Maintain benches and other resting areas as well as emergency phones and other security equipment (Flink, Olka and Searns 144).

Long-Term Maintenance

Some common long-term maintenance needs include repainting buildings and trail markings every five years, renovating buildings every 10-20 years and resurfacing trails every ten years, depending on the surface and conditions. Bridges and tunnels should be inspected annually as well as walls, fences, and other barriers (Parsons HBA 5-3). Additionally, check the structural integrity of other built features (Kirschbaum et al. 18-3).

Emergency Maintenance

Emergency repairs deal with the unexpected damage from weather-related events. Always conduct inspections after weather events. The Virginia Trails Handbook recommends that managing agencies develop a list of volunteers owning equipment, such as large trucks and chain saws, who can be called upon if an event overwhelms maintenance staff (Parsons HBA 5-3). Also, remember snow and ice can also be ADA issues (U.S. Access Board 52).

Additional Maintenance-Related ADA issues

- Keep pedestrian surfaces free of obstacles that obstruct passage such as trash receptacles, utility poles, newspaper vending machines, and mailboxes (Kirschbaum et al. 4-10- 4-12). Avoid situations such as light posts blocking curb ramps (Hodges).
- Maintain facilities in a condition that can be negotiated by users and keep trail surfaces free of hazards. For example, extend the trail to its original width, fill ruts and holes, and restore raised approaches for bridges as needed (Kirschbaum et al. 12-7-12-8).
- Fill in missing sections of sidewalks, especially on key routes (U.S. Access Board 51). ADA agencies have received some complaints about gaps in the sidewalk system (Hodges).

If an inspection or user complaint reveals areas where a trail is not up to standards, either the trail must be brought up to standards or closed to avoid liability concerns. The managing agency has three closing options: temporary, permanent, or seasonal. Seasonal or temporary closings can prevent agencies from expending significant resources to keep the trail in an operable condition. Temporary closings may be used to give staff and volunteers more time to return the trail to sufficient conditions from weather-related events (Parsons HBA 5-10). For example, The Pennsylvania Bureau of Forestry closes ATV trails during hunting seasons and spring and fall rainy seasons to prevent damage to people and trails (Beaver). Other jurisdictions may prohibit specific types of users such as ATVs, snowmobiles, or horses to prevent damage to trails.

SNOW REMOVAL

An article in the spring issue of the *Salt and Highway Newsletter* (Briscoe) makes clear that agencies that ignore snow maintenance related to sidewalks and pedestrian facilities can face potentially serious litigation. According to a Salt Institute survey, some municipalities and cities designate agencies responsible for snow maintenance of sidewalks, but most require homeowners to clear sidewalks:

- Eighty-three percent of the agencies surveyed have a written policy requiring homeowners to remove snow within 24 hours after the end of a snowstorm
- Seventy percent of the agencies surveyed do not issue tickets to property owners who fail to remove ice and snow from their sidewalks
- Fifty-eight percent of the agencies surveyed have been sued for a sidewalk incident

Poorly maintained sidewalks are the cause of about 50 percent of lawsuits involving a public agency and sidewalk-related injuries—even when the homeowner has primary responsibility. Just 25 percent of these cases involve only the homeowner in litigation. Even if the agency or municipality successfully defends itself, legal expenses are still costly. Clearly, public works officials and local politicians must decide how to provide winter mobility and reduce their liability risk.

Icy or uneven surfaces are very dangerous for pedestrians using walking aids such as canes, crutches, and walkers. Furthermore, where sidewalks have virtually no separation from the street, crowds, rain, snow, or ice, all increase the chance of falls or slips. Other issues related to shared-use paths and safety incidents include:

- Dangerous conditions on the trail such as rain, snow or physical obstacles.
- Maintenance on multi-use paths should be year-round and involve snow removal (Reitmayer et al.).
- Steep grades become even more dangerous with inclement weather and debris (Bustos 19).

According to Cottrell in *Evaluating and Improving Pedestrian Safety in Utah*, the failure to remove snow on sidewalks and shoulders creates multiple safety hazards for pedestrians. Sidewalks that have not been cleared force pedestrians to either use the facility in unsafe conditions (potentially resulting in frequent slips and falls) or walk in the street. Crosswalks and curb ramps are frequently blocked by snow because it is dumped by plows or neither the homeowner nor the snow crews clear it. As a result, pedestrians must climb over the snow pile, maneuver around it or walk in the street. Snow accumulation can also impair both motorist and pedestrian visibility and sightlines. The above conditions provide the reasoning behind the statistical numbers that show a rise in pedestrian fatalities during winter months (Cottrell 22-23).

How a jurisdiction handles snow removal from sidewalks and trails is also an ADA issue. Snow removal is considered to be maintenance, although of a different nature. Snow removal is treated differently because of its temporary nature and because responsibility for clearing the snow is diffused. However, there is a legal obligation to remove snow within a reasonable period of time (Horton). Most jurisdictions need to have a plan in place to do it, and snow removal programs must include clearing curb ramps (U.S. Access Board 51). In addition to clearing sidewalks and handicap ramps, it is very important for ADA access to clear snow and ice from the detectable

warning pavement at ramps (D. Smith). Even after pedestrian areas have been cleared, there may be problems later with ice, frozen snow, and slush (D. Smith).

ADA complaints and issues related to snow removal involve response times and proper clearing:

- Many complaints are received when snow is plowed into handicapped parking spaces for storage (Horton).
- Many snow removal complaints come from residential areas, such as apartment buildings. If management does not clear sidewalks or parking lots, disabled individuals may be imprisoned in their apartments. Many more do not complain because they are afraid of possible negative repercussions (Waterland).
- Snow-blocked curb cuts due to plowing are an ADA issue (Horton).

Many jurisdictions require a minimum distance between the curb and the sidewalk specifically to accommodate snow storage. In Wisconsin, the minimum recommended setback for a median is 5 feet from back of curb, which is just adequate for snow storage in most parts of the state (Huber). They do occasionally build sidewalks right at the back of curb especially in downtowns and where there are restricted right-of-ways, however, this is frowned upon. In these cases, snow removal is a big issue since the street snow is plowed onto the sidewalk and then has to be removed by the city (Huber).

Most, but not all, of our interviewees' jurisdictions require homeowners to remove snow from adjacent sidewalks. Snow removal in central business districts or business improvement districts are often handled by the city government or private contractors paid collectively through various businesses. Some of the policies include:

- Similar to Delaware, Iowa also holds the homeowner responsible for clearing the sidewalk in front of their property (D. Smith). With regard to sidewalks, a city ordinance requires the homeowner to remove snow within 24 hours or be fined (Ross).
- Like other states, Wisconsin holds municipalities and cities responsible for removing snow and ice from public areas. In turn, 90 to 95 percent of these municipalities have ordinances that require the homeowners to clear snow and ice from adjacent sidewalks. However, some Wisconsin cities monitor priority roadways more carefully to ensure pedestrian access. In general, Tom Huber stated that most homeowners in Wisconsin are very effective at clearing snow and sometimes more diligent about clearing the snow than the government on city properties such as schools and parks. In downtown Madison alone, around 40,000 homeowners are responsible for clearing snow on the city sidewalks (Huber).
- The City of Rochester snow crews clear the sidewalks in the central business district. The businesses located in the district pay into a fund for this service (Saltreli).
- There are also around 10 to 15 municipalities with business improvement districts in Wisconsin that handle snow and trash removal within the districts (Huber).

Some municipalities and agencies have responded by providing sidewalk snow and ice removal. These agencies and municipalities have sidewalk crews that operate sidewalk plows equipped with rear hoppers to distribute salt and sand. Many municipal snow removal policies are only activated when snow exceeds a certain number of inches (Briscoe). According to the City of Rochester Sidewalk Snow Policy, the city initiates its sidewalk plowing service when snowfall exceeds four inches. Private contractors are used to plow some 878 miles of sidewalks. The

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sidewalks are divided into specific plowing runs with each taking around five hours. The service costs the average homeowner about \$17.84 a year. The service is limited to sidewalks that are at least 58 inches wide to accommodate the width of sidewalk snow plows. The plowing runs are usually conducted in evening and morning hours, but are dependent on snow conditions. City sidewalk plows are not permitted to travel faster than 10 mph. Residents can receive updated sidewalk and street plowing information by calling a special phone number or contacting the Office of Customer Satisfaction (City of Rochester 1).

There are always problems related to pedestrian and handicapped facilities at intersections. Some jurisdictions do attempt to clear these, but generally not systematically or only in priority areas. For example, the City of Rochester pays special attention to areas where there are high numbers of elderly, handicapped, or disabled individuals with respect to snow removal. The city assigns specific crews for snow removal operations in those areas. Sidewalks near schools, the Rochester Institute of the Blind, and the Regional Institute are cleared by crews equipped with Bombardiers. He also noted that ramps and intersections are cleared with hand shovels and de-icing spreaders in these critical areas (Saltrelli). Proactive policies, like the City of Rochester's, help reduce liability and increase the mobility of disabled individuals in winter months.

Duane Smith, Associate Director of the Center for Transportation Research and Education, commented that Iowa makes an effort to keep snow out of the pedestrian right-of-way. In Iowa sidewalks are usually clear within one day. According to Duane, particular attention should be made to sidewalks on snow routes (D. Smith).

Snow Removal: Shared-Use Paths

Most, but not all, paved municipal trails are cleared of snow, usually by the municipal jurisdiction. Some jurisdictions give path clearing a higher priority than others. In some Wisconsin communities there are more pedestrians using the paths than the sidewalks during the winter (Huber). However, the best way to avoid liability on commuter or frequently used facilities is to apply the same standards for wheelchair users, cyclists, and pedestrians as for roadways (Bustos; Flink, Olka and Searns 52-53). Snow removal policies on shared-use paths include:

- A few locations where paved urban trails are routinely cleared of snow include Colorado (Collins); Madison, Wisconsin (Ross); and Ames, Iowa (D. Smith). Rochester, New York, does not remove snow from urban trails (Saltrelli).
- Unpaved trails are generally not cleared of snow. SSPR does not clear any of their crusher fine trails of snow. They do get some use by snowshoers and cross-country skiers (Woodcock).
- If snow clearing is impossible, the trail network should at least be checked for extremely dangerous situations such as black ice, ice on bridges, and blocked passes (Flink, Olka and Searns 144).

Madison, Wisconsin, and SSPR on the south side of Denver, Colorado, include shared-use paths in their snow plowing policies:

- Madison, Wisconsin's citywide street plowing policy is to start in the center of the city and work outwards, then clearing wherever needed. A priority system is also applied to the

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multi-use paths with the major paths being cleared first. Crews will go back to clear sidewalks and handicapped ramps at intersections, but this is not systematically done (Ross).

- SSPR does maintain a hierarchical winter maintenance strategy that focuses on first clearing administration buildings, then paved commuter trails and trails that connect to schools. Today, this district comprises 120 miles of trails that have become a commuter route into Denver (Woodcock).

Maintenance Equipment

Maintenance organizations keep equipment for sweeping, vegetation management, trail surface repair, and snow removal. Interviewees cited the use of small street sweepers and/or vacuum sweepers for debris removal on paved sidewalks and trails.

On the Washington & Old Dominion Trail in northern Virginia, the maintenance crews use a bootmower (having a blade mounted on the side) that can reach up in the air to cut back trees and bushes to clear overhanging brush (Pauley). Many jurisdictions use brush-hogs, mini brush-hogs, or brush-saws, or will contract out to a company who has the proper equipment if a certain area of overgrowth is too difficult for the agency's equipment (Saltreli). Power mowers are still important for maintaining turf areas. A NPS publication (NPS 87) notes that hand-pruning shears are better than long loppers for light work.

For unpaved trails, especially crushed stone, the Bureau of Forestry uses bobcats and gators for basic trail maintenance, as well as roller to compact crushed limestone. The bureau uses a roller tube pulled by a Bobcat to reduce the damage after the annual winter freeze. The roller is also useful anytime the limestone trail becomes uneven (G. Smith). Other useful equipment for rural recreational trails includes track dumpers (4-foot-wide dump trucks) to replace aggregate on trails, a mini skid-steer excavator, and a 9000-lb, 4-foot-wide Sweko-dozer (Beaver).

Some jurisdictions have snow removal equipment specifically for sidewalks, while others use converted street vehicles, with some problems. Equipment used in various jurisdictions includes:

- Bobcats are used to clear sidewalks, bikeways, and other pedestrian facilities in Iowa. Some are equipped with brushes on the front and others use a small blade for clearing, depending on the type and depth of snow (D. Smith). Similar specialized equipment mentioned included: special small track tractors (Huber), a 5-foot-wide tractor specially designed for snow clearing of trails (Huber), a Bombardier sidewalk plow with track and blade (Saltreli), skid steers equipped with brooms and small S-10 trucks with snow blades for light snow removal (Woodcock).
- The *Salt and Highway Newsletter* recommends sidewalk plows equipped with rear hoppers to distribute salt and sand (Briscoe).
- Curb ramps and intersections are cleared with hand shovels and de-icing spreaders in Rochester (Saltreli).

Larger equipment may be useful on shared-used trails designed and constructed to withstand vehicles, but may cause problems on sidewalks. This equipment includes:

- Most contractors use orchard tractors fitted with blades for sidewalk snow clearing (Saltreli). Jeeps and small pickup trucks and tractors are used for snow clearing on many sidewalks by

municipal crews, contractors, and private businesses, but they regularly tear up the sides of sidewalks because of their wide turning radius (Huber).

- Madison uses pick-ups equipped with plow blades to clear snow from paths (Ross), and for larger snowfalls, South Suburban Parks and Recreation uses larger trucks on their paved trails (Woodcock).

Special Situations: Rural and Recreational Trails

Very few rural trails are maintained in winter. Those that are, are generally groomed for snowmobiles, cross-country skiers, or snow-shoers (G. Smith; Collins; D. Smith; Huber). Trailheads, parking lots, comfort stations, and administration buildings are usually cleared of snow. Some winter trail maintenance includes:

- The agency clears sidewalks (including steps and ramps) and plows trailheads, parking lots and around comfort stations (G. Smith; Beaver).
- The Bureau of Forestry takes a very limited approach to winter maintenance. The Bureau's trails are heavily used by snowmobiles during the winter, and therefore it has a fleet of snow groomers that prepare the trails for snowmobiles. The special equipment used by the Bureau of Forestry for snow includes tri-axes and large snowplows for clearing trailheads and parking lots, and a fleet of 27 snow groomers (Beaver).

Special Situations: Rail-to-Trail Conversions

Although it is a paved trail, the Parks Authority does not remove snow during inclement weather from northern Virginia's Washington and Old Dominion Trail. Due to the nature of the trail as a former rail bed with many cuts and fills, it is not possible to safely or effectively clear the snow. The agency would increase its liability by attempting snow removal. By not providing any service, the agency avoids liability issues. In short, since it cannot be done right, it is better not to do it at all. In addition, plowing causes extensive damage to the trail surface that the Parks Authority cannot afford to repair. It would also be a very time-consuming process to plow the entire 45-mile trail. However, they do try to make the trail accessible for walkers. They may put down salt or use equipment in specific locations to mitigate icing. At intersections, they may do rudimentary snow removal using a tractor with a blade and/or a front-end loader. Chris Pauley stated that the agency monitors the trail for winter drainage issues where water freezes on the trail. The agency equipment consists of farm tractors, a loader truck, scrapers, and other basic snow-clearing tools (Pauley).

PART 4: MANAGING TO ENHANCE SAFETY, SECURITY, AND MAINTENANCE

Responsibility

Given the safety, security, and maintenance issues as well as legal liability, it is extremely important that agencies understand who is responsible for everything related to sidewalks and shared-use paths, including maintenance, funding, snow removal, signage repair and replacement, enforcement and police, and emergency medical response. Where more than one agency needs to be involved, it is imperative that agreements or MOUs be negotiated and adopted.

At a minimum, agencies that require sidewalks and trails must be sure that their code requirements also meet ADA requirements and that their inspectors also inspect for ADA accessibility. Agencies that require homeowners to repair sidewalks or remove snow are still responsible for enforcing those requirements. Those who fail to enforce these types of requirements can still be held liable in case of an incident. Some additional liability recommendations include:

- Public agencies should assume all sign-related activities with all expenses for materials paid by trail groups or sponsors due to the risk of tort claims. Sometimes, trail groups are responsible for installation, inspection and maintenance of trail signing along roads. This creates inconsistent signing as different groups have different capabilities and resources (Gittings et al. 106-107).
- Municipal inspectors should evaluate to ensure accessibility standards are met if the municipality allows contractors to complete repairs (U.S. Access Board 47).

Interviewees discussed how different types of responsibility are handled in their jurisdictions:

- In Madison, Wisconsin, a number of different agencies are responsible for snow removal ranging from engineers to parks and streets personnel. These agencies and others use GIS mapping to divide up responsibilities. Responsibilities are not determined solely on who is technically responsible, but on what agency is closest to the location, has the correct equipment, etc. (Ross).
- The City of Rochester is responsible for almost all roads and sidewalks in its jurisdiction. There is only one county and one state road that come close to the city, and the city has specific agreements on responsibilities for snow removal. The city is responsible for sidewalks along these two roads (Saltrelli).
- Wisconsin Department of Transportation (DOT) does not own any trails; all are turned over to the local community or county (Huber).
- Duane Smith stated that it is important to have clear chains of responsibility including interagency agreements for handling emergencies. Iowa law has agreements between different agencies and levels of government called “28E” agreements that specifically state which party is responsible for maintenance and emergency issues for various overlapping facilities. In rural areas, the state government usually has responsibility (D. Smith).
- SSPP in Colorado maintains its own sign shop that handles changing out damaged signs and is currently producing uniform graphics throughout the trail system (Woodcock).

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- Wisconsin DOT does not regard themselves as enforcer to other communities unless federal or state funds are used. The department will enforce ADA standards when state or federal funds are used. They try to make sure that communities have all the information and guidelines in order to encourage ADA compliance. If a community chooses not to comply with ADA, then that community exposes itself to liability (Huber).
- In Davis, California, whichever entity has primary responsibility for the facility must factor in maintenance. There is no debate over the issue and it is regarded as a serious, cut-and-dry requirement (Bustos).

In Delaware, determining responsibility for sidewalks and trails can be very difficult, and government entities may need to be educated regarding their specific responsibilities. Through our interviews with several state officials it became apparent there is a serious confusion over specific responsibilities:

- Often, no one really knows who is responsible for a particular facility, such as around DART bus stops. Responsibility depends on the location and circumstances. In addition, the party responsible for enforcement may not be the party responsible for design (Hodges).
- Questions over responsibility for mixed-use facilities and residential areas are inherently difficult because they may be private facilities that are not covered by ADA; however, the right-of-way (trails, paths, sidewalks) is public and therefore covered (Horton).
- Questions regularly arise over who is legally responsible for sidewalk maintenance and repair. Most ADA complaints are the result of non-compliant design, incorrect implementation, or lack of maintenance (Waterland).
- It is very confusing to determine who is actually legally responsible for trails and paths (Hodges).
- There is a lack of awareness in Delaware on the part of governments regarding their responsibilities and the design and maintenance standards required by ADA. There is a great need for the people who write the regulations and review and inspect development to be trained or educated so that they understand the standards and specifications that are applicable (Waterland).
- Many preventable situations are the result of a lack of awareness of ADA regulations and responsibilities. For example, many snow plow operators use accessible parking spaces as storage for snow. They have also addressed complaints about accessible spaces that were not properly designed, and even a situation where bike racks were located in the accessible parking spaces (Waterland).

PLANS AND PROTOCOLS

Having plans and protocols in place and following them are important to reduce liability in the event of an incident. The literature and interviewees recommend a number of topics be addressed:

- Develop agency rules related to emergencies and educate staff members on emergency responses to avoid liability issues (Olka, Searns and Flink 146). Develop an emergency response protocol with police and other emergency agencies (Searns 3-4).
- Plan ahead for emergency responses. For example, Pennsylvania provides marked areas reserved for helicopter landings in certain areas (G. Smith).

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- Have a security plan for shared-use paths. An example of a good public safety plan is Portland, Oregon's *Police for the Eastbank Esplanade* (Birk et al. 67).

Oregon's Department of Transportation requires all communities with a population over 2,500 to have a transportation system plan, which includes a provision that these plans include an inventory of facilities and maintenance policies (Reitmayer et al.). Pennsylvania's Department of Transportation encourages the development of local bicycle and trail plans (Gittings et al. 107). FHWA recommends developing a pedestrian safety plan including (Birk et al. 5-8, 141, 41-50):

- Providing sidewalks and crosswalks.
- Utilizing engineering measures like lighting and traffic control devices.
- Enforcing traffic laws and ordinances—yielding to pedestrians and jaywalking.
- Promoting education programs highlighting the use of reflective clothing, crossing at correct areas, etc.

The City of Nashville developed a *Strategic Plan for Sidewalks and Bikeways*. Under this plan, the city inventoried all 750 miles of sidewalks and 16,000 ramp locations using customized GIS software on hand-held computers to identify sidewalk maintenance and ADA repairs. The city's project developed a Sidewalk Priority Index (SPI), which rated the need for future sidewalks, but was also used to identify areas where repairs were needed most. The SPI determined the priority based on a number of factors including land use and transportation, development type, density, proximity to schools, transit areas, and other "pedestrian generators" (Boroski et al. 47-48).

Planning is also important with respect to ADA. With regard to ADA law, the courts examine whether governmental agencies followed their procedures with respect to snow removal and ADA accessibility. Therefore, it is critical to have an overall, logical snow removal plan in place and to follow it (D. Smith). The best way to avoid liability is to apply the same maintenance standards for wheelchair users, cyclists, and pedestrians as for motorists. Tim Bustos noted that wheelchair users may be solely dependent on sidewalks and paved paths for transportation (Bustos). Snow removal plans should also include protocol for clearing snow between the sidewalk and road, especially at crosswalks and street crossings (Cottrell 23).

Austin, Texas, implemented a very successful curb ramp program. The City of Austin has a population of 500,000 with 15 percent having disabilities. In 1991, the city appointed an ADA program manager along with an ADA coordinator in each of the city's 23 departments. The city also established a Mayor's Committee for People with Disabilities (Harkey and Zegeer 156-157). As part of developing the plan, the city:

- Held public hearings to obtain input from disabled citizens.
- Scheduled development based on available personnel and funds.
- Developed a map dividing the city into 12 sections and showing the highest priority facilities.
- Prioritized areas based on the map, in descending order outwards from the downtown area.
- Assigned highest priority to the areas with the most government buildings and pedestrian activity, and to areas along major roadways or bus routes.
- Established a citizen request program to handle specific needs.
- Established an ADA work group.

Through this process, the City of Austin was able to identify some of the key difficulties in implementing the program including: utilities in the right-of-way increase costs; curb ramps that

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conflict with existing drainage; agency coordination; and the meeting of the ADA compliance deadlines (Harkey and Zegeer 156-157).

It is also important to have a maintenance plan in place that establishes standards related to inspection and maintenance (Olka, Searns and Flink 32-34). Because high-quality planning leads to better maintenance, the plan should be reexamined and updated annually with tasks, operation policies, standards, and routine and remedial maintenance objectives (Searns 2). ADA issues and accessibility should be part of all maintenance programs (Kirschbaum et al. 67).

There are six parts to a successful maintenance plan (Searns 2): routine and remedial maintenance, user safety and risk management, programming and events, resource stewardship and enhancement, marketing and promotion, and oversight and coordination. In addition, plans should focus on:

- Inspection and citizen response.
- Surface maintenance.
- Repaving and pavement overlays.
- Sweeping and/or street sweeping.
- Trailhead parking lot repair.
- Maintenance for on-street and sidewalk routes.
- Vegetation and pest management.
- Irrigation/drainage systems.
- Dust reduction.
- Alternative routes for detours or disruptions.
- Repair shortcuts or “social trails.”
- Rest areas, shelters and toilet facilities.
- Patrol, security, enforcement.
- Safety hazard reduction.
- Education.
- Accident and incident tracking system.

No matter the focus of the plan, an important component of every plan is prioritization, or determining which actions or projects need to be completed first. Following are some examples of how various plans are prioritized:

- The Oregon Plan focuses on renovating streets with bikeways and walkways first (Reitmayer et al. 6-7).
- Some suggest that highest priority should be given to conditions near schools and connections to major employment centers, etc. (Reitmayer et al.), as well as facilities near retirement homes (Zegeer et al. 5).
- Other priorities include urban highways that are “main streets through communities,” and spot problems where high number of pedestrian crashes occur (Reitmayer et al.).

Some additional tools for establishing priorities include:

- Using walkability checklists (Zegeer et al. 19).
- Establishing classification systems to differentiate between high pedestrian traffic and low pedestrian traffic areas (Bustos 16-17).
- Reporting crash data, calculating pedestrian level of service, and surveying drivers and pedestrians are all tools that can be used to gauge how dangerous certain geographic areas are (Harkey and Zegeer 3, 12).

GIS/GPS Systems: Increasing Management Efficiency

Databases and GIS mapping are recommended for tracking crashes and safety incidents in the network (Zegeer et al. 19; Searns 3-4). Data can be monitored and analyzed to formulate ways to improve bicycle and pedestrian safety (Reitmayer et al.). Tracking crashes allows Madison, Wisconsin, to determine where crashes are happening primarily and make design changes, if necessary (Ross). Mapping reported pedestrian accidents using GIS software allows planners, engineers, and elected officials to prioritize their efforts toward the most dangerous and traveled areas. In order to increase pedestrian safety, bicycle and pedestrian coordinators must be able to identify high-risk areas (Harkey and Zegeer 12).

In addition, fire, EMS, and police personnel should have a map of the trail system identifying access points and have keys to any bollards or other devices (Searns 3). An NPS handbook recommends establishing an electronic database coupled with software to document conditions and generate reports regarding maintenance needs and activities. Specifically, it recommends the Tread database or the Ice Age NST Inventory and Assessment Process used by the Appalachian Trail Conference. Local managing agencies responsible for trail segments should be required to adopt these practices and software. Purchasing compatible software for different agencies allows for easier communication between agencies and managers (NPS 80).

Also, necessary trail information can be collected by volunteers or staff using a uniform paper log that is entered into the database or through GPS/GIS units. With hand-held GPS/GIS units, staff or volunteers enter data while surveying the trail. This data is then updated into the system. In these databases, logs of the frequency and type of maintenance activities are noted (NPS 80).

Specialized database applications can be created through Microsoft Access to automatically generate reports. Sidewalk inspectors can enter specific sidewalk areas in need of repair and select from a list of maintenance issues. GPS location of problems allows city personnel to create maps of sidewalk repairs and defects. Data programs can also be used for curb ramp installations. Each ramp can be assigned a compliance rating and be identified as needing to be replaced or as being up to standards. This allows agencies to plan for future upgrades and better coordinate repairs with other construction and maintenance projects (Lentz and Weis).

PROBLEM REPORTING, INSPECTIONS, AND OTHER PROGRAMS

Irrespective of how a locality chooses to deal with maintenance and snow removal, the jurisdiction is still responsible for enforcement (Kirschbaum et al. 10-1-10-3). Municipalities that require adjacent landowners to repair damaged sidewalks and remove snow must consider how to guarantee the appropriate level of accessibility is provided (Briscoe 1). Sources

recommend instituting both regular inspections and an easy system for users to report problems and complaints.

Kristine Olka, Robert Searns, and Charles Flink recommend developing a system to monitor user complaints and concerns as well as maintenance requests. Not only is this important for the safety of users and regular maintenance, but having a formal reporting and monitoring system also reduces liability concerns (Olka, Searns and Flink 144-146). A number of experts recommend instituting an easy system for users to report problems and complaints. However, an agency can be found negligent if it does not respond to a safety-oriented maintenance issue within a reasonable period of time. The U.S. Access Board also cautions that public works departments must respond quickly to citizen complaints. Take steps to make requests easier to respond to user complaints and requests by:

- Providing maintenance request forms to user groups, bicycle shops, and at trail facilities. Forms should ask for name, date, time, location, daytime phone number and a description of the problem.
- Installing mile markers along the trail.
- Requiring staff to respond to petitioning individuals to relay the response.
- Recording citizen complaints and review them after each snow season (Cottrell 23).
- Implementing additional avenues to receive feedback, including a phone hotline and internet requests (RTC and APBP 20).

Some locations have expanded their user reporting systems to other issues. Seattle set up a system whereby citizens can phone in complaints including malfunctioning street lights and to report crosswalks and pavement markings that need to be repainted (Barreras et al. 51). In addition, Madison, Wisconsin, allows complaints to be filed online regarding sidewalk maintenance and snow removal violations (Ross; Briscoe). Madison's Department of Planning and Development, which is responsible for sidewalk policy, issued 820 tickets last year related to snow removal (Briscoe).

Seattle instituted the Spot Improvement Program, which relies on citizen users to report maintenance needs and safety improvements in the city. Seattle developed a uniform form and distributed it to bike shops, community centers, and other major public venues. The program is funded through already existing sources such as the city's Pothole Ranger Crew, responsible for pothole repairs. Requests for new facilities such as bike racks and new signs also can be made through the program. Staff responds to all requests and indicates when the problem will be fixed or suggestion evaluated (RTC and APBP 20).

Documentation is another important aspect to protect agencies from liability. One source recommends developing a system to monitor user complaints and concerns as well as maintenance requests. Plan to maintain excellent records of maintenance activities, responses to complaints, upkeep of signs, and all emergency incidents (Olka, Searns and Flink 144-146). In fact, the Virginia Greenways and Trails Toolbox cites regular documentation of inspections and maintenance work as the best practice to minimize liability claims (Parsons HBA 5-5).

INSPECTIONS

In addition to user reporting systems, all trails and sidewalks need to be regularly inspected by trained professionals. It was the opinion of several of the interviewees that biking and walking facilities should be treated no differently than other mainstream transportation modes (Bustos). To that end, many jurisdictions have instituted sidewalk inspection programs, irrespective of who is responsible for making repairs. Examples of these programs are:

- The City of Rochester, not the homeowner, is responsible for sidewalk replacement. Through the city's Sidewalk Area Replacement Program and Hazardous Sidewalk Replacement Program staff physically survey one-third of its 800 mile sidewalk network each year. This survey identifies cracking, deteriorating, or damaged sidewalk segments (Saltreli).
- While smaller communities in Wisconsin may conduct annual sidewalk surveys, larger communities with more extensive sidewalk networks generally survey their entire sidewalk network every 4-5 years. The longer cycle presents problems for larger communities with tripping hazards and ADA compliance because sidewalks can easily deteriorate beyond ADA standards due to freeze/thaw cycles during the time between surveys. An area could be out of compliance for 3-4 years before a trip hazard is identified and repaired. Most large communities permanently deal with trip hazards on a rotating basis through contracts on a neighborhood by neighborhood basis. If they get a complaint, they will temporarily fix it with an asphalt ramp, but it may be a few years before it gets into the rotation for a permanent fix (Huber).

Recreational trail systems also require regular inspections to assess and catalog problems (Kirschbaum et al. 84). The frequency of inspections depends on the level of use. The Virginia Trails Handbook recommends popular trails that experience heavy use should be inspected quarterly, and if trails have an active volunteer base, the trails should be inspected monthly by volunteers. Additionally, trails should be inspected after weather events (Parsons HBA 5-3). Again, it was expressed that biking and walking facilities should be treated no differently than other mainstream transportation modes (Bustos). The most advanced jurisdictions have regular inspection and repair programs for trails, similar to their street programs.

- The central principle to the City of Madison's maintenance strategy is to treat their paths as streets, as an integral part of the transportation network. City engineering staff evaluate trail pavement using the same methods as for street pavement. Since all of their paths are paved, the city has a crack-sealing operation. When older paths start to require significant work, they expand the path to 10 or 12 feet (Ross).
- Tim Bustos made four suggestions to ensure adequate maintenance of bicycle facilities. First, he stated that agencies and governments must make every effort to have an annual maintenance budget. Second, use a pavement management program, similar to road programs, to conduct annual inspections and resurfacing. Third, prioritize facilities for repairs based on length of time since their last resurfacing, importance, etc.: the "scientific approach." Fourth, physically survey the system on bike each year to identify if resurfacing is needed or cracks need filling (Bustos).

Some jurisdictions have developed programs to address specific problems or issues:

- Seattle started the City Light program that allows business districts to petition to have pedestrian lighting installed. Maintenance is undertaken by City Light as long as the pedestrian lights are installed to maximize sidewalk lighting, installed according to City Light Standards, and one of four approved lighting designs are selected. City Light also pays for the power (Barreras et al. 51-53).
- Agencies all over the country use the Universal Trail Assessment Process (UTCP) was developed by Beneficial Designs in 1990 so that disabled individuals could determine whether it was possible for them to use a particular trail. The project expanded to include a trail assessment that allowed all users to ascertain the difficulty and type of trail network. The process involves two to four people, with one person trained in the UTCP and some basic tools. The collected data are generated into a Trail Access Information report that details trail length, width, and elevation change, maximum and average cross-slopes, grades, and obstacles (RTC and APBP 19).
- The City of Salt Lake Pedestrian Safety Committee developed the “Adopt-a-Crosswalk” crossing flag program. Under this program, orange crosswalk flags are available at either end of the crosswalk for pedestrians to carry with them while they cross. This low-cost approach makes pedestrians more visible and communicates intent to cross to drivers. Businesses and other organizations are encouraged to “adopt” a crosswalk to pay for replacement flags as needed. The city also increased the fine range for drivers failing to yield to disabled pedestrians, flag-carrying pedestrians, and school crossing guards from a maximum of \$425 to \$725 and a required court appearance (City of Salt Lake).

ENFORCEMENT

Rules and regulations are also an important part of trail safety. It is encouraged that regulations be developed in concert with trail groups to maximize their effectiveness and reduce the potential for excessive regulations that could affect the popularity of the facility. Three principle regulations can be used. The first, speed limits, is important because differences in user speed can create dangerous collisions and situations. However, speed limits should not be used unless they are absolutely necessary as they can discourage commuting bicyclists, and they require enforcement. Speed limits for different sections of the trail may be appropriate on some trail systems to accommodate different situations. The second regulation that is commonly used is zoning particular areas for specific users. It can be used in multiple formats such as time (time, day or week, season), activity (only bicyclists, no snowmobiles), or section (snowmobiling on first mile). The third regulation is right-of-way, that specifies which user group must yield to other groups (Moore 36-37). Although these three regulations are the most common, some others may be useful depending on trail and user characteristics:

- Mandating one-way travel on particular segments or paths.
- Requiring bicyclists to walk their bike in congested areas.
- Closing trails during rainy or other dangerous weather-related events.
- Requiring all bicycles to have bells.
- Implementing user fees.

Enforcement is another component to reduce potential liability. Not only do jurisdictions need to enforce snow removal ordinances and sidewalks conditions, but they also need to consistently

enforce compliance with laws related to motorists, pedestrians, and bicyclists (Zegeer et al. 20-22; Moore 38). These laws include imposing vehicular and bicycle speed limits, yielding to pedestrians, and jaywalking.

One report recommends enforcement actions to prevent user conflicts, and without this aspect trail sharing cannot be completely effective (Moore 36-37). The report lists a few actions that have been found to increase compliance:

- Signing regulations effectively.
- Communicating the reasons behind regulations.

Another important component of enforcement is regular patrols. Provide policing and surveillance by police, neighborhood groups, or private security (Loukaitou-Sideris 225). The Virginia Greenways and Trails Toolbox recommends daily security patrols; however, for many agencies without volunteers or sufficient funding this is not possible (Parsons HBA 5-3). Agencies lacking funding or volunteers should prioritize their patrols. When possible have a variety of enforcement personnel such as peer policing programs, volunteer trail patrols, uniform patrols, and cooperative agreements with police and fire personnel.

There are a number of possibilities for patrolling trails including local law enforcement, volunteers, and agency staff. However, unless patrols are being conducted by police, the purpose of trail patrols is *not* to apprehend criminals, but rather to provide assistance and information regarding trail etiquette. Trail patrols increase the comfort levels of users and also provide valuable information over the maintenance of the trail (Olka, Searns and Flink 146-147).

The report *Rail-Trails and Safe Communities: The Experience on 372 Trails* reviewed a number of volunteer trail patrol programs throughout the country (Tracy and Morris). The authors discovered a wide range of trail patrols. Some patrolled monthly to perform litter removal and maintenance needs, others patrolled daily. However, the authors stated that main objective of trail patrols should be to educate users, provide assistance if needed, have the capability to contact emergency services quickly, and deter crime through visible patrols. Local law enforcement, civic organizations, and “Friends of the Trail” groups are all organizations that should be considered in organizing patrols. The frequency of trail patrols should be dependent on the trail characteristics and resources (funding and availability of volunteers).

The report includes several examples of successful trail patrols. In Bedford, Massachusetts, the police conduct regular bicycle patrols on the Minuteman Trail. In addition, they organized the Bedford Police Explorers (BPE) to conduct patrols as well. The BPE are volunteers trained in CPR and first aid and are equipped with radios. On the North Augusta Greenway, 20 police officers volunteer to patrol the 3-mile facility by coordinating their exercise workouts on the trail.

A much longer trail with an active trail patrol is the Pinellas Trail in Florida. The Pinellas Auxiliary Rangers consist of uniformed volunteers, 18 and older, who assist with directions, user safety, and first aid. The 25-plus volunteers are subjected to background checks and are trained in the trail history, public relations, trail-riding, first aid and nutrition. Volunteers patrol by bike and use cell phones to communicate.

An example of a cooperative effort is the Regional Trail Corporation for the 23-mile Youghiogheny River Trail-North. Three local trail organizations are responsible for around 20 uniformed volunteers that patrol on bike, horse, and by foot. Volunteers carry first-aid kits and cell phones, and explain trail rules and report user suggestions and concerns. Volunteers also report maintenance issues and graffiti incidents. The Great River Trail in Illinois uses its volunteer patrol during daylight and depends on the police during dusk hours. The East Bay Regional Park District Public Safety Department uses its maintenance crew to regularly patrol the trail.

The Municipality of Anchorage's Trail Watch Program was created through community forums and meetings where citizens expressed concern about poorly lit and overgrown trails, inadequate signage, and the inability of emergency responders to incidents on the trail. Another issue was the lack of tracking of crime incidents on the Anchorage Trail network. In response to these concerns the Trail Watch Program was implemented (Municipality of Anchorage) that includes:

- A two-tiered program consisting of Trail Watchers who patrol at their own schedule and Trail Watch Ambassadors who patrol on a regular schedule and have additional training.
- A maintenance reporting system whereby volunteers use the Trail Watch feedback form to report maintenance issues such as graffiti, erosion, and unlit trail lights. The online reporting system increases the number of reports filed (Municipality of Anchorage).
- Enhanced signage was installed in partnership with a local business resulting in trail signs installed at all trail/road intersections and trail maps available at all major trailheads.
- Training for all volunteers. Volunteers must participate in an Anchorage Police orientation that involves dispatchers and policemen. The police department developed a new sub-code to identify all crimes initiated on the trail network. The volunteers must undergo background checks and be equipped with visible Trail Watch armbands.
- Community Partnerships: The Trail Watch program has partnered with the Anchorage Responsible Beverage Retailer's Association (ARBRA) for all alcohol-related litter on or near the trail facilities. Once reported to the (ARBRA), a clean-up crew will respond within 48 hours. Other forms of partnership have involved donations from businesses. One business donated backpacks to volunteers, and another provided calendar software.

SUCCESSFUL SECURITY RESPONSES

Interviewees also shared some success stories related to using people and patrols on the trails to increase security:

- The City of Madison, Wisconsin, works with the neighborhood and police to address issues. Last year, there was a rash of assaults on a specific path, so a neighborhood patrol was instituted, and the police increased patrols on the path as well (Ross). It can be difficult to increase usage after an incident, but the community urged citizens to use the trail in groups and during daylight hours (Huber).
- The City of Rochester, New York, recommends having as many staff of all types on the trail as possible as this increases users' perceptions of safety. For example, he suggested having maintenance personnel work during high traffic times. In addition, the city has a parks patrol of nine uniformed officers during the summer who patrol on bikes, foot, or ATV. The police department has a mounted unit and a bicycle unit that also make their presence known on the trails (Saltrelli).

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- The Washington and Old Dominion Trail (W&ODT) instituted a volunteer trail patrol. This trail patrol stresses etiquette on the trail and provides extra eyes on the trail. Although it cannot issue tickets, the trail patrol has an open line of communication to management and staff (Pauley).
- In addition to the mile markers, the Littleton & Sheridan Police conduct bicycle patrols on the SSPR trail network. These officers and the park rangers are equipped with radar guns to ticket users who are traveling beyond the speed limit of 15 mph. (Road bikes are the usual culprits.) Park rangers also patrol and are often the first on the scene for an incident. They maintain radio contact with paramedics (Woodcock).
- One agency has responded to persistent problems with lewd behavior by using undercover rangers from other state park regions to deter activities (G. Smith).

In dealing with problems, one report offers some recommendations for crafting appropriate responses (Moore 23, 27-30):

- Understand the motives of users. Deliberate illegal activity is harder to prevent with signage than incidents caused by the users' ignorance of applicable regulations.
- Attempt to identify the groups that are more likely to engage in the dangerous, reckless, or illegal activity, and then structure efforts toward them.
- Identify specific sources of conflict causing problems such as "bikers speeding down hill after trailhead" or "littering by youth."
- If possible, attempt to rectify conflicts on multiple-use trails on the local level.

EDUCATION AND OUTREACH

In cases where jurisdictions assign snow removal responsibility to adjacent homeowners, property owners must be reminded frequently about their snow removal responsibilities (Cottrell).

Most bicycle crashes are the result of improper behavior on part of bicyclists or the result of unskilled or uneducated trail users. Therefore educational programs are very important (Bustos 5; Moore 12). One approach is the "Four E's" approach to creating safe and effective pedestrian systems. The "Four E's" stand for: education, engineering, enforcement, and encouragement (Bustos).

- Education means educating users regarding rules for trail use and due care. Tim Bustos described an incident involving a college-age female who was attacked while running alone on a trail at 2 a.m., despite the incorporation of security and safety elements into the design.
- Engineering is important, and it is critical that designers be trained in bicycle and pedestrian design. Frequently, traffic engineers are only schooled in one type of road user: motorists.
- Enforcement concerns the enforcement of laws, such as cracking down on speeding cyclists and cars and aggressive drivers.
- Encouragement refers to the encouragement of quality facility design through outreach—bringing all groups (community, design professionals, law enforcement) to the table.

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The City of Seattle, Washington, followed the “Four E’s” to implement a Pedestrian Summer Safety campaign (Cottrell):

- Education: Provided pamphlets and presentations at public events, a billboard campaign, traffic calming tours, mailings from insurance companies, held an elected officials forum on walking and other education efforts from May through October.
- Enforcement: The Seattle Police implemented targeted efforts at motorists disobeying crosswalk laws.
- Engineering: The city installed new pedestrian safety devices at dangerous intersections and school areas.
- Encouragement: Offered guided walking tours of the city.

More than 20 companies, non-profits, and government agencies participated and provided financial donations for this awareness campaign.

General public education campaigns are very important for both pedestrians and cyclists to increase the safety and security of users. More successful trails will post rules and regulations throughout their networks (Bustos). Programs should promote bicycle use and safety (Bustos 30), highlighting the use of reflective clothing, crossing at crosswalks, and other pedestrian safety actions and raising motorist awareness (Reitmayer et al.).

General public education campaigns can be very effective for increasing pedestrian and bicyclist safety. In addition, it is also important to target children and the elderly. These two user groups are involved in a significantly high percentage of pedestrian-related accidents each year.

Parental involvement in child pedestrian training programs and activities should be increased. Research indicates that parents should receive training in child pedestrian safety so they can in turn teach their children. Some experts have found that child safety programs are more effective when parents are involved and outdoor training is included. Research also indicates that a high percentage of parents misjudge their children’s ability to walk safely (Cottrell 14).

Safety education programs focused on the elderly should be increased. The elderly also frequently report problems seeing oncoming vehicles and judging “crossing gaps” when they are involved in accidents. Programs should reinforce “looking behavior” to the elderly population. Safety education courses should be held and safety material should be distributed at senior centers, organizations, and communities (Cottrell 14, 21). In 2001, due to increased complaints from the senior citizen community about crossing streets, the city’s transportation department distributed brochures titled *How Pedestrian Signals Work* to all senior residential areas within city limits. Staff also held question and answer sessions and solicited concerns regarding specific intersections (City of Salt Lake Pedestrian Safety Committee 3).

Efforts directed at information and education should (Moore 28-30):

- Convey that the trail is shared.
- Mention trail courtesy, yielding rules, and user responsibility.
- Provide physical and social trail conditions such as difficulty and trail length.

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- Highlight that cooperation can benefit everyone.
- Communicate the consequences of certain behaviors.
- Build trust.

The following list of manners, mechanisms, and strategies were documented from discussions with trail managers and other sources. The report recommends using multiple approaches maximize educational effectiveness (Moore 32-34):

- Posters.
- Brochures, flyers, and other handouts.
- Maps and guidebooks.
- Presentations to clubs and other groups.
- Videos.
- Educational kits for schools.
- Volunteer trail patrols.
- Ranger role modeling.
- Personnel at trailheads and campgrounds.
- Public meetings.
- Trail day events.
- Safety days on the trail.
- Education “roadblocks” on trails.
- Bumper stickers.
- Theme events to encourage a message (walking litter pick up).
- Workshops.
- Information signs.
- Water bottles with rules printed on them.
- Accurate information on trail difficulty.
- Education of new users.
- Surveys at rail heads.
- Contests or awards for groups.

According to a survey by Rails to Trails, the most common practices employed by trail managers are (Moore 23):

- Signs.
- Brochures.
- Ranger patrols.
- Trail guides.
- Presentations to groups and children.
- Visitor contact areas.
- Trail striping.
- Press releases.

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Some examples of successful education activities include:

- Pennsylvania's Schuylkill River Trail has regular signage to stay on the path (Birk et al. 96).
- The Springwater Corridor Trail in Oregon has a "Teens on Trail" program in which teenagers provide maintenance assistance and give tours (Birk et al. 96).
- Pennsylvania's Lehigh River Gorge Trail has volunteer groups that give safety demonstrations on the trail (Birk et al. 96).
- Operation Lifesaver is a national program that has state coordinators available to provide safety information and coordinated educational events with trail organizations. Safety efforts can be coordinated with railroad safety programs such as Operation Lifesaver, which provides signage, brochures, and education regarding appropriate behavior near railroad facilities (Birk et al. 96).
- A Pedestrian Safety Committee in the City of Salt Lake, Utah, initiated a Jaywalking Prevention Campaign, handing out leaflets detailing jaywalking laws followed by police enforcement (City of Salt Lake).
- Portland distributes free bicycle maps and safety information to over 10,000 residents (RTC and APBP 2-3).
- Bicycle bells, helmets or other safety equipment can be given away (Moore 23).
- The National Capital Regional Planning Board implemented the "Street Smart" campaign, a one-month mass media campaign coordinated with increased law enforcement. According to research, fear of fines and legal trouble is greater than fear of death or injury. This program was targeted towards male drivers between the ages of 18 and 34. The total number of pedestrian and bicycle fatalities dropped by 17 from 2001 to 2004. The program is funded by the federal government, through state governments, and requires matching local funding (Farrell and Meese et al. 3-10,3-11).

The majority of motorists are also pedestrians. Consider expanding pedestrian education efforts when issuing driver's licenses for first-time drivers. Include some information on pedestrian and automobile conflicts in motorist tests and revise *Motorist Handbooks* (used for driver education) to contain specific pedestrian safety actions (Wisconsin Department of Transportation):

- Safety at crosswalks.
- Night-time pedestrian visibility by wearing light-colored clothing.
- Walk facing traffic on the left side of the road if there are no sidewalks.

Several sources recommend making an effort to reach out to the community and users for their opinions and suggestions to make the trail better and safer. Planners and engineers should utilize new approaches such as interactive public workshops, surveying drivers and pedestrians and regular communication with police to identify dangerous pedestrian areas instead of implementing safety improvements after injuries or fatalities have occurred (Harkey and Zegeer 3, 12). Transportation agencies should consider and consult trail users when deciding trail and road crossing treatments. Trail users should be considered transportation customers (Gittings et al. 107).

- Encourage public participation and maintain a communication system for complaints, questions or concerns by the public (Searns 1-2).
- Hold a pedestrian workshop with local officials focused on design-related issues, improvement of pedestrian safety, and other pedestrian-related concerns (Wisconsin Department of Transportation).

The plan for Loudoun County, Virginia, offers several methods to address pedestrian safety issues (Pastor et al.). Some of the safety efforts recommended are:

- Encourage school boards to adopt pedestrian and safety curriculum both for K-5 and in Driver Education classes.
- Expand public education efforts in areas with higher levels of walking and bicycling.
- Initiate a constant safety education program.
- Make law enforcement aware of traffic safety enforcement issues.
- Organize outreach activities.
- Meet with user groups (Moore 23).

In areas where congestion on the trail is causing problems, users can be encouraged to change their habits. Trail managers in backcountry settings offered a number of suggestions in a NPS study (Moore 23):

- Inform citizens of crowded conditions.
- Encourage the use of less crowded trail access areas.
- Divide trails into different user groups or assign certain areas for particular user groups.
- Persuade large groups to use less traveled areas.

Assistance and Coordination

Many jurisdictions have committees or commissions that deal with safety, transportation, and/or recreation issues. All interviewees felt that these groups were very valuable in highlighting and helping to solve problems. One interviewee recommends establishing a collaborative group because of the ideas different parties bring to the design process. It is important to the design process to biking club members, maintenance professionals, citizens, and the police. Committees can increase communication and understanding between planners, different users groups, and trail managers. More importantly, it allows staff the opportunity to speak to the leaders of different groups and develop relationships with them. Citizens and bike club members also take information back to their members and other trail users (Woodcock).

Safety committees are also highly recommended in the literature. For multi-use trails with a higher level of security issues, a technical security team, including the police and fire departments, emergency service and a representative from the trail agency, can be formed (Olka, Searns and Flink 146-148). A safety task force to handle reoccurring problems can be created (Searns 4-5). This team can share information, coordinate responses, and work together toward informing the public about risks. Include operations, police, and rescue personnel in the annual review and daily management processes (Searns 3-4). Teams and committees may be statewide, for a specific jurisdiction, or focused on a specific facility.

- In Colorado, there is a State Trails Committee for Oversight that oversees trail issues statewide and includes representatives from seven congressional districts, a board member of Great Colorado Outdoors, an at-large member, and all trail user groups. This group provides recommendations on state trails policy, direction, planning, and grants to the State Parks Board for approval (Collins).
- Colorado also has a state Safety Committee composed of a variety of agencies that is working on developing safer standards for trail networks. The safety committee has been analyzing a number of ideas and recommendations including ticketing speeding bicyclists,

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using the Sheriff Department in high problem areas, and using comment boxes to increase the ability of users to supply input (Collins).

- Pennsylvania has a statewide recreation committee that includes representatives from the ADA/disabled community (Beaver).
- The City of Madison, Wisconsin, has a Transportation Commission charged with developing policies and programs to ensure that the bike, pedestrian, and motor vehicle systems function as an integrated part of the overall transportation system (Ross).
- The South Suburban Parks and Recreation District (SSPR) is a special district with an elected board and encompasses seven jurisdictions and 140,000 residents, eight miles south of downtown Denver. The district is responsible for parks, recreation, open space, and trails (Woodcock).
- The Colorado Metrowide Trails Safety Committee is composed of maintenance personnel, police, and citizens who meet three times a year to discuss and improve design, safety, and security issues. Meetings are often held as an informal brown-bag lunch to encourage user participation (Woodcock).

Many states are providing assistance to local jurisdictions related to safety, security, and maintenance of sidewalks and shared-use paths:

- Utah works to increase local municipalities' awareness concerning their risk of liability for failing to ensure clear sidewalks and reduce snow-related safety incidents (Cottrell 22-23).
- The Bureau of Planning within the Wisconsin Department of Transportation (WisDOT) provides a *Best Practices Resource Guide* to local governments (WisDOT).
- WisDOT provides staff training for local officials (WisDOT).
- Wisconsin provides funding for implementation of local safety education programs (WisDOT).
- The Oregon Department of Transportation (ODOT) is providing technical and financial assistance to local governments for bikeway and walkway projects on local streets (Reitmayer et al.).
- ODOT shares the costs of ADA upgrades with local agencies (Reitmayer et al.).
- ODOT shares sidewalk and trail maintenance costs with local agencies (Reitmayer et al.).
- At WisDOT, two staff people are dedicated to pedestrian and bicyclist issues. One position is in the Planning Office of the Division of Investment Management. The second position is located within the State Police and focuses on safety, education and enforcement (Huber).
- Colorado provides educational programs, such as bicycle safety and certification for off-highway users (Collins).
- Colorado provides planning grants including GIS, and GPS inventories, as well as for trail maintenance and master plans. Around 80 percent of communities in Colorado have master trail plans. Funding for the grants comes from a wide diversity of federal and state programs (Collins).

Funding

Maintenance funding is a big issue. Frequently, funding is provided for the construction of new trails, but not for their maintenance. In Wisconsin, a state fund reimburses municipalities for highway/street maintenance, but not for trail maintenance. There are frequent complaints regarding the lack of state or federal funding for maintenance. In Tom Huber's experience, maintenance funding issues start to arise when a municipality or agency builds a second or third

trail; then users start to use the trails more frequently and demand more upkeep on the network (Huber). No matter how well-designed the trail, there will always be some maintenance costs associated with basic tasks. However, investing more money on the initial construction and design of multi-use trails could reduce future costs associated with maintenance, safety, and security issues (Pauley).

The *Virginia Trails Handbook* recommends that each annual budget allocate funds towards long-term maintenance. Also, the handbook states that if a trail crosses through several municipalities, a formula should be developed and agreed upon so each municipality contributes to the maintenance budget. Furthermore, the authors warn against reducing maintenance budgets as it leads to higher costs in the future, when the facility must be returned to a functional standard (Parsons HBA 5-4). One interviewee recommended the inclusion of citizen input to determine which areas should receive priority for maintenance (Huber).

The costs associated with maintaining a proposed trail should be factored into a comprehensive budget that breaks down cost per mile. The maintenance budget must be developed before the facility is built so that the managing agency can prepare for future requirements. The sponsoring agency should develop a maintenance checklist of all the necessary maintenance. Then the tasks can be divided into routine and remedial maintenance. Maintenance activities must also be prioritized based on which are critical to user safety and which are important to keeping the trail aesthetically appealing. After prioritizing maintenance operations, a schedule should be developed (Olka, Searns and Flink 158). The following guidelines are provided for routine maintenance activities:

- Drainage and channel maintenance 3-5 times a year.
- Sweeping or blowing debris 16-24 times a year.
- Garbage removal 12-24 times a year.
- Vegetation management 8-12 times a year.
- Mowing of shoulders 8-24 times a year.

The authors realize that the above guidelines are dependent on local conditions and the quality of the trail design. The more rain in a specific area, the more the vegetation may need to be trimmed and drains checked. The authors also included the following guidelines on resurfacing:

- Asphalt every 7-15 years.
- Concrete more than 20 years.
- Boardwalks 5-7 years.
- Wood chips replace 6 inches every year.
- Crushed stone every 7-10 years (assuming regular maintenance).

Our interviewees get funding for maintenance and operating expenses from a variety of general, dedicated, and one-time sources. Capital improvement programs and maintenance budgets are critical sources of funding for maintenance, and agencies and governments must make every effort to have an annual maintenance budget (Bustos).

- Regular funding for City of Madison, Wisconsin, maintenance operations comes from the general budget allocation, but large rehabilitation or expansion projects may be funded from the capital program (Ross).

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- There is a systematic inspection of the parks and trails every three years in Pennsylvania, with an annual meeting to determine projects to be funded. Also, there are maintenance funds specified for different areas (G. Smith).
- Minor maintenance costs are paid for under the operations budget of Colorado's SSPR; however, major maintenance projects such as trailhead resurfacing can be completed with capital funding. They do have an annual capital program in addition to the operating budget (Woodcock).

Dedicated funding sources are always preferred, but not always easy to come by:

- The ATV trails get more maintenance attention because of a dedicated funding source. There are over 225,000 ATVs registered in Pennsylvania, and each one pays a registration fee that pays for ATV trail maintenance (Beaver).
- User fees and other charges supply around 80 percent of the general operating budget for the Washington and Old Dominion trail in Virginia. NVRPA receives funding from fiber optic cables and power lines located on its property through a lease with Virginia Power for utility delivery. All of the funds flowing from agreements with Virginia Power are channeled into a restricted fund allocated for special improvements. An additional source of dedicated funding is the equal compensation NVRPA receives for land utilized by the government for transportation or other public purposes. Since NVRPA owns the land outright, unlike many other rail trails, they alone receive the government's compensation for funding. Other funds come from each jurisdiction as a per person tax (Pauley).
- The Colorado SSPR district has an annual budget of around forty million dollars with about 40 percent coming from property taxes. The Colorado lottery and golf course user fees are other major funding sources for parks and recreation, including trails (Woodcock).

Most agencies are always looking for additional sources of funding, especially for maintenance:

- It is hard enough to maintain what Pennsylvania has now (Beaver).
- Colorado state trails money is also available for specific projects (Woodcock).
- The Pennsylvania Bureau of Forestry just applied for a SIMS grant (federal money administered by the state) to buy more trail maintenance equipment. They have also gotten ISTEA funds for specific projects in the past (G. Smith).
- The City of Rochester, New York, is always looking for grants and other sources of both capital and operating funds for trails (Saltreli).
- With increasing maintenance costs, Chris Pauley's organization has begun to look for grants and other sources of additional funding to supplement their budget. He, like many others, called for increased funding for on- and off-road facilities and additional people (Pauley).
- Missouri's Katy Trail operates on a \$100,000 budget that is almost entirely designated for maintenance. However, the low cost associated with maintaining and operating this 185-mile trail is partially due to its extensive fundraising and cost-cutting operations. It has an Adopt-a-Section program which allows trail groups to adopt a trailhead or a 2-mile segment for a \$100 contribution. Groups are also encouraged to adopt park benches for \$285 with proceeds going towards trail maintenance (RTC and APBP 16-17).

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Money for the initial construction of shared-use trails seems to be a bit easier to come by but everyone would like to have more:

- The state of Colorado passed a bill that requires developers to dedicate at least ten percent of their development to open space, including trails (Woodcock).
- The Platte River Greenway in Colorado was funded by setting up a nonprofit 501C3 organization (Woodcock).
- Ballot initiatives have also been successfully used to secure extra funding. Voters in the SSPR district of Colorado approved a one million dollar increase for a ten-year open space acquisition and trail construction/upgrade program (Woodcock).
- In Milwaukee County, WisDOT funded the expansion of 7-foot trails to 10-foot trails using federal Congestion Management and Air Quality (CMAQ) money. Unfortunately, this is no longer allowed (Huber).
- Local police organizations provide funding for bike patrols and other necessary items (Pauley).
- Colorado uses a wide diversity of federal and state programs to provide planning grants to local jurisdictions. Grants can be used for GIS and GPS inventories as well as for trail, maintenance, and master plans (Collins).
- Many municipalities “piggy-back” onto state projects to reduce costs (Waterland)
- Davis, California, requires all new developments to incorporate provisions for bicycles, for example, bicycle parking, bicycle lanes, and connecting residential areas to the network (RTC and APBP 4). However, this works best if the facility can be constructed before the homes (Bustos).

Staffing Issues

Staff should be on the trails as much as possible checking for hazards and maintenance needs. On shared-use paths where speeding bicycles are present, staff should have the same protective gear as highway workers, and work zones should be set up using the same considerations as for highway work zones. Bill Woodcock described a bicycle accident that occurred when the pedal of a rider was snagged in construction fencing (Woodcock). When facilities are under construction, it is important that trained inspectors conduct quality control to ensure that the facility is constructed according to all applicable codes and ADA standards (Waterland).

Staff may need to be educated about ADA issues and emergency responses so they can help to avoid liability issues (Olka, Searns and Flink 146). Since snow removal programs must include clearing curb ramps, jurisdictions must train snowplow operators either how to clear these areas (if possible) or, at a minimum, how to avoid making them worse by avoiding piling snow near corners, and positioning plow blades to avoid spraying snow onto adjacent sidewalks (Cottrell 22-23). However, trucks cannot really plow sidewalks, so the agency needs a different team, with appropriate equipment to deal with walks and curb cuts. Contractors and employees should be reminded to avoid using accessible areas or routes for snow storage. Contracts with snow plowing companies should include stipulations related to clearing of accessible facilities, and that they must return to clear them if accidentally blocked (Waterland).

A strategy that has worked well in Madison is that snow removal responsibilities are divvied up among city agencies using GIS mapping and based on which agency is closest to the location, has the correct equipment, etc., rather than solely on jurisdiction (Ross).

Volunteers

Volunteer groups can be an important component of safe, secure, and well-maintained trails. Volunteers can provide eyes on the trail and assistance in emergencies, educate users, and report hazards or maintenance issues. Volunteers can help with specific projects supervised by agency staff or assist with the day-to-day management of the trail. NPS refers to adopt-a-trail and trail sponsors as part of the “overseer system.” Furthermore, NPS recommends that responsibility for the trail or a trail segment should be given to one individual to increase their familiarity with a particular segment. However, this can lead to trail organizations becoming tired of their segments. The Handbook for Design, Construction and Maintenance, North Country National Scenic Trail (1996) cites the Appalachian Mountain Club’s *Organizing Outdoor Volunteers* as a great resource (U.S. Department of the Interior 86).

Volunteers can also reduce costs. One publication provided examples of different volunteer maintenance groups (Olka, Searns and Flink 160). The first example, the Lower Trail in Pennsylvania, maintains a volunteer database. The managing agency, Rails-to-Trails Central Pennsylvania, sets workdays for routine maintenance such as removing fallen trees and branches as well as major projects such as constructing rain shelters. The Lower Trail also has a ten-member mowing crew in charge of 23 acres. Another example in Michigan called the Musketawa Trail created an adopt-a-trail program to assist with trail maintenance:

- Any organization with over six members can adopt a segment for two years.
- The trail manager identifies projects for the organizations to do such as litter pickup, fixing trail furniture, and planting trees.
- Safety rules, vests, refuse bags, recognition signs, and adoption certificates are provided to the sponsoring organizations.

If a trail agency decides to use a volunteer trail patrol, the following procedures should be considered (Olka, Searns and Flink 137, 160):

- Provide training courses in CPR and agency policies.
- Equip volunteers to respond to medical emergencies.
- Distribute maps and brochures and perform bicycle safety checks.
- Fill out maintenance forms.
- Evaluate itself at the beginning and end of each year through user surveys.

In addition, volunteer recreational organizations in some areas have helped to expand the trail system by working to create easements over private property. From time to time, the Pennsylvania Bureau of Forestry enters into agreements with private landowners and trail clubs to create trail easements and connections on private property. Those organizations can then apply for grant money for maintenance. The bureau does not have any patrol jurisdiction or maintenance responsibility on these lands (Beaver).

Rail-to-Trail Conversions

As noted previously, long trails extending through multiple jurisdictions can have some specific issues. Ensuring the security of the users on the Washington and Old Dominion (W&OD) trails is a difficult task, especially given that the 45-mile trail passes through seven jurisdictions, and there is no typical experience across the trail due to the many different environments. One of the biggest security issues is getting local police agencies to report security or safety incidents to the

WO&D staff. Chris Pauley cited the importance of encouraging the police to patrol the trail network. There are four to six staff members on the trail everyday (two full-time rangers plus seasonal rangers), however clearly this small number spread along a 45-mile network provides very limited protection and response capabilities. The main office is located at the halfway point of the trail (mile 27), which means it can take up to an hour and half for an individual to reach someone at the far ends of the trail. The W&OD does have a ranger patrol, although they primarily rely upon a volunteer trail patrol. This trail patrol stresses etiquette on the trail and provides extra eyes on the trail. Although it cannot issue tickets, the trail patrol has an open line of communication to management and staff. Local police organizations provide funding for the bike patrols and other necessary items (Pauley).

Chris Pauley's staff now meets regularly with Arlington County officials to discuss security and safety concerns. It is also important to regularly meet with local authorities to discuss issues, provide support, and share information, and it is important to make sure all the jurisdictions know they can come onto the trail. In a specific example, on one trailhead in Arlington County, day laborers were congregating at a trailhead to solicit work from users of the trail and were repeatedly reported as displaying offensive behavior to female users. Although not really a crime, there were discomfort and traffic issues. Working with the Arlington County Police, they encouraged police patrols and redesigned the trailhead to be a more open trail plaza without any public seating. He also stressed the importance of understanding the different issues in each jurisdiction. Arlington County's problem with day laborers was quite different from another jurisdiction's issue with groups drinking on the trail.

APPENDIX I: PEDESTRIAN CRASH TYPES AND COUNTERMEASURES

Federal Highway Administration. Pedestrian Facilities User Guide—Providing Safety and Mobility. FHWA-RD-01-102. Mclean: 2002

There are 12 major crash types that have been identified by the National Highway Traffic Safety Administration and the Federal Highway Administration based upon analysis and studies conducted on national pedestrian crashes and incidents. This guidebook purposely lists multiple solutions to the problems not only to give planners and engineers a range of successful solutions, but because most responses to pedestrian incidents require a combination of treatments (Harkey and Zegeer 7-34). Chapter three of the PEDSAFE guidebook details the following:

DART/DASH

This accident type comprises 24 percent of all pedestrian accidents. This type involves a pedestrian who has entered the roadway at an intersection or mid-block location and is hit by a vehicle. The following problems are frequent causes of this problem, followed by successful treatments:

Countermeasures for children darting onto a collector/neighborhood streets:

- Improve or provide adequate nighttime lighting.
- Provide curb extensions.
- Install spot street narrowing at areas with busy mid-block crossings.
- Narrow travel lanes.
- Install traffic-calming measures.
- Provide raised pedestrian crossings.
- Remove or restrict on-street parking.
- Educate children about safe crossing behavior.
- Design gateway to alert motorists they are entering into a neighborhood with many kids.

Countermeasures for pedestrian-vehicle conflict on high-speed or high-volume arterial:

- Relocate bus stop.
- Provide nighttime lighting.
- Install overpasses or underpasses.
- Install medians or pedestrian crossing islands.
- Provide curb extensions.
- Stagger the crosswalk through the median to force pedestrians to walk and look to the right.
- Employ speed-monitoring trailers.
- Enforce speed limits and pedestrian ordinances.

MULTIPLE THREAT/TRAPPED

These accidents occur when a pedestrian begins crossing in front of a stopped vehicle and gets struck by a vehicle traveling in the next lane. Common causes are the stopped vehicle blocked the visibility of the pedestrian for the traveling car and the speed of the car traveling in the next lane.

Countermeasures for multiple-threat:

- Relocate bus stop to far side of crossing areas.
- Improve roadway lighting.
- Install traffic-calming devices like speed tables or raised pedestrian crossings.
- Recess stop lines 30 feet in front of crosswalks.
- Install traffic signals.
- Install flashers or advance warning signs.

General countermeasures for pedestrians becoming stuck in middle of roadway after light changes from red to green:

- Adjust signal timing.
- Provide mid-block or intersection curb extensions.
- Provide raised crosswalks.
- Provide raised pedestrian crossing island.

UNIQUE MID-BLOCK ACCIDENTS

These accidents involve pedestrians exiting or entering parked vehicle or getting mail.

General countermeasures:

- Relocate mailboxes.
- Restrict on-street parking.
- Add bike lanes and reduce roadway widths.
- Improve lighting.
- Implement traffic-calming measures.

ACCIDENTS INVOLVING PEDESTRIANS CROSSING AT UNSIGNALIZED INTERSECTIONS

In these cases, either the pedestrian or motorist may have failed to yield.

Motorist failing to yield countermeasures:

- Improve crosswalk marking visibility.
- Reduce curb radius.
- Install curb extensions or chokers.
- Use landscaping that slows vehicles without adversely affecting sight lines.
- Install overhead CROSSWALK, school zone, or other warning signage.
- Install speed humps, speed tables, raised intersections, or raised crosswalks.

Countermeasures for motorists unwilling to yield due to high speeds and high traffic volumes

- Reduce lane width or number of lanes.
- Construct pedestrian crossing island.
- Install overhead pedestrian-actuated flashers.

BUS-RELATED

Countermeasures for conflicts from poor visibility (bus blocking view of motorist in the next lane:

- Install crosswalk markings to encourage pedestrians to use the crosswalk behind the bus.
- Move the bus stop to an alternate location.
- Install curb extensions.
- Remove parking areas that block pedestrian and motorist sightlines.
- Provide bus pull-off area.
- Add recessed stop lines.

TURNING-VEHICLE ACCIDENTS

These conflicts happen when a right- or left-turning vehicle strikes a pedestrian.

Countermeasures for left-turning conflicts:

- Add curb ramps or curb extensions.
- Install raised median and pedestrian crossing island.
- Design modified T-intersections, intersection barriers, or diverters.
- Apply traffic-calming measures such as raised intersection or raised crossings to reduce vehicle speed.
- Add pedestrian signal phasing—like leading pedestrian intervals.
- Prohibit left turns.
- Install warning signs for motorists and pedestrians.

Countermeasures for right-turning conflicts:

- Provide marked crosswalks and advanced stop lines.
- Improve intersection lighting to improve visibility.
- Remove intersection snow/ clutter at corners to improve visibility and allow for the pedestrian to stand in a visible location.
- Reduce right turn radii.
- Provide leading pedestrian interval.
- Prohibit right turn on red.
- Install warning signs for pedestrians and motorists.
- Remove on-street parking near crosswalks.
- Remove obstructions and/or roadside obstacles such as trees, mailboxes, poles, newsstands, trash cans.

THROUGH VEHICLE AT SIGNALIZED INTERSECTION

These conflicts occur at an intersection or mid-block crossing between cars traveling straight ahead and pedestrians.

Countermeasures to pedestrians who are delayed before the WALK interval:

- Provide pedestrian crossing islands.
- Re-time signal to more responsive.
- Provide quick-response pedestrian push-buttons or automatic detectors.

Countermeasures for pedestrians who ignore WALK phase:

- Re-time signal to more responsive.
- Provide adequate walk and clearance intervals.
- Provide pedestrian and motorist education.
- Install new or larger pedestrian WALK signals.

Countermeasures for poor sight distances for motorists (unable to stop in time):

- Add marking treatments that enhance visibility.
- Move bus stop to far side of intersection.
- Improve nighttime lighting.
- Provide curb extensions.
- Provide raised intersections.
- Remove sight obstructions—parked vehicles, unnecessary signage, etc.
- Provide raised crosswalks.

Countermeasures for red-light violator accidents:

- Add short all-red interval at signal.
- Increase police enforcement.
- Install camera enforcement.

PEDESTRIAN WALKING ALONG THE ROADWAY INCIDENTS

Pedestrians who run or walk alongside a roadway and are struck.

General countermeasures:

- Provide a sidewalk on both sides.
- Provide an asphalt path or paved shoulder.
- Construct and maintain sidewalks and curb ramps to be usable by disabled individuals.

Countermeasures for high-vehicle speeds or volume:

- Add sidewalks or walkway.
- Maintain sidewalks.
- Increase separation from roadway through landscaping.
- Provide lighting.
- Install “Walk on left facing traffic” signage.

- Increase enforcement of speeding.
- Ensure adequate routes to school.
- Remove obstacles in sidewalks.
- Relocate poles and street furniture.

NON-ROADWAY SIDEWALK, DRIVEWAY, PARKING LOT, OR OTHER

These conflicts occur when pedestrians are struck by vehicles in a parking lot, alley, or on a sidewalk crossing a driveway.

Countermeasures to pedestrian standing near curb:

- Provide nighttime lighting.
- Create sidewalk buffers such as bike lanes or planting strips.
- Reduce curb radii.
- Install sidewalk barriers.

Countermeasures to parking lots, driveways, alleys, etc.:

- Maintain level sidewalk across driveway.
- Move sidewalk farther back to increase motorists' time to stop.
- Remove landscaping or other objects blocking visibility near driveways.
- Redesign or re-stripe parking lots to provide a clear pedestrian path through parking lot.

Countermeasures for accidents involving vehicles exiting or entering driveway or alley:

- Maintain level sidewalks.
- Remove unnecessary alleys and driveways.
- Remove sight obstructions such as lowering fences or trimming hedges.
- Add planting strip or form of sidewalk separation.
- Provide advance warning signs for drivers.

VEHICLE BACKING-UP CONFLICTS

General countermeasures:

- Provide walking paths in parking lots.
- Increase motorist and pedestrian education.
- Improve parking lot lighting.

EXPRESSWAY ACCIDENTS

Pedestrian accidents on limited access expressways or ramps.

General Countermeasures:

- Educate drivers on proper policy for disabled vehicles.
- Provide pedestrian underpass or overpass.
- Install pedestrian barriers along roadway.
- Install visible pedestrian warning signs.

APPENDIX II: TRAILS ALONG ACTIVE RAILROAD TRACKS AND DESIGN GUIDELINES FOR RURAL AND RECREATIONAL TRAILS

RAILS WITH TRAILS: LESSONS LEARNED—LITERATURE REVIEW, CURRENT PRACTICES, CONCLUSIONS

The Federal Railroad Administration, Federal Highway Administration, and two other agencies dedicated resources to examine the expanding number of Rails with Trails (RWT) being built across the country. Currently, there are about 239 miles of these trails in 30 states, which run alongside active freight and Amtrak commuter lines (Birk et al. 11). This report gives a number of high-quality recommendations on how to plan, construct, and operate these shared-use paths.

Rails with Trails (RWT) represent a unique challenge as they are often built under conflict between railroad companies and trail advocates. Primary concerns for railroad companies include liability and restrictions on future use. In addition to a literature review, this report gathered data from law enforcement, trail managers, trail planners, and railroad officials.

As stated in the report, there are no agreed upon standards for rails to trails, however, there are numerous considerations that must be taken into account. This report recommends using the Manual on Uniform Traffic Control Devices (MUTCD), American Association of State Highway and Transportation Officials (AASHTO) Guide for Development of Bicycle Facilities and the Americans with Disabilities Act resources for trails and pedestrian facilities along with Federal Railroad Administration policies on grade crossing and trespassing prevention. The following factors should be considered when designing these facilities:

Setback Distance

This is the gap between edge of trail surface and the centerline of the closest active track. There is no single recommendation due to the differences between rail lines and trails. When selecting a setback distance, trail planners should consider: type, speed, and frequency of trains, separation technique, topography, sight distance, and maintenance requirements.

- The higher the speed and rail traffic, the further the distance.
- The average setback distance is 33 feet.
- Researchers have not been able to prove that less setback distance heightens safety incidents.
- Issues of debris being thrown by trains should be considered when planning setback distance.

Separation Techniques

Along with setback distance, use measures such as vegetation, fencing, drainage ditches, and vertical separations as tools to keep trains and trail users effectively separated. Whichever application is selected, it is important to consider crime prevention into the design as well as the maintenance needs of the railroad company. Therefore, before selecting a separation treatment consult with the operating railroad companies and security personnel.

- Fencing: the type of fencing ranges from small 2-foot high picket fences to solid 6-foot concrete walls. The type of fencing should reflect the extent of trespassing in the area. Chain-linked and Israeli Steel fencing are examples of fencing that can be detrimental to the

appearance. Important in selecting fencing is maintenance, replacements costs, and its ability to withstand vandalism. Typical fence height ranges from 2-6 feet dependent on the situation.

- Vertical separation: in certain circumstances trails can be constructed below the operating train line. However, although more vertical separation allows closer placement to the train lines, trail managers should install fencing to prevent falling objects.
- Vegetation and ditches: also common applications to ensure separation between users and passing trains. Dense underbrush combined with thickets can be excellent deterrents to trespassing, but may need to be supplemented with fencing until they are fully grown. Ditches are also good sources of prevention, especially if the ditch is long, deep and used for drainage. (Water presents another obstacle.)

Operational Practices

This section of the report focused on issues of maintenance and daily operational functions, but also incorporated some additional considerations that could affect design decisions. An important recommendation is coordination between trail authorities and railroad companies, especially since the railroad companies need maintenance access to their facilities. Trail planners and authorities should assume that in instances where their setback distance is less than 25 feet, the trail facility may be used as a maintenance access road for railroad personnel and vehicles. Coordination of important access points will minimize future problems. In addition, this report indicated the maintenance costs of existing RWTs. The average annual maintenance cost was \$17,000 or \$4,200 per mile. However, costs were highly dependent on location and whether volunteer maintenance groups were formed.

The report made the five following recommendations for operational issues on RWT shared-use facilities:

- Factor in the maintenance and access needs of the railroad companies.
- Develop and implement an education and outreach plan.
- Develop a security and enforcement plan for the facility.
- Post regulations.

DESIGN GUIDELINES FOR RURAL AND RECREATIONAL TRAILS

Rural Recreational Trails

The surface and width of recreational trails varies widely based on local conditions and intended users. Trails are seldom paved, except where vehicle access is needed.

- There are over five hundred miles of trails in Region 3. The trail surfaces range from 18 inches to wide enough for vehicles to travel on. The types of trail surfaces within Gary Smith's region vary between dirt, mowed turf, asphalt, and crushed limestone. (Crushed limestone is preferred.) Most of the trails are designed for hiking and biking. Gary Smith also forwarded on the following stats on The Pennsylvania Bureau of State Parks trails: 343.00 miles of hiking trails, 21.99 miles of bridle trails, 38.54 miles of interpretive trails, 51.03 miles of sole source snowmobile trails, 7.90 miles of joint use snowmobile trails, and 73.81 miles of ungroomed cross-country trails. Most trails are available for cross-country skiing in the winter (G. Smith).

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- The Pennsylvania Bureau of State Parks has been very happy with the performance of the crushed limestone surface. However, this type of surface needs good drainage or it will wash away. The crushed limestone must be very fine, or it will not make a good trail surface. Gary Smith recommended ensuring good drainage on crushed limestone trails and recommending finer limestone to reduce difficulty for users with wheelchairs and baby carriages (G. Smith).
- The vast majority of the Wisconsin state trail system (approximately 1300 to 1400 miles) is of crushed limestone and most state trails are open for snowmobile use in the winter. Also, around one-half of county trails are ATV trails with no involvement from the state perspective. Tom Huber also indicated that there are very few bridle trails throughout the state (about 100 miles), and there very few areas where equestrian use is permitted, as equestrians are not usually allowed on the same surface as pedestrians. In the state of Wisconsin, most trails are primarily for bicycle and pedestrian use (Huber).
- Outside of inner-city trails, most trails in Colorado are natural surfaces. The state of Colorado estimates it has between 30,000 to 40,000 miles of multi-use trails (Collins).
- None of the trails maintained by the Pennsylvania Bureau of Forestry are paved, but consist mostly of native surfaces. Problem spots are treated with geo-textile and aggregate. Snowmobile trails are usually 8 feet wide and equestrian/bike and hiking trails are generally 5 feet wide. All Bureau of Forestry trails are open for use unless posted otherwise, in comparison to state trails, which are closed unless posted as open for use (Beaver).

In *Designing Sidewalks and Trails for Access Part II of II: Best Practices Design Guide*, guidelines are provided for trails and shared-use facilities, which contribute to universal accessibility. The following are some of the basic considerations managing agencies should consider:

- Trail width depends on the trail's intended type, use, and user groups, amenities, barriers, and furniture.
- The types of emergency situations likely to occur and the vehicles used for emergencies and maintenance should be considered.
- Trails are broken into three components: trailhead, trail corridor, and trail elements.
- Trails should be wide enough to allow access to individuals with all types of disabilities, such as individuals using wheelchairs and others riding hand power cycles, tandem cycles, or horses.
- Surface materials should be consistent with the intended use of the trail and the surrounding area. A rustic backwoods trail through the wilderness, for example, should not be designed as a paved shared-use path.
- Surface materials should be consistent throughout the trail (i.e., a wide paved trail should not come to a half-log crossing over a stream or require wading through the stream).
- Soft or unstable surfaces should be avoided, but never allowed for more than 45 feet in accessible areas, and should be avoided around elements that would be used by the disabled.

Special Situations Related to Rail-Trail Facilities

Access Today publication states the conditions for departure in the report (National Center for Accessibility):

- "Compliance would cause substantial harm to cultural, historic, religious, or significant natural features or characteristics."

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- “Where compliance would substantially alter the nature of the setting or the purpose of the facility or portion of the facility.”
- “Where compliance would require construction methods or materials that are prohibited by Federal, State or local regulations or statutes.”
- “Where compliance would not be feasible due to terrain or prevailing construction practices.”

Exceptions

- The combination of running slope and cross-slope exceeds 40 percent for more than 20 feet.
- Trail obstacle 30 inches or more in height exists across the entire tread width.
- Surface is not firm or stable for more a distance over 45 feet.
- Clear width is less than 12 inches for more than 20 feet.
- Firm and stable is not required when one or more condition for departure exists.
- Clear tread widths may be reduced to 32 inches if one of the condition for departure exists.
- Openings or gaps can be parallel to the most path of travel when the gaps are smaller than 0.25 of an inch. Openings can also go up to 0.75 inch when one or more of the conditions of departure factors are present.
- Vertical clearance may be reduced below 80 if one of the conditions of departure apply.
- Passing space need not be provided if one of the four conditions for departure exist.
- Open drainage structures: a running slope of 14 percent is permitted for a maximum of 5 feet with a maximum cross-slope of 1:20. Cross-slope can be 1:10 at the bottom of the open drain where clear tread width is a minimum of 42 inches unless one of the conditions for departure applies.
- Resting intervals are not mandated where one of the conditions for departure apply.

There is little to be done about naturally occurring grades, but one is obligated to do as much as possible. There are options for dealing with areas that naturally exceed the five percent requirement. When a pedestrian crossing above a freeway exceeded a five percent grade because it had to cross over six lanes of traffic, instead of failing to construct the structure at all, a compromise was made. The compromise included rest stops every few feet to compensate for the higher than 5-percent grade. These rest stops allowed the physically challenged and disabled to utilize the structure and created an attractive serpentine rolling look. Tim Bustos, from Davis, California, mentioned two other alternatives for steep slopes that he deemed to be much less successful. First, the design could include switchbacks; however, these create problems for cyclists. Second, California has tried using bike stairs, but no longer uses this approach and does not recommend them (Bustos).

A few additional recommendations for rural and recreational trails include:

- Waterbars stretch across the width of the trail and direct water to the path edge. They are typically constructed of wood, rocks, or rubber. Wood and rocks tend to be obstacles for individuals using mobility devices (Kirschbaum et al. 86-87).
- Trails in extreme climates should provide rest areas or shelter from harsh conditions (Kirschbaum et al. 12-25).
- Trail elements, such as water fountains, bathrooms, and fire rings, should provide enough clear space for the maneuvering of mobility devices (Kirschbaum et al. 12-25).

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- If the path or sidewalk is less than 60 inches wide, then provide periodic passing spaces of at least 60 by 60 inches (Kirschbaum et al. 81).

The rest of the report details technical provision laid out in the Regulatory Committee's Report for Accessible Trails (National Center for Accessibility):

- Clear tread width: Accessible trails must have a clear path of 3 feet (National Center For Accessibility).
- Openings: This refers to gaps on boardwalks or other surfaces, they must not exceed 0.5 inches and be perpendicular or diagonal to the primary direction of travel to prevent catching by disabled individuals devices.
- Protruding objects: The trail must be clear from the surface up to 80 inches including vegetation and other objects.
- Tread obstacles: Rocks, roots, and other debris must not exceed 2 inches. Exception: when a cross-slope is 1:20, 3-inch obstacles are permitted.
- Passing space: Must be 60 by 60 inches; Occur every 1000 feet when the trail width is less than 60 inches; and be a T-shaped space that extends 48 inches beyond the intersection, every 1,000 feet.
- Edge protection: this is not necessarily required; where provided, there must be a height of 3 inches.

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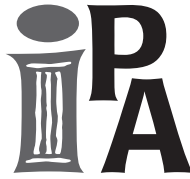
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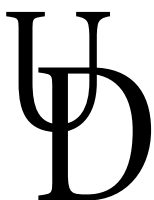


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