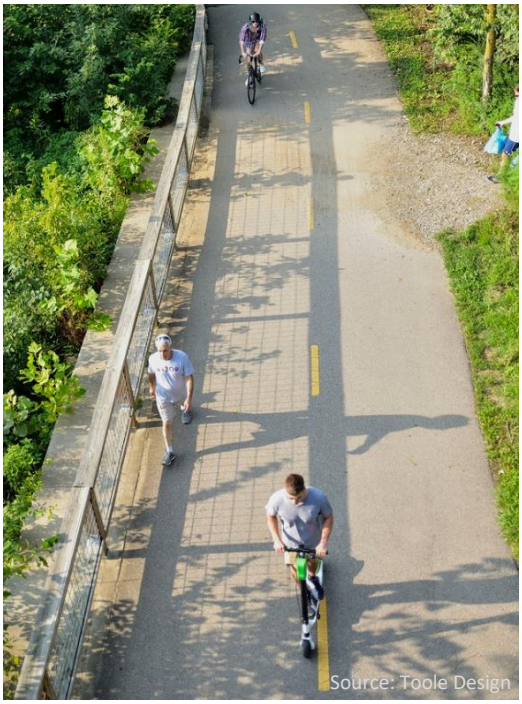

Guide for Maintaining Active Transportation Infrastructure for Enhanced Safety

U.S. Department of Transportation
Federal Highway Administration

ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE

FHWA-SA-23-005

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in2	square inches	645.2	square millimeters	mm2
ft2	square feet	0.093	square meters	m2
yd2	square yard	0.836	square meters	m2
ac	acres	0.405	hectares	ha
mi2	square miles	2.59	square kilometers	km2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft3	cubic feet	0.028	cubic meters	m3
yd3	cubic yards	0.765	cubic meters	m3
		NOTE: volumes greater than 1000 L shall be shown in m3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (EXACT DEGREES)		
oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m2	cd/m2
		FORCE AND PRESSURE OR STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm2	square millimeters	0.0016	square inches	in2
m2	square meters	10.764	square feet	ft2
m2	square meters	1.195	square yards	yd2
ha	hectares	2.47	acres	ac
km2	square kilometers	0.386	square miles	mi2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m3	cubic meters	35.314	cubic feet	ft3
m3	cubic meters	1.307	cubic yards	yd3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (EXACT DEGREES)		
oC	Celsius	1.8C+32	Fahrenheit	oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m2	candela/m2	0.2919	foot-Lamberts	fl
		FORCE AND PRESSURE OR STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in2

*SI is the symbol for the International System of Units. Approximate rounding should be made to comply with Section 4 of the ASTM E380. (Revised March 2023).

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List of Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ABA	Architectural Barriers Act
ADA	Americans with Disabilities Act
APS	Accessible Pedestrian Signals
ATE	Automated Traffic Enforcement
CFR	Code of Federal Regulations
CR	County Road
DOT	Department of Transportation
DOJ	Department of Justice
FHWA	Federal Highway Administration
GIS	geographic information system
GPS	global positioning system
HSIP	Highway Safety Improvement Program
IIJA	Infrastructure Investment and Jobs Act
LED	light-emitting diode
MMA	Methyl Methacrylate
MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways
NCHRP	National Cooperative Highway Research Program
PROWAG	Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way
RTP	Recreational Trails Program
STBG	Surface Transportation Block Grant
TIF	Tax Incremental Funding
TTC	temporary traffic control
USDOT	United States Department of Transportation

1. Purpose and Background

The *Guide for Maintaining Active Transportation Infrastructure for Enhanced Safety* (hereinafter referred to as the Guide) provides guidance for maintaining active transportation facilities with the primary goal of increasing safety, access, and mobility. This updated resource supports the United States Department of Transportation's *National Roadway Safety Strategy* (USDOT, 2022) and the Federal Highway Administration's (FHWA's) *Complete Streets program* (FHWA, 2023a) by providing up-to-date information on how to integrate active transportation facilities into an agency's overall transportation maintenance program.

> Active transportation is human-powered transportation, and low-speed electronic assist devices, including bicycles, tricycles, wheelchairs, electric wheelchairs, scooters, skates, and skateboards (Southern California Association of Governments, 2022).

FHWA developed the original October 2013 *Guide for Maintaining Pedestrian Facilities for Enhanced Safety* to directly address maintenance of pedestrian facilities to improve safety as part of a broader effort to curb the thousands of pedestrian fatalities and tens of thousands of pedestrian injuries occurring in the United States annually (FHWA, 2013a). Since then, the focus on safe and accessible active transportation facilities has continued to grow. With this update, the focus of the Guide has been expanded to address maintenance of bicycle facilities, while also touching on specific maintenance-related issues pertaining to the safe operation of micromobility devices such as electric scooters, one-wheels, and skateboards. There are various definitions of "micromobility," but in this Guide it is defined as "any small, low-speed, human- or electric-powered transportation device" (Price et al., 2021).

The original 2013 Guide was based on the FHWA report, *Guide for Maintaining Pedestrian Facilities for Enhanced Safety Research Report*, which was developed in consultation with a stakeholder group (FHWA, 2013b). FHWA convened a new working group to provide direction on this update.

1.1. Purpose

The purpose of this Guide is to identify effective practices for active transportation infrastructure maintenance based on experience from State, local, and Tribal agencies. **In this Guide, maintenance is defined as inspecting, preserving, repairing, and restoring an active transportation facility and keeping it in condition for safe, convenient, and accessible use.** Maintenance includes repairing surface defects and changes in level (e.g., heaving) as well as snow, ice, debris, and vegetation removal.

Active transportation facilities require maintenance, similar to highway and roadway facilities, to ensure safe and dependable access. Neglected active transportation facilities may be rendered completely unusable by people with disabilities and for those without disabilities, can be uncomfortable, and

discourage use.

A typical example is a sidewalk in a state of disrepair, which may cause pedestrians to walk in the roadway, increasing the risk of a crash for all roadway users. Poorly maintained bicycle lanes may also discourage people from choosing to bicycle or create conflicts between pedestrians and bicyclists if the latter are encouraged to use the sidewalk.

Part of FHWA's mission is to improve safety for all road users, with a particular focus on reducing fatalities and injuries among vulnerable road users such as people walking, bicycling, or rolling. The provision of well-maintained active transportation networks is central to reducing fatal and serious injuries among vulnerable road users.

Although there are guidelines and standards for the design of pedestrian and bicycle facilities, it can be difficult to adequately maintain facilities once they are in place, and to ensure that they remain accessible and optimize user safety. Additionally, many State, local, and Tribal government agencies have severely constrained resources for monitoring, inspecting, and maintaining active transportation facilities (Town of Irondequoit, New York, 2022; Dunkel and Jones, 2021). Furthermore, many types of Federal funds cannot be used for routine maintenance. There is flexibility for some preservation projects, as shown in FHWA's 2016 memo *Guidance on Highway Preservation and Maintenance* (FHWA, 2016). In addition, trail maintenance generally is eligible, because maintenance of existing trails is an eligible activity under the Recreational Trails Program (RTP) (23 U.S.C. 206(d)(2)(A)), and apportioned funds under the Federal Highway Aid Program that are obligated for a recreational trail or related project are administered as if they were funds for the RTP (23 U.S.C. 206(j)).

1.2. Audience for Guide

This Guide is intended for any agency, group, or organization that builds and maintains active transportation infrastructure. Most commonly, this includes government bodies at the State, Tribal, or local level, but it may also include individual homeowners, homeowners' associations, private land management organizations, and other groups. For brevity, these groups will often be referred to as "agencies," "municipalities," or "communities" in this Guide, even though the group may also include nongovernmental entities such as homeowners' associations.

1.3. Types of Pedestrian Facilities

This Guide focuses on the following categories of pedestrian facilities and pedestrian control devices:

- Sidewalks, walkways, and curb ramps.
- Shared use paths.
- Crosswalks, signals, and other treatments of facilities for crossing streets.
- Signs.

The Guide includes discussion of the Americans with Disabilities Act (ADA), as it pertains to curb ramps, detectable warning surfaces, and sidewalk surface materials. Crossing facilities, such as crosswalks and signals, and their associated maintenance issues, are also discussed. The Guide also includes information on funding and techniques to increase the longevity of pedestrian facilities.

1.4. Types of Bicycle Facilities

Bicycle facilities come in many configurations, with variations in level of separation (from motor vehicles and pedestrians), elevation in relation to sidewalks and roadways, and materials.

This Guide focuses on the following categories of bicycle facilities:

- Bicycle lanes and shared lanes.
- Separated bike lanes (sometimes referred to as “protected bike lanes” or “cycle tracks”).
- Shared use paths and side paths (in conjunction with pedestrian facilities).
- Bicycle crossing markings, symbols, and signal equipment.

Bicycle facilities are often retrofitted into existing street space, generally allowing maintenance to continue within those facilities in a similar manner to the existing street maintenance programs. However, as more jurisdictions start to implement separated bicycle facilities, including more complex intersection designs, the additional separation and devices used can create a need for specialized maintenance practices. This Guide addresses funding for new maintenance vehicles and processes, as well as noteworthy practices for durable materials and placement to increase longevity of facilities.

1.5. Facilities for Micromobility

For the purposes of this Guide, micromobility devices are considered electric-powered (such as scooters, seated scooters, hoverboards, and other similar devices) (table 1). Bicycle facilities, shared use paths, and in some cases, sidewalks are often used by micromobility device users (figure 1).

Source: Toole Design

Figure 1. Photo. Maintaining good pavement quality and prompt seasonal maintenance enhance the safety of micromobility users.

Table 1. Types of powered micromobility vehicles as classified by the Society of Automotive Engineers (ITE, 2021).

Attribute	Powered Bicycle 	Powered Standing Scooter 	Powered Seated Scooter 	Powered Self-Balancing Board[1] 	Powered Non-Self-Balancing Board[1] 	Powered Skates 
Center Column	Y	Y	Possible	N	N	N
Seat	Y	N	Y	N	N	N
Operable pedals	Y	N	N	N	N	N
Floorboard / foot pegs	Possible	Y	Y	Y	Y	Y
Self-balancing[2]	N	N	N	Y	N	Possible

Source: 2021 Institute of Transportation Engineers (ITE)

[1]Self-balancing refers to dynamic stabilization achieved via a combination of sensors and gyroscopes contained in/on the vehicle.

Local policies may place restrictions on where micromobility users can operate (Goodman et al., 2019). Micromobility users have similar needs to bicyclists and sidewalk riding can be expected where there are no comfortable bicycling facilities provided (National Association of City Transportation Officials, 2019). This Guide addresses maintenance considerations that impact micromobility users because they often use the same facilities as pedestrians and bicyclists.

1.6. Using This Guide

This Guide provides practitioners with specific guidance and noteworthy practices related to active transportation maintenance.

- **Section 2** presents the case for proper pedestrian and bicycle facility maintenance.
- **Section 3** discusses pedestrian, bicycle, and micromobility maintenance programs in the United States.
- **Section 4** outlines common maintenance issues as a means to communicate the wide breadth of considerations associated with maintaining active transportation facilities.
- **Section 5** discusses the policies and procedures related to inspection and compliance that agencies should have in place for effective maintenance programs.
- **Section 6** discusses planning and tracking maintenance, the importance and usefulness of this process, as well as important pieces such as performance measures and prioritization of maintenance.
- **Section 7** discusses specific maintenance measures for facility repair as well as ongoing or seasonal activities such as sweeping, vegetation management, and snow and ice removal.
- **Section 8** presents construction and vegetation planting techniques to reduce maintenance needs over time.
- **Section 9** discusses the various funding mechanisms that may be available for active transportation infrastructure maintenance.

2. The Case for Pedestrian and Bicycle Facility Maintenance

2.1. Pedestrian and Bicycle Facilities: An Integral Part of the Transportation System

Sidewalks, shared use paths, and other pedestrian facilities are important components of the transportation network. Regardless of the primary means of transportation, nearly everyone is a pedestrian at some point in their day. Because of this, it is important to provide dependable pedestrian facilities that are usable year-round by people of all ages and abilities.

Bicycle facilities are similarly important elements of the larger transportation system. Since many people rely on bicycling for daily transportation throughout the year, it is critical to provide dependable facilities that can be accessed year-round. A connected, well-maintained bicycle facility makes it convenient and appealing for more people to have the option of safely using a bicycle to connect to transit, employment, shopping, school, and other destinations.

In many States, the definition of a street or highway includes everything within the public right-of-way, including all of the pedestrian or bicycle facilities contained within that space. Road maintenance should also cover the maintenance of the pedestrian and bicycle facilities, including sidewalks, bicycle lanes, curb ramps, pedestrian and bicycle signals, signs, vertical separation (e.g., bollards, flex posts, etc.), and pavement markings.

2.2. Maintenance is Critical for Safety

There are many safety issues that are directly attributable to poorly maintained pedestrian and bicycle facilities. Improved safety through proper maintenance takes two forms: the reduction of crashes with motorists and the reduction in trips, slips, and falls.

According to a review of pedestrian-related roadway measures from 2014, the presence of a sidewalk or pathway on both sides of the street corresponds to approximately an 88-percent reduction in the chance of that location having a "walking along road" pedestrian crash when compared to an area with no sidewalk (Mead et al., 2014). Providing raised medians or pedestrian refuge areas at pedestrian crossings at marked crosswalks has demonstrated a 46-percent reduction in chances of a pedestrian crash (FHWA, 2007). To fully realize the potential for crash reductions for these facilities, routine maintenance is critical. Likewise, poorly maintained bicycle facilities may result in solo bicycle crashes and can force bicyclists to suddenly maneuver into adjacent motor vehicle traffic.

Poor maintenance can also result in trips, slips, and falls. Unfortunately, these incidents are not recorded in the same way as crashes between pedestrians and motorists. However, based on hospital records and claims, these incidents can be very harmful and, on occasion, fatal (Centers for Disease Control and

Prevention, 2021). The severity of falls disproportionately impacts older adults because aging is associated with changes in gait and balance, increased inactivity, and more severe chronic conditions—all of which are risk factors for falls (Ambrose et al., 2013).

Surface treatments and conditions also affect the safety of bicyclists and micromobility users. Bicycles and micromobility devices generally have narrow tires with higher internal pressure, which result in less traction than a motor vehicle. Maintaining a clean pavement surface makes it more likely that a person bicycling will be able to ride safely and steadily without fear of skidding, sliding, or falling. This requires keeping bicycle facilities clear of loose gravel, sediment, leaves, ice, and snow. The smaller tire size and lack of suspension on most bicycles also means that small inconsistencies in pavement, including potholes, ruts, cracks, and upheaving, can be problematic to someone riding a bicycle and can cause a bicyclist to crash. Similarly, broken roadway devices, like the mounting base of a flexible delineator post, can block the bicycle facility, remove the physical barrier provided for bicyclists, and remove the visual guidance for drivers that a separated bicycle facility is present. These maintenance-related issues can have even greater crash risk at nighttime when visibility is low.

2.3. Maintenance Improves Mobility

Access, safety, and mobility are inextricably linked to one another. Mobility for people who depend on or prefer walking and biking to meet their daily needs is dependent on the presence and accessibility of pedestrian and bicycle facilities. Any gap or state of disrepair in the pedestrian or bicycle network can result in circuitous, long detours, or cutting off routes altogether, deterring users and diminishing mobility. These issues may be seasonal, such as a curb ramp covered in ice, or year-round, such as sidewalk defects or a malfunctioning pedestrian signal.

Equity Spotlight

Transportation policies and practices in the United States have a long history of prioritizing the automobile to the detriment of other travel modes and the people that rely on these modes to meet their everyday needs (Governors Highway Safety Association, 2021; Melton, 2017; Lucas, 2012). Active transportation investments can help address these disparities by enabling safer and more comfortable use of affordable transportation options. Active transportation equity can be described as the equitable distribution of active transportation costs and benefits across space and between social groups (Lee, 2017). For an active transportation network to be equitable, performance measures such as facility quality, safety, and accessibility should be considered. Long-term and ongoing maintenance to ensure the quality of active transportation facilities is a critical element to transportation equity more broadly.

2.4. Maintenance is Critical for People with Disabilities

Accessibility for people with disabilities (figure 2) will be significantly diminished if maintenance is neglected. There are generally two accessibility issues related to maintenance. First, proper and routine maintenance of walkways allows access between intersections. Second, the maintenance of transition points—curb ramps, medians, crosswalks, etc.—permits access at intersections. Both are necessary to form an accessible network of pedestrian facilities.

Under the ADA, public entities are responsible for ensuring that accessible pedestrian routes and operable features, such as accessible pedestrian signals, in their jurisdiction remain accessible throughout the year through regular maintenance policies and practices (28 Code of Federal Regulations [CFR] § 35.133(a)). This includes snow and debris removal and maintaining pedestrian travelways in work zones. Seemingly minor maintenance issues can form a significant barrier to people with disabilities.

Source: Toole Design

Figure 2. Photo. Sidewalks and street crossings should be accessible to all users.

A 2008 FHWA memo discussed walkway maintenance, stating: "In accordance with 28 CFR § 35.133, a public agency must maintain its walkways in an accessible condition, with only isolated or temporary interruptions in accessibility. Part of this maintenance obligation includes reasonable snow removal efforts" (Wlaschin, 2008). Even if a community puts in place an ordinance that requires adjacent property owners to maintain the public entity's pedestrian facilities on a day-to-day basis, the public entity as owner of the pedestrian facilities still has ultimate responsibility for maintaining the facilities based on the US Department of Justice's ADA regulations (28 CFR §35.133).

2.5. Micromobility Operations

Micromobility devices have become an important component of transportation systems throughout the United States and the use of these devices has grown rapidly in recent years and continues to evolve. (figure 3) The rules dictating where micromobility devices can be operated vary across cities and States. Regulations tend to require micromobility devices to operate on streets instead of sidewalks, as the differences in speed between pedestrians and micromobility users creates conflicts. Thus, micromobility operations should generally be considered in street design and maintenance operations.

A smooth, paved, well-maintained surface is best for safe micromobility operations as studies have shown a significant portion of injuries from micromobility device use were due to adverse surface features and infrastructure, and not related to conflicts or collisions with pedestrians, bicyclists, or motor vehicles (Cicchino et al., 2021). Storm drains and non-slip utility covers should be integrated into the roadway and maintained to enhance safe operation of micromobility devices.

Source: Toole Design

Figure 3. Photo. The unique characteristics of micromobility devices should be considered in maintenance programs.

2.6. Liability Considerations

The objective of maintenance programs is to keep facilities accessible for users and to efficiently extend the lives of these facilities through routine and preventative efforts. When there is a breakdown in maintenance of pedestrian and bicycle facilities, the outcome can result in an injury (figure 4). A related objective of active transportation facility maintenance programs is to manage liability. It may be possible for agencies to have liability for incidents stemming from maintenance problems (FHWA, 2013b). Agencies should assess their own exposure to liability by fully understanding their State's statutes, local ordinances, and related case law.

Having a sound maintenance program can significantly reduce an agency's exposure to liability by avoiding the breakdowns in active transportation infrastructure that may cause injuries.

Source: Toole Design

Figure 4. Photo. Maintenance programs can keep facilities accessible for users and efficiently extend the lives of these facilities through routine and preventative efforts.

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3. Overview of Maintenance Programs in the United States

3.1. Pedestrian Facility Maintenance Programs

The maintenance of pedestrian facilities varies across the United States. This is due to a variety of factors including differing maintenance management structures, legislative requirements, and climates. Although pedestrian facilities are generally not subject to the wide variation in traffic volumes and vehicle loads as roadways are, their maintenance can be more challenging than roadway maintenance. For instance, sidewalk maintenance may involve specialized treatments or require equipment not typically owned by an agency. The situation is complicated by the fact that sidewalks and sidepaths are generally the only transportation facility type that sometimes have their maintenance costs delegated to property owners. Thus, a wide variety of parties responsible for pedestrian facility maintenance (e.g., different local agencies, individual property owners, State departments of transportation [DOTs], and community and homeowners' associations) need to work together to maintain the network.

Several pedestrian-related maintenance patterns were identified in FHWA's *Guide for Maintaining Pedestrian Facilities for Enhanced Safety Research Report* (FHWA, 2013b), which are still relevant today, including:

- **Day-to-day maintenance.** In most States, local and Tribal governments can and do require that adjacent property owners perform day-to-day maintenance of sidewalks including snow and ice removal, vegetation removal and trimming, and sweeping (FHWA, 2013b). Jurisdictions may be ultimately responsible for this type of maintenance, but at least initially, that responsibility is shifted to the property owners. In the absence of the adjacent property owners providing the maintenance, local jurisdictions may have to perform the maintenance, although they may charge or fine the adjacent property owner for that service. This management structure can result in the maintenance not occurring, which negatively impacts multimodal access and safety (FHWA, 2013b).
- **Sidewalk repairs.** The State, local, or Tribal government that owns a facility is ultimately responsible for it, even when the agency has policies to accomplish maintenance-related work through others. Specific policies or laws ensuring maintenance often do not exist (FHWA, 2013b). In many cases, the agency will notify the property owner that the work will be done by city or village crews at partial or full cost charged or assessed to the property owner. In a less common arrangement, communities initially enlist or obligate adjacent property owners to perform this work themselves only to later intervene if the work is not undertaken in a specified timeframe (often 30 to 60 days). A small percentage of communities require that the adjacent property owners conduct the work

themselves or hire a contractor to complete the work. A list of approved contractors is often supplied to the property owner, but the agency will not arrange for any of the repair work. In this scenario, the property owner will likely be fined if found to be noncompliant (FHWA, 2013b).

- **Curb ramps, crosswalks, and signals.** These pieces of pedestrian infrastructure should be part of a jurisdiction's maintenance program. Maintaining crosswalk markings can be challenging because of the excessive wear caused by motor vehicles. This is because crosswalks can often fall within vehicle driving paths, unlike other pavement markings that run parallel to motor vehicle travel, and they also cover a wider area that is more prone to being driven over. Damaged or faded markings may diminish safety results by causing crosswalks to be less visible to motorists (FHWA, 2013b).
- **Shared use paths.** The maintenance of shared use paths is typically performed by local governments, although State governments, homeowner associations, and other groups may also be involved. In many communities shared used paths are not cleared of snow and ice by the local government or maintaining authority (FHWA, 2013b). However, communities are beginning to make changes to this approach, and winter maintenance is increasingly more commonplace, particularly for paths that serve as critical transportation corridors.
- **Maintaining accessible pathways.** Public entities are responsible for maintaining accessible features, including the clear width needed on pedestrian facilities. For example, public entities should have policies and inspection/reporting programs in place that ensure that micromobility devices do not obstruct pedestrian facilities like sidewalks, access to push buttons, and curb ramps, as that would render sidewalks inaccessible. The same is true for temporary signing and other objects that might be placed within the sidewalk.

3.2. Bicycle Facility Maintenance Programs

In many cases, the maintenance of standard bike lanes is wrapped into traditional roadway maintenance processes and programs. Debris in the roadway tends to accumulate within the bike lane; therefore, more frequent sweeping of the bike lane is often needed. Bike lanes should also be kept clear of snow and ice.

As new facility types and devices are implemented, the need for new maintenance programs and additional funding that specifically address bicycle facilities and the unique issues arising from them is becoming more evident. For example, many cities implementing separated bike lanes are faced with the decision to make the facilities wide enough to accommodate standard

maintenance equipment or invest in specialized equipment. Furthermore, the use of elements like flexible delineator posts and other separation devices, along with other features that are implemented as part of bicycle facilities such as traffic calming features, has resulted in the need for more frequent, replacement-oriented maintenance programs.

Additionally, jurisdictions are incorporating elements into bikeway design that function as both vertical separation and public amenities, such as planter boxes within the buffer zone of a bikeway. Creating community partnerships and maintenance agreements are among the strategies agencies are using to maintain high-quality bicycle infrastructure.

3.3. Addressing Micromobility Needs in Maintenance Programs

Programs to directly address maintaining facilities that serve solely micromobility users are not common, but as usage increases, this may change. This Guide addresses some of the maintenance issues an agency is likely to encounter as they work to safely accommodate micromobility devices as a component of their transportation system.

Micromobility Device and System Maintenance

Agencies that permit or contract with shared micromobility operators often set specific device maintenance requirements. Common requirements include meeting State vehicle code requirements, geofencing areas to ride and park micromobility devices, and removal of devices that are obstructing the public right-of-way. Examples of additional specific requirements for three cities that permit shared micromobility are included below:

San Francisco, California: Operators must implement an approved maintenance, cleaning, staffing, and repair plan, as well as an updated record of maintenance activities. Devices must include tamper-resistant security hardware (City of San Francisco, 2022).

Chicago, Illinois: Devices must be maintained by operators at least once per calendar month (including checks for tires, brake function, handlebar grips, brake levers, braking capabilities, bell, lights, and kick stand) (City of Chicago, 2022).

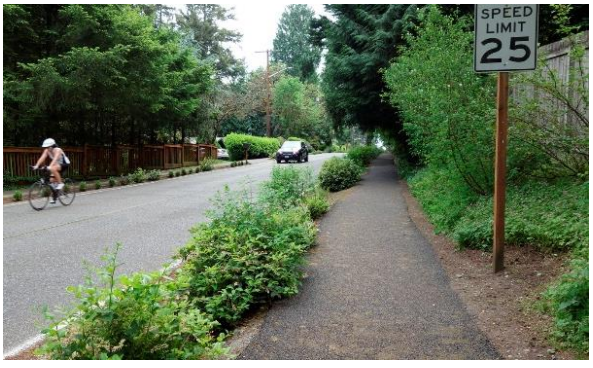
Atlanta, Georgia: Devices must meet ANSI/CAN/UL standards for electrical systems for personal e-mobility, which covers safety features of the electrical drive train system, battery, and charger combination. Brakes must enable the operator to make a braked wheel skid on dry, level, clean pavement (City of Atlanta, 2021).

4. Common Maintenance Issues

4.1. Surface Types

The surface material used for sidewalks, shared use paths, and other areas open to pedestrian travel can have a significant effect on how often maintenance is performed. Concrete is the most common material type for sidewalks, while asphalt is commonly used for shared use paths (PBIC, 2012). However, there are communities that rely entirely on concrete for shared use paths and others that may use asphalt for sidewalks (figure 5).

Bricks and pavers are also used for certain pedestrian facilities. In some communities (e.g., Savannah, GA) these materials are used to preserve the traditional material and appearance in a downtown or historic district. In some settings, pavers are used to border concrete sidewalks. Although these materials tend to be durable, they have unique maintenance issues which will be discussed in more detail later in this Guide.



Source: Toole Design

Figure 5. Photo. Asphalt sidewalk in Bellevue, Washington.

Trail or path surfaces can also be "soft," composed of compacted stone or gravel. These materials provide a more natural, but still firm and stable surface that may be preferred in some communities. Stone surfacing, especially crushed stone, is sometimes used for sidewalks. It is more likely that stone or gravel will be used for sidewalks as a temporary fix before a more permanent surface material ultimately replaces it. Wood chips are not considered a firm and stable material type for accessibility purposes and are very rarely found in the public right-of-way, and thus are not discussed in this Guide.

Rubber is a surface type that is used by some jurisdictions in specific sidewalk applications.

Crosswalk surfaces are typically asphalt and concrete (same as the roadway being crossed). Colored concrete and post construction surface treatments like paint or thermoplastic are also often installed by jurisdictions to distinguish a crossing from the roadway.

Where bicycle lanes are provided at street level, the surface type typically matches the roadway surface, usually either concrete or asphalt. On sidewalk and intermediate level bike lanes, surface types vary based on design choices. Reducing joints is a common design objective on any bicycle facility as joints can create an uncomfortable travel surface (Great Rivers Greenway, 2022).

The next section includes descriptions of the main types of surface materials with a brief discussion of their maintenance characteristics.

Source: Toole Design

Figure 6. Photo. Concrete is the most widely used material for sidewalks in the United States.

4.1.1. Concrete

Concrete is the most common form of pavement material used for sidewalks in the United States (PBIC, 2012; figure 6). It is very durable and has a lifespan between 40 and 80 years (Alan M. Voorhees Transportation Center, 2006; Rajani and Zhan, 1997). Shortly after being placed, a smooth finish is applied to the surface followed by a broom finish to help with traction. Because of its semi-fluid state when it is poured, it is an especially suitable material to use when there are multiple grades and cross slopes that require precise measurement such as at corners and curb ramps. Repair and replacement of concrete requires skilled finishers.

4.1.2.Asphalt

Asphalt is the most common material used for shared use paths and bikeways in the United States (Great Rivers Greenway, 2022). Asphalt is a less common material for sidewalks than concrete and typically has a significantly shorter life than concrete. However, the initial cost to install asphalt is typically significantly less than concrete. Asphalt is commonly used on bicycle facilities because it provides a smoother riding surface without joints and provides surface differentiation between adjacent concrete sidewalks. Asphalt must be compacted soon after it is applied to the surface, preferably by heavy equipment. This makes it an attractive material for long stretches of sidewalk or path where a roller can be used. Asphalt can be used in other tighter settings, such as corners and curb ramps, where a hand mechanical tamper is used, but results and grading precision typically do not match that of concrete. Often when asphalt is used for a path or sidewalk, concrete is used for the curb ramps. Asphalt is commonly used as a temporary patching and wedging material for concrete sidewalks.

Source: Toole Design

Figure 7. Photo. Installation of pavers over gravel.

4.1.3. Brick and Pavers

Brick is a traditional sidewalk material type that has been used for centuries in the United States and throughout the world. Bricks offer a high level of durability and can be reused and easily replaced. Bricks differ from concrete pavers in that they are made from formed clay which is then fired in a kiln. Bricks and concrete pavers are considered a "segmental material" because each paver is separate and is often not tied or bonded together the way a concrete slab is formed. Bricks are primarily rectangular and are manufactured in a wide range of colors. Bricks and pavers usually rest on a leveled sand or fine gravel subsurface layer (figure 7) and are free standing, which can lead to settling over time.

Source: Toole Design

Figure 8. Photo. Porous pavers in downtown Denver allow storm water infiltration into tree planting areas.

Bricks have unique maintenance requirements and can be more costly and difficult to maintain than concrete. However, bricks and pavers can be individually replaced by experienced personnel with a smaller amount of effort than replacing entire sections of concrete sidewalks. Some communities use bricks and concrete pavers to highlight sidewalks in commercial areas or plazas. This approach often reduces maintenance costs and limits the potential for tripping within the accessible path because the bricks are often laid over a solid concrete surface. More recently, bricks and pavers have been manufactured and placed to create a more permeable surface and reduce surface runoff (Hatlen, 2023), but this requires more spacing between the materials (figure 8).

Concrete pavers are also used for sidewalks and for sidewalk border applications. They consist of a mixture of cement, sand, and water and function much like bricks when they are set in place as sidewalks or walkways. Concrete pavers can be produced in many shapes,

sizes, and colors. They are durable, versatile, and can be reused. Like all other sidewalk materials, attention to proper construction can reduce future maintenance problems and costs.

One of the shortcomings of bricks and pavers is that they can dislodge and increase the chances of tripping. Both concrete and asphalt can be horizontally cut or ground to mitigate the chances of tripping, whereas bricks and pavers often must be removed and repositioned so the base material can be modified to facilitate the leveling of the sidewalk.

Stamped concrete is another common surface material that can be used for sidewalks. It has the advantage of looking like pavers or bricks without the maintenance issues of these materials.

4.1.4. Rubberized Pavers and Flexible Porous Pavement

Pavers made from recycled rubber and plastic are used as a substitute for traditional sidewalk pavements in certain applications. These pavers are modular systems (e.g., 2-ft by 2-ft squares) (figure 9). They are linked together with tabs. Communities have been attracted to these pavers for applications around trees where tree roots have caused concrete sidewalks to heave, although they can be used in most environments where sidewalks need to be placed in a relatively straight alignment. They are typically half the depth of concrete sidewalks. Similar to brick, such pavers may shift to create tripping hazards over time and may require regular inspection and maintenance.

Source: Toole Design

Figure 9. Photo. Rubberized pavers allow for modular installation.

Flexible, poured rubber is another alternative surface treatment. It is made of rubber (often recycled), aggregate, and binder materials. The material provides a non-slip surface and there are also porous options which allow water infiltration. It can be used in tree wells to provide continuity of the walking path, while allowing water to access tree roots. It can also be used in larger installation of sidewalks. Flexible poured rubber pavement can be installed in two ways: poured in small batches and hand finished, which is useful for small spot locations, or poured in larger batches and finished using a leveling and compaction machine.

4.1.5. Unpaved Trails and Paths

Unpaved trails and paths comprised of gravel or crushed stone may be an appropriate alternative to concrete or asphalt in some applications. Material such as decomposed granite has the added benefit of being permeable. Regardless of the material used for unpaved trails and paths, drainage infrastructure and proper grading are important to prevent ponding and erosion as well as other more severe

drainage impacts like washouts, scouring, and rutting. Crushed stone is commonly used as a trail surface because it holds up well under heavy use. If crushed and compacted properly, it can also accommodate nearly every trail user (apart from those using devices with small or narrow wheels, such as inline skates and skateboards) and may satisfy accessibility requirements for outdoor recreation locations in accordance with the *Architectural Barriers Act (ABA) Accessibility Standards* (U.S. Access Board, 2013). The U.S. Access Board's report on *Outdoor Developed Areas: A Summary of Accessibility Standards for Federal Outdoor Developed Areas* provides additional information on applicable ABA standards (U.S. Access Board, 2014).

4.2. Common Maintenance Issues

There are several specific maintenance issues that commonly occur for pedestrian and bicycle facilities. These issues can be sorted into two broad groups: 1) those that are directly related to the facility infrastructure itself, such as surfacing deficiencies, and 2) those that relate to seasonal or day-to-day maintenance, which require keeping the facility clean and free of nuisance materials and removing vegetation, snow, ice, sand, and other materials. An effective facility maintenance program needs to address both sets of issues. This section describes the common issues associated with these two broad categories while later sections discuss inspection of active transportation facilities, and a range of solutions to address issues.

4.2.1. Infrastructure Issues Leading to Increased Maintenance

Infrastructure issues associated with pedestrian and bicycle facilities can be broadly categorized into two groups: surfacing and structural problems. Both cause maintenance issues. Most structural deficits will ultimately affect surface conditions, but there are certain surface conditions that are not caused by structural conditions. Other infrastructure deficiencies, including issues affecting curb ramps, traffic signals, and crosswalks, are also discussed in this section.

Source: Toole Design

Figure 10. Photo. A crumbling surface in this bike lane can lead to uncomfortable conditions and crash risk.

Surfacing Defects

Surfacing defects (figure 10) lead to a multitude of problems impacting maintenance. Certain defects cause concrete surfaces to crumble, including spalling, scaling, and pop outs (figure 11). Poor curing and concrete quality or finishing techniques can all contribute to surface defects. Often these defects appear in the first several years after application. Minor

defects may only affect appearance at first but can deteriorate over time and become moderate to major defects. Moderate to major defects may become a safety risk and may significantly affect the usable life of the facility.

Source: FHWA

Figure 11. Photo. Spalling on a sidewalk. (FHWA, 2013a)

Other surfacing deficits include raveling and cracking. Raveling is caused by high air voids in the material due to poor compaction or late season paving. Cracking can lead to a series of problems for asphalt and concrete surfaces overtime. Cracking is caused by underlying structural defects below the surface. Poor compaction of the subgrade can even cause sidewalk panels to collapse.

The surface of bricks and concrete pavers occasionally exhibit surface problems. While the quality of material is generally and consistently good because it is produced through a controlled and stable manufacturing process, major maintenance issues with pavers and bricks can be associated with displacement of the material itself, not the surface deterioration of the material.

Deformation Forces Causing Structural Problems for Sidewalks and Paths

The most common maintenance problems with hard surface materials result from structural conditions such as those caused by cracking, heaving, tilting, gaps (often at concrete joints), and sidewalk and path sections that either are depressed or raised (Rajani and Zhan, 1997). The Institute for Research in Construction of the Canadian National Research Council has undertaken a study of concrete sidewalk issues and has defined the following four major deformation actions leading to structural damage to sidewalk (Rajani, 2002), which are described in table 2. These same conditions can cause failures in asphalt, bricks, and pavers. Roadways can have similar structural issues, which can impact bicycle facilities that are integral to the roadway.

Apart from cracking and gaps (which can be just a surface condition), all the problems listed below are structural in nature and result from a series of structural failures from deformation forces described in table 2. Many of the forces that cause damage to pedestrian and bicycle facilities are related to freeze and thaw action of the subbase.

Table 2. Common forces causing structural problems for sidewalks and paths (Rajani, 2002).

Rigid Body Uplift or Settlement

A concrete slab can tend to rise, subside, or tilt because of expansive native soil, frost action (freeze and thaw), or thermal expansion of the concrete slab. This could also result from nonuniform compaction of the subgrade.

Since asphalt has a low tensile strength compared to concrete, deformation around the uplift will occur more often in asphalt, causing a crack or a mounding of the material, but typically not a break characterized by a rift or fault of the material as seen with concrete. This is also commonly known as “vertical uplift” or “projecting edge” (as seen in figure 12).

Source: Toole Design

Figure 12. Photo. Example of a rigid body uplift or settlement.

Tensile Shrinkage

The pavement subgrade can consolidate over time due to decreasing moisture content resulting in concrete slab deformation from tensile stresses and alligator cracking in asphalt pavement (as seen in figure 13).

Source: Toole Design

Figure 13. Photo. Example of tensile shrinkage.

Sagging

Sagging may occur when the center of the sidewalk or path has a larger thaw settlement than at the edges, or native soils with high clay content swell significantly at the edges. This leads to longitudinal cracking in concrete and alligator cracking or longitudinal cracking in asphalt surfaces (as seen in figure 14).

Note: The term sagging is commonly used to describe sidewalks that subside and the entire slab or set of slabs drop below the initial grade. The forces that contribute to that are more accurately explained as tensile shrinkage described above.

Source: Toole Design

Figure 14. Photo. Example of sagging.

Raised or Heaved

A concrete slab may exhibit unequal movement due to frost heave, tree roots, or upward vertical forces due to swelling of clay native soils.

Asphalt pavement can displace upwards due to environmental stresses such as frost heave, tree roots, or subgrade swelling. This results in small, localized areas that are bumped up and can lead to cracking and eventually to disintegration of the pavement (as shown in figure 15).

Source: Toole Design

Figure 15. Photo. Example of raised or heaved pavement.

Cracking

Cracking can occur in every direction of a surface when concrete is used (as shown in figure 16). Since any given length of concrete will eventually crack, methods are used to control it.

The main method of avoiding extensive cracking is using joints which are placed in the concrete by either manually finishing them into the surface or making cuts with concrete saws as the surface is curing.

- Alligator cracking is characterized as typically fine, longitudinal hairline cracks running parallel to each other with none or few interconnecting cracks.
- Longitudinal cracking occurs along the length of the sidewalk, usually in the middle third of the sidewalk, and can extend through several expansion or control joints.
- Transverse cracks occur across the width of the sidewalk due to nonuniform subgrade compaction. This usually occurs where there are high vehicle loads, such as when driveways cross sidewalks.

Source: Toole Design

Figure 16. Photo. Example of cracking.

Other Pedestrian and Bicycle Facility Infrastructure Problems

There are other pedestrian and bicycle facilities beyond sidewalks, paths, and bicycle lanes that incur problems which increase the need for maintenance. These facilities include curb ramps, tactile directional indicators, markings, signals, and signing.

Curb Ramps

Curb ramps provide the transition between sidewalks and street crossings and allow pedestrians to reach street level at corners without stepping up and down at a curb. They are required per the ADA Standards (United States DOT, 2006). Most of the same maintenance issues impacting sidewalks also impact curb ramps. Many of the same forces outlined in table 2 also have the potential to deform curb ramps. All new curb ramps should have detectable warning surfaces to communicate to people who are sight-impaired or blind that they are about to enter a street. Although many different forms of detectable warning surfaces have been used over the past 40

years, only truncated domes have proven effective. Truncated domes can be inserted into concrete as cast iron or stainless-steel plates, applied as a glued-on or bolt down material, formed in place as the concrete curb ramp is finished, or set using truncated dome pavers. Each of these processes may lead to maintenance problems. For example, the plate could become displaced causing an increased risk for tripping, adhesive may weaken for glued-on domes, the concrete domes could chip off when plowed, or the pavers could settle unevenly. Additionally, the detectable warning surface should provide a color contrast to the adjacent walking surfaces. If they become faded to the point that contrast levels are not met, they need to be replaced. (28 CFR § 35.133(a)).

Tactile Directional Indicators

In addition to detectable warning surfaces at curb ramps, tactile directional indicators can help orient sight-impaired or blind pedestrians around obstructions and towards curb ramps. These accessibility tools offer directional orientation in open spaces and designate the continuous path. They can also be used as directional orientation when a person must deviate from the continuous accessible path to gain access to a public transport access point, or entrance to a significant public facility (such as a public restroom, information center, etc.).

As these indicators are placed on top of sidewalks and are made of similar materials, most of the same maintenance issues associated with truncated domes impact these features. Additionally, tactile directional indicators may be impacted by defects or dislodging of the pavement material upon which they are placed.

Markings

Painted pavement markings should be repainted at a regular and ongoing frequency based on the volume of traffic and the severity of the weather. Epoxy and Methyl Methacrylate (MMA) are more durable liquid pavement markings that typically require less frequent reapplication. Thermoplastic is also very durable but is significantly more expensive than epoxy and MMA. Following the manufacturer's specifications and ensuring a clean surface during application are key to extending the life of pavement markings. However, in cold weather climates where salt and sand are used and frequent snow plowing occurs, pavement markings tend to deteriorate more rapidly.

Another maintenance challenge of pavement markings is maintaining their conspicuity and retroreflectivity. Glass beads or other reflective materials are added to marking materials to enhance nighttime retroreflectivity. When the markings wear, the reflective quality of the material can be compromised.

Another area of concern with pavement markings is selecting materials that will minimize loss of traction. Manufacturers of these materials have taken steps to significantly improve the friction factor of their materials, but as the material wears, sometimes it can become slick, causing a need for reapplication.

Signals

The most serious maintenance problems involving signals tend to be signal "take-downs" related to vehicle crashes (FHWA, 2013b). Other significant problems requiring maintenance include push buttons and signal heads that are malfunctioning. Light-emitting diodes (LEDs) use approximately 75-percent less energy, and last up to 25-times longer than incandescent lighting (Energy Saver, 2023) significantly reducing signal head maintenance. However, LEDs do not produce as much heat as incandescent bulbs and can become snowed over in blowing snow conditions. A 2014 FHWA study found that there is no device or application that proved to be completely effective at preventing snow and ice buildup for LEDs (FHWA, 2014). However, several countermeasures such as deicing spray applied prior to the snow event or wide visors/covers that attempt to counter the blowing snow can have a positive impact on addressing the issue (FHWA, 2014).

Detection for bicycles is an important accommodation to provide for actuated signals where parallel vehicle traffic may not be frequently present to actuate the signal or where bicycles have protected or leading phases. When bicycle detection is present either through an induction loop or video detection, maintenance issues regarding sensitivity are important to look out for so that bicycles continue to be detected. It is also important for agencies to make sure loops are not cut or pulled up during either adjacent roadway work or plowing.

Source: Toole Design

Figure 17. Photo. Signs for pedestrians and bicycles require periodic replacement to ensure visibility and retroreflectivity.

Signs

Signs for pedestrians and bicycles (figure 17) require on-going maintenance. Unlike markings, signs have a much longer life—quite often more than 10 years. Several factors tend to lessen the life of signs—ultraviolet radiation and airborne pollutants can dramatically reduce the sign's contrast and retroreflectivity. Vandalism to signs is also a significant maintenance problem in general. In-street signs used at crossings may require frequent maintenance as they can be struck by passing vehicles unless they are placed in a raised median.

4.3. Seasonal Maintenance

The conditions of sidewalks for safe, comfortable, and accessible travel are influenced not only by infrastructure problems, but also by seasonal events such as snowfall, the accumulation of leaf debris, and the overgrowth of vegetation. Maintenance activities to keep pedestrian and bicycle facilities accessible and obstruction-free year-round are important for enhanced safety (figure 18).

Source: Toole Design

Figure 18. Photo. To maintain accessibility and safety, soil and sand that accumulates in bike lanes over time or from storm events should be cleared as soon as possible.

Weather-related maintenance concerns are becoming more of an issue as areas of the United States experience more extreme weather events as well as new climate-related challenges (Venner and Zamurs, 2012). Increasingly intense droughts in the Western United States or frequent flooding in the Midwest and South are examples of issues that might require a change in maintenance practices and funding. The Houston Park Board (in Texas) reported that they spend over $400,000 a year cleaning up the effects of repeated flooding, including the removal of thousands of pounds of soil and downed trees (Houston Parks Board, 2022).

Public entities are responsible for ensuring that pedestrian routes and operable features, such as accessible pedestrian signals, in their jurisdiction remain accessible throughout the year through regular maintenance policies and practices (28 CFR § 35.133(a)). This includes removing snow and debris, trimming vegetation, repairing broken or shifting sidewalks (including damage from tree roots), maintaining accessible pedestrian walkways in work zones, and correcting other disruptions that impact pedestrian accessibility.

Snow and Ice

For many U.S. communities, the removal of snow and ice presents a significant maintenance challenge. Following a snowfall, snow and ice should be cleared from sidewalks, paths, curb ramps, and crosswalks to provide safe and accessible passage for pedestrians. It is also important to remove snow and ice on bicycle-only facilities (figure 19). Unlike for pedestrian facilities, bicycle facilities are not subject to Federal accessibility requirements, but cities can expect bicyclists to use road and path networks year-round and should accommodate this use through winter maintenance programs. Common challenges exist to resumption of pedestrian and bicycle travel after snowfalls. These include street plowing that pushes snow onto sidewalks, and into bike lanes, or blocks crosswalks; clogged or obstructed drains that create puddles at curb ramps; patches of ice that increase the risk of users slipping; and failure to remove snow and ice completely from sidewalks and bike lanes. Winter maintenance needs vary based on the amount of snowfall, the mean winter temperature, the amount and intensity of sunlight, and a host of other issues in urban and suburban areas.

Where snowfalls and ice storms are infrequent and temperatures rebound quickly, snow and ice removal maintenance needs are low due to the temporary presence of the snow. Jurisdictions may still have policies and an action plan in place that addresses these key maintenance issues even though snow and ice are infrequent.

The maintenance issues with snow and ice are straightforward. The accumulation of snow causes difficulty for people to move through it. More importantly, snow is slippery and becomes even more slippery as the water content of the snow increases. As snow melts, it can refreeze as ice causing increased difficulties in removing it and greatly worsening conditions for pedestrian and bicycle travel. It can also pool and then refreeze on sidewalks, bicycle facilities, and curb ramps, causing unexpected and adverse conditions for pedestrians and bicyclists, especially during nighttime hours when visibility is compromised. On their own, ice storms or ice accumulations are very serious for safe pedestrian and bicycle movement. Rain that freezes on contact can present a maintenance issue depending on the amount and duration of the accumulation. Each snow and ice accumulation calls for a different maintenance approach or technique and level of resources, which can add complexity to how communities respond to these conditions.

Source: Toole Design

Figure 19. Photo. Plowing a parking-protected bike lane.

Curb ramps and median cut-throughs present challenges for accumulations and removal. They are often depressed and near gutters where water (and ice) can accumulate. Because of the presence of truncated domes in newly constructed curb ramps and crossing islands, removal of snow and ice may be more of a challenge than in other pedestrian facilities. Shoveling out or sweeping curb ramps is often the best way of controlling the snow and ice problem. However, very few communities have personnel available to shovel curb ramps. If the curb ramps and median cut-throughs are not easily accessible by a pick-up truck, snowplow, or smaller equipment (e.g., skid steer), snow removal and ice control is often delayed.

Different municipal ordinances have varying degrees of detail for how best to achieve a clear path for pedestrians after a snowfall. For example, most ordinances specify that snow be removed across the full width of the sidewalk. Others do not require this but specify the use of gravel, ash, or salt on ice to decrease the risk of users slipping (FHWA, 2013b). Some ordinances specify the maximum allowable height of snowbanks and where snow cannot be piled to insure proper visibility of pedestrians. Some jurisdictions require snow removal from specific features such as fire hydrants, benches, driveways, and curb ramps. Of the communities contacted, the most successful programs specify clearance expectations in detail by ordinance and in education materials provided to the public about their responsibilities (FHWA, 2013b).

Extreme Heat

Just as snow and ice can create outstanding problems for maintenance, so can extremely heat, which is especially common in the southwest United States. Most of the issues caused by extreme heat manifest themselves as serious structural problems. When concrete expands it can cause the sidewalks to buckle or heave. Given its more malleable properties, asphalt can also have issues in extreme heat conditions, which can cause softening, sloughing, and pitting. Asphalt can also become deformed as it expands in the heat or is subjected to heavy loads. For instance, the expansion of asphalt on streets at concrete curb ramps at higher trafficked intersections or along a gutter line in a bike lane causes maintenance issues. When the asphalt gets heated up, heavier vehicles rounding the corner or driving along the road push it out and up which can create a 1-inch to 2-inch-high asphalt lip next to the pavement edge. This causes issues for wheelchair users who cannot cross the street and bicyclists who may be unable to ride along the uneven surface and requires maintenance crews to shave off the lips to make the transition smooth again.

Another problem in hot climates is associated with pavement markings on newly paved streets. Markings can be quickly degraded by bitumen from the fresh asphalt being tracked over them by vehicles. To avoid this issue, markings should be placed several days to a week after new asphalt has been laid. Temporary markings may be used in the interim.

Vegetation Overgrowth and Debris Accumulation

Routine maintenance of vegetation is required to keep active transportation facilities accessible and reduce safety risks (figure 20). Vegetation should be maintained so that sightlines to and from driveways and intersections are maintained for the safety of all roadway users, including pedestrians and bicyclists. Additionally, the surface of pedestrian and bicycle facilities should be kept free of debris. Many communities require adjacent property owners to keep a sidewalk free of vegetation or property owners do so on their own. However, bicycle facilities often are the responsibility of the jurisdiction. Here are the main issues with vegetation:

- Vegetation overhanging into the pedestrian path at a height that is not detectable by a pedestrian with vision impairment.
- Vegetation growing at sidewalk level narrowing the effective width of the sidewalk and causing an obstruction.
- Vegetative debris such as leaves, seed pods, fruit, and branches building up on sidewalks or bicycle facility.
- Tree roots upheaving sidewalk and bicycle facility sections.

In communities with street trees and large amounts of street vegetation, management of leaves, branches and other vegetative debris requires year-round management. When leaves are left unattended on pedestrian and bicycle facilities, several issues arise: users cannot make out the path below the leaves or are unable to spot obstructions or surface irregularities below the vegetation that might trip them and the vegetation itself can become wet creating a slip and fall risk.

Source: Toole Design

Figure 20. Photo. Overgrown vegetation decreases pedestrian space and makes pathway less accessible to people with disabilities.

Other debris can also form on pedestrian and bicycle facilities often carried by water or wind. This includes sand and other fine material. By the same token, many communities will use these materials to improve traction during ice or snow conditions. When these materials collect or reach a certain concentration, they can compromise traction and cause slipping or be an obstruction for those using a wheelchair or less sure-footed pedestrians. The buildup of fine material at detectable warning surfaces can also reduce their effectiveness in letting people who are blind or have low vision know they are at the edge of the street.

Other materials collecting on pedestrian and bicycle facilities can also present an issue. This includes rubbish that is simply discarded by people, such as bottles and cans, or roadway debris pushed into the bike lane. Many communities sweep streets clean of debris, but do not extend that same level of care to pedestrian

facilities (FHWA, 2013b). As with other maintenance practices, sweeping and dealing with the collection of debris is commonly made a responsibility of the adjacent property owners. The presence of debris on shared use paths presents the same issues, with broken glass being an especially acute problem for bicyclists and people using wheelchairs and other mobility aids.

Maintenance of Quick Build Facilities

Quick-build facilities use fewer permanent materials and are intended to be installed for an interim timeframe to pilot a new design or until a time when more permanent material installation is feasible. Quick-build facilities allow for lower-cost design modifications to better accommodate communicated community needs or environmental changes (Metropolitan Transportation Commission, 2022).

Quick-build facilities are generally defined by the following criteria:

- Projects are installed roughly within a year of the start of planning.
- The design process reflects the expectation that it may undergo change after installation.
- Materials are chosen to allow such changes over time.
- Projects are often used to inform permanent designs and can be reinforced to be more durable.

4.3.1. Quick-Build Materials

The below presents strategies to optimize the maintenance of quick-build facilities.

Incorporate Maintenance at the Beginning of the Design Process

Coordinate with maintenance partners and understand the minimum requirements and dimensions needed to upkeep facilities. For example, ensure that chosen facility widths allow for vehicles in the respective agency's fleet to access and perform all maintenance required. In colder climates, snow removal is a key factor to consider.

Use Available Materials

Use temporary materials that are already used by the jurisdiction, such as flexible delineator posts, wheel stops, or concrete separators. Using materials that are commonly used by the jurisdiction increases the likelihood of the jurisdiction having stock available and eliminates the need for a separate procurement process.

Materials Should Reflect the Desired Durability and Flexibility of the Project

There may be tradeoffs between durability and flexibility (more durable facilities tend to be less adaptable). Choose materials based on the capacity to maintain them and then set expectations accordingly.

Set up a Schedule for Regular Monitoring

Once facilities are installed, regularly monitor that they are in working order and perform routine maintenance as necessary.

Maintenance notes and scheduling for each material are outlined in table 3.

Table 3. Quick-Build material type, notes, and scheduling.

Material Type	Maintenance Notes	Maintenance Scheduling
Flex Posts/Flexible Delineator Posts	• Choose extra strength materials – consider strike resistance, base type, and adhesive/fitting requirements (bolt down, epoxy, cored). • Perform regular inspections and cleanings (e.g., retroreflective tape can wear and become less visible at night). • Consider procuring a smaller sweeper or leaving adequate clearance for a standard size sweeper as flex posts can be difficult to sweep around, resulting in more debris in the bike lane. • Consider seasonal and event removability (e.g., cored flex post with screwed base and cap).	Monthly/Quarterly
Plastic or Concrete Barriers/Blocks	• Avoid using water-filled plastic barriers in areas with prolonged periods of freezing temperatures. • Check the water level for water-filled plastic barriers. • Adjust/move location if necessary.	Water-filled/Plastic barriers: Monthly Concrete Barriers: Annually
Planters	• Remove litter and trash. • Move location if necessary. • Water and trim as needed. • Plan for the planting schedule and selection of plants.	Monthly, although may be more often with new plantings depending on vegetation and planter used.
Armadillos, Concrete Buttons, Parking Stops	• Ensure that material can accommodate mountability and fitting requirements of each object. • Perform regular inspection and cleaning (retroreflective surface can become less visible after multiple strikes). • Remove for winter to facilitate snow plowing/removal, if necessary. If designed for year-round use, they may be paired with posts to increase visibility for snowplow operators.	Quarterly
Paint/Surface Material Treatment	• May require annual reapplication, especially if pressure washed frequently (StreetPlans, n.d.). • Assess marking material durability (thermoplastic or MMA should be considered on high-volume or high-speed roads, especially on markings adjacent to travel lanes). • Use raised pavement markings for extra visibility at night. • Consider in-laying markings in pavement to extend lifetime with plowing.	Annually, but should be more regular for extreme environmental conditions such as coastline or locations where salt is used for snow melt.
Signs	• Clean sign face if sign is vandalized. • Use graffiti-resistant materials when possible. • Replace sign following dislocation or uncleanable, unrepairable damage. • Place in-street signs outside of vehicle path to be less at risk for being struck down.	Quarterly

Burlington, VT Case Study: Seasonal Considerations and Quick-Build Facilities

Burlington, Vermont is well known for its snow removal programs, which are described in more detail in the seasonal maintenance section; however, the City has also been a leader in the implementation of quick-build facilities in the Northeast. Quick-build projects in Burlington have included curb extensions and bike lanes. The City's goal is that all quick-build facilities will eventually be made permanent (Baird, 2020). At the intersection of Winooski/Howard/St. Paul, a five-leg intersection, the City implemented curb extensions at more than half of the corners using quick-build facilities, and these improvements were made permanent through reconstruction (Baird, 2020). Transportation program funds are used to support quick-build maintenance through a program funded by a voter-approved bond (Baird, 2020).

Debris Build-Up

Debris such as gravel, dirt, and litter must be dealt with to maintain safe access to active transportation infrastructure. As a preventative measure, providing enough cross slope and positive drainage along a sidewalk can prevent ponding and sediment build-up. Facilities should be regularly cleaned, and it is important to include in the design phase consideration of the vehicles and equipment to be used to clean debris. It is important to understand that users may need to navigate debris in between cleaning. For example, providing bike lanes at least 6-ft wide enables bicyclists to ride far enough from the curb to avoid debris while still maintaining distance from vehicle traffic.

5. Inspection, Accessibility, Compliance, and Policies

Source: Toole Design

Figure 21. Photo. Temporary asphalt wedging.

The work of maintaining active transportation facilities (figure 21) should be guided by an inspection and repair routine, supported by asset management databases, data analysis, policies, and ordinances. A community's desire to comprehensively address their active transportation networks should be expressed in plans and policies that help the maintenance staff do their jobs and, if applicable, allow adjacent landowners and residents to understand what is expected.

A proactive inspection program and clear assessment criteria are hallmarks of an effective maintenance agency. One size does not fit all though. Every community is different, with varying amounts of resources. There are many ways to approach an inspection program, from what personnel are used for inspection to the role new technologies play in measuring and documenting conditions.

Sidewalk maintenance policies may cover the inspection procedures and criteria, priorities, responsibilities of property owners and the community, reporting methods, and how funding is allocated for sidewalk repair or replacement.

Bicycle facility maintenance differs from pedestrian facility maintenance. The maintenance and inspection requirements and policies for bicycle facilities will often be included under those written for streets, especially where the bicycle facility provided is within the street, like a bike lane. However, it is important to make sure that bicycle-specific issues are called out. For example, given their typical placement at the edge of the roadway, bicycle lanes may accumulate roadway debris and require more frequent sweeping than the adjacent roadway. Separated bike lanes may require specialized equipment for seasonal maintenance and require a different maintenance schedule than the adjacent roadway. In general, agencies

should expect bicyclists to be present all year round, and those communities that want to encourage bicycling for more trip purposes should have maintenance policies and appropriately funded programs in place to ensure year-round accessibility.

5.1. Inspection and Accessibility

5.1.1. Importance of Inspection

To make pedestrian facilities safer and accessible, the maintenance problems identified in section 4.2 *Common Maintenance Issues* should be addressed; but there may be a point where the infrastructure becomes an obstruction, inaccessible, or impassable. Even facilities built to the tightest tolerances will have irregularities or suffer some displacement during freeze and thaw cycles. Measurable criteria need to be established to determine when facilities become an obstruction or inaccessible for pedestrians. There are national guidelines and criteria (provided later in section 5.1.3 *Inspection and Accessibility*) which communities are advised to use for their own adopted inspection criteria. Appendix A offers a model sidewalk inspection policy from the League of Minnesota Cities.

Sidewalk and path inspection criteria serve many useful purposes, especially to reduce or eliminate slips and falls based on avoidable sidewalk and path obstructions. Damaged surfaces and defects can make facilities impassable, particularly for people with mobility disabilities. Other reasons include providing guidelines to agency employees, conveying information to residents, and limiting liability exposure. Section 5.1.5 *Inspection Types*, below, summarizes the actual thresholds or measurements that should trigger a response from a maintaining authority. Inspection results will help guide a program and are integral to a community's maintenance program.

5.1.2. Inspection Criteria

Communities should develop and adopt sidewalk inspection and maintenance criteria. At a minimum, inspections should consider displacements (heaving, faults, changes in level), changes in grade, cross-slopes (including cross slopes at driveways), vertical clearances, maximum running grades, minimum clear width, and guidelines for protruding and post-mounted objects.

Providing photos on agency websites that clearly depict sidewalks that fail to meet inspection criteria is an effective information tool as it provides illustrative examples of maintenance problems and establishes clear expectations for repairing and replacing sidewalks.

5.1.3. Inspection and Accessibility

Pedestrian facilities should be accessible to everyone, including people with disabilities. Consequently, accessibility standards and guidelines should be referenced when establishing minimum criteria for maintenance inspections.

ADA and Section 504

The ADA of 1990 and Section 504 of the Rehabilitation Act of 1973 (Section 504) prohibit discrimination against people with disabilities. Section 504 explicitly prohibits discrimination against people with disabilities under any program or activity receiving Federal financial assistance. The term "program or activity" includes any

operation of a State or local government entity that receives Federal financial assistance directly or indirectly from the Federal government. Title II of the ADA applies to public entities (e.g., State, local governments, or other public agencies), and requires each program, service, and activity be operated so that, when viewed in its entirety, it is accessible to and usable by individuals with disabilities. Title III of the ADA applies to homeowners' associations whose facilities are available to the public and requires accessibility and readily achievable barrier removal.

These laws do not require public agencies to provide pedestrian facilities, or to build new facilities. However, where pedestrian facilities are present, they should be accessible.

The ADA sets forth a two-step process for the adoption of accessibility standards applicable to public entities' facilities. First, the ADA directs the U.S. Access Board to adopt minimum guidelines for the accessibility of buildings and facilities. (42 U.S.C. § 12204(a)). At this stage, the minimum guidelines are not enforceable under the ADA. The ADA then directs the U.S. Department of Justice (DOJ) and the U.S. Department of Transportation (USDOT) to adopt accessibility standards that are "consistent with" the Access Board's minimum guidelines through separate rulemaking procedures before such standards become enforceable (42 U.S.C. §§ 12134(c), 12149(b)).

The DOJ and USDOT adopted initial ADA Standards applicable to the accessibility of buildings and sites in 1991. The Access Board published revised minimum accessibility guidelines in 2004, which USDOT adopted as standards in 2006 and DOJ adopted in 2010.

The DOJ's 2010 ADA Standards are the measure of accessibility for buildings and sites and can be enforced at the Federal level. Some agencies will use these standards for the accessibility of pedestrian facilities in the public right-of-way to the extent they seem to fit. While this may work in limited circumstances, the 2010 ADA standards do not address the situations commonly found in the public right-of-way, such as steep terrain and the constraints of being located next to the roadway. They also do not address additional features such as pedestrian signals, crosswalks, refuge islands, on-street parking, and the need for detectable warning surfaces at street crossings.

In 2011, the U.S. Access Board issued a *Notice of Proposed Rulemaking* to establish accessibility guidelines for the design, construction, and alteration of pedestrian facilities in the public right-of-way, known as the Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (U.S. Access Board, 2011). In 2013, the Access Board published a Supplemental Notice of Proposed Rulemaking to include proposed accessibility guidelines for shared-use paths (U.S. Access Board, 2013a). Following consideration of all public comments, the Access Board issued its final rule on Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG) on August 8, 2023 (U.S. Access Board, 2023). The final PROWAG establishes minimum accessibility guidelines, but the guidelines are not enforceable on their own. As previously

discussed, the ADA requires DOJ and USDOT to adopt accessibility standards that are "consistent with" the PROWAG's minimum guidelines through separate rulemaking procedures before such standards become enforceable.

Until that time, public entities have some degree of flexibility in determining how they will comply with the general obligation under Title II of the ADA to ensure that their pedestrian facilities are "accessible to and usable by" individuals with disabilities. Public entities are not required to adopt the final PROWAG at this time but may refer to those guidelines or other resources, such as DOJ's 2010 ADA Standards for buildings and sites, for guidance when determining how to ensure accessibility of pedestrian facilities in the public right-of-way. Since the final PROWAG establishes minimum accessibility guidelines, and DOJ's and USDOT's eventual accessibility standards must be "consistent with" these minimum guidelines, they have considerable significance for this section of the Guide.

Alterations

When public agencies alter facilities affecting access for pedestrians, the completed alteration must be made accessible to and usable by persons with disabilities to the maximum extent feasible (28 CFR § 35.151(b)). DOJ's regulations define an alteration as a change to a facility "that affects or could affect the usability of the facility or part of the facility" (Id.). Maintenance activities, by contrast, are those activities that do not rise to the level of an alteration—that is, they simply maintain the operable working conditions of the facility.

The distinction between maintenance of pedestrian facilities and the alteration or new construction of facilities is central to the provision of accessible facilities. The determination of what activities fall into each category should be considered carefully. This Guide addresses the maintenance of pedestrian facilities. Routine maintenance activities do not trigger accessibility upgrades on their own.

Maintenance and Repair under ADA

Maintenance projects do not require simultaneous improvements to pedestrian accessibility under the ADA and Section 504. For example, the spot repair of a tripping hazard does not require reengineering a steep cross-slope. Nevertheless, as the scale of the repair or replacement grows, the work is more likely to be considered an alteration, rather than maintenance. All pedestrian facilities should be accessible, however, maintenance activities may also provide an opportunity to improve conditions and move agencies closer to meeting their accessibility obligations.

The DOJ's ADA Title II regulations do not provide a list of activities that qualify as alterations versus maintenance. FHWA, however, has considered common maintenance activities associated with roadways as those that are intended to preserve the system, slow down future deterioration, and maintain the functional condition of the roadway without increasing the structural capacity (FHWA, 2020).

The DOJ and FHWA have released their *Joint Technical Assistance on the ADA Title II Requirements to Provide Curb Ramps When Streets, Roads, or Highways are Altered Through Resurfacing*. This guidance states that the following types of pavement treatments are considered maintenance of streets or roads under the ADA (FHWA, 2013c):

- Painting and markings.
- Chip seals.
- Crack filling and sealing.
- Diamond grinding.
- Dowel bar retrofit.
- Fog seals.
- Joint crack seals.
- Joint repairs.
- Pavement patching.
- Scrub sealing.
- Slurry seals.
- Spot high-friction treatments.
- Surface sealing.

In some cases, the combination of several maintenance treatments occurring at or near the same time may qualify as an alteration and would trigger the obligation to provide curb ramps. Other pavement treatments and surfacing are considered an alteration under the ADA, triggering the obligation to provide simultaneous improvements to pedestrian accessibility, including the installation of compliant curb ramps.

Although there is no similar guidance related to sidewalk maintenance activities opposed to alternative activities, as a general matter, surfacing treatments for sidewalks such as filling holes and cracks, wedging, grinding, and horizontal cutting are likely to be considered maintenance. The replacement of sidewalk segments is more likely to be considered an alteration, requiring the altered portions of sidewalk to meet accessibility requirements. The burden is on the public entity to justify and defend its decisions if a complaint is filed. Most of the communities who were contacted for this Guide indicated that they are meeting ADA standards when doing routine maintenance work (FHWA, 2013b).

Day-to-Day Maintenance and ADA

A public agency must maintain its walkways in an accessible condition, with only isolated or temporary interruptions in accessibility (28 CFR §35.133). This means that as part of maintenance operations, public agency practices must ensure that day-to-day operations keep the path of travel open and usable for persons with disabilities throughout the year. This includes snow and debris removal, and maintenance of pedestrian traffic in work zones with only isolated or temporary interruptions in accessibility. Part of this maintenance obligation includes reasonable snow removal efforts (FHWA, 2022b).

Local ordinances should prohibit impeding accessible sidewalks with items such as outdoor café seating, trashcans, sports equipment, micromobility devices, and parked cars. This maintenance requirement does not prohibit isolated or temporary interruptions in service or access due to maintenance or repairs (28 CFR § 35.133(b)). In such cases, an

alternate accessible path complying with Part 6 of the Manual on Uniform Traffic Control Devices (MUTCD) should be provided (FHWA, 2023b). Allowing obstructions such as cones or barricades, survey equipment, "out of service" equipment, or other items to persist beyond a reasonable period of time is problematic as these objects can make the walkway inaccessible.

Accessibility Guidelines Relevant for Sidewalk Repair and Maintenance

As discussed above, the Access Board issued its final PROWAG rule on August 8, 2023. Although these guidelines have not been adopted as enforceable standards, they include provisions that are relevant for sidewalk repair and maintenance. These provisions are summarized, in part, below. However, they may be revised in some manner when DOJ and USDOT adopt the final PROWAG into their respective regulations, so public entities should remain alert for updates on those rulemaking processes.

Firm, Stable, and Slip Resistant. PROWAG's guidance on surfaces advises that public sidewalks and paths should be stable, firm, and slip resistant.

Displacement/Changes in Level (includes faults and heaves). PROWAG guidance states that changes in level between 1/4 inch (6.4 mm) and 1/2 inch (13 mm) should be beveled with a slope not steeper than 1:2 (50.0 percent). Changes in level greater than 1/2 inch (13 mm) up to 6 inches should have a 1:12 (8.3 percent) maximum slope. Changes in level greater than 6 inches (150 mm) should comply with accessibility provisions for ramps.

Maximum Running Grade. PROWAG guidance states that accessible pedestrian routes should be a maximum of 1:20 (5.0 percent) grade, except where they are contained within a street or highway right-of-way. In this case, the grade of the pedestrian access route may follow the general grade established for the adjacent street or highway. Crosswalks should be a maximum grade of 1:20 (5.0 percent), except where roadway design requires superelevation greater than 1:20 (5.0 percent) at the location of a crosswalk, in which case the grade of the pedestrian access route within the crosswalk may be the same as the superelevation.

Cross-Slope. PROWAG guidance on cross slope of pedestrian access routes varies according to specific circumstances. The PROWAG guidance states that the cross slope of a pedestrian access route not contained within a crosswalk should be 1:48 (2.1 percent) maximum, except that the portion of a pedestrian access route within a street that connects an accessible parallel on-street parking space to the nearest crosswalk at the end of the block face or the nearest midblock crosswalk should not be required to meet that specification.

PROWAG guidance states that the cross slope of a pedestrian access route within a crosswalk at an intersection approach with yield or stop control devices should be 1:48 (2.1 percent) maximum. Within a crosswalk located at an uncontrolled approach, a pedestrian hybrid beacon, or at an intersection approach controlled by a traffic control signal, the cross slope should be 1:20 (5.0 percent) maximum.

PROWAG guidance also states that the cross slope of a pedestrian access route within a midblock crosswalk or a crosswalk at a roundabout should not exceed the street grade.

Minimum Clear Width. PROWAG guidance states that the continuous clear width of pedestrian access routes (exclusive of the width of the curb) should be at least 4 ft (1.2 m), with 5-ft wide passing areas provided every 200 ft. At medians and pedestrian refuge islands, the clear width should be at least 5 ft (1.5 m) to allow for passing space, except that where shared use paths cross medians and pedestrian refuge islands the clear width of the pedestrian access route should be 60-inches (1,525-mm) minimum or at least as wide as the crosswalk, whichever is greater.

Protruding Objects. Objects with leading edges between 27 inches (685 mm) and 80 inches (2 m) above the finish surface, such as tree limbs and shrubs, are not detectable by pedestrians with vision disabilities. PROWAG guidance states that objects in this range should not protrude into sidewalks more than 4 inches (100 mm) and cannot reduce the clear width as required for the pedestrian access route. Handrails, however, are permitted to protrude 4.5-inches maximum. Cities should be responsible for clearing overgrown vegetation in the right-of-way. Similar to winter maintenance regulation, property-owners should be responsible for any vegetation that protrudes from their property onto the adjacent sidewalk. See Appendix B for more discussion and illustrations about post-mounted objects.

5.1.4. Using Maintenance to Improve Accessibility

Communities should adopt a multipronged approach to addressing accessibility through maintenance that includes both short-term actions and long-term planning.

Communities should respond to and eliminate immediate risks to pedestrians, such as protruding objects, and obstacles that lead to tripping, as soon as possible. Many of these obstructions are related to displacements in sidewalks and paths, especially around trees and utilities, but serious obstructions could also result from cracks, holes, and damaged surfaces or from objects protruding into walkways. Inspections using the locally-specific criteria adopted by the agency should uncover these issues, which should be addressed immediately.

Communities should address other maintenance-related deficiencies in an ADA transition plan. Transition plans should lay out a timeframe for repairing or replacing pedestrian facilities that contain barriers to accessibility. Transition plans can also be used to address equity in barrier removal when they create a prioritization process for barrier removal projects based on how critical they are to accessibility for underserved populations.

Roadway marking replacement can be an advantageous time to evaluate curbside usage and the need for accessible parking spaces (per guidance in PROWAG, adjacent land use, and parking utilization). When providing a new accessible parking space or upgrading a previously noncompliant one, it is important to consider roadway and sidewalk grades, width requirements, and

sidewalk access via nearby curb ramps or direct unloading. Accessible parking spaces are usually placed at the end of the block face and include room for unloading via either a clear level sidewalk area adjacent to the space or level in-street areas near side and rear doors. An accessible path, outside of vehicle or bicycle lanes, to access a nearby curb ramp should also be provided when in-street unloading is required. New curb ramps and roadway regrading should be considered to better accommodate accessible parking spaces. Markings and signing for accessible parking spaces should comply with the MUTCD and State and local policies. The PROWAG also has information pertaining to on-street parking spaces (U.S. Access Board, 2023).

Temporary Closures

If an inspection reveals areas where a sidewalk or path is not up to the agency's inspection criteria, a planned course of action should be developed to bring it up to the standard. If the facility presents a risk, a temporary repair should be made as soon as possible. In some cases where alternate pedestrian facilities can clearly serve the same adjacent land uses and destinations, a temporary closure can be considered. Temporary closures can give staff more time to return the pedestrian facility to sufficient condition; however, it is important to avoid any situation where people with mobility disabilities are prevented from reaching transit stops, work, school, and other destinations.

5.1.5. Inspection Types

Inspections can be conducted on a community-wide basis, by zones, or simply on the spot after a complaint (see Equity Spotlight in section 5.2). There are reporting mechanisms that are important components of these three main approaches.

Community-Wide Inspection

A community or agency may inspect every sidewalk, path, and curb ramp within a defined period, such as a six-month window. Community-wide or system-wide inspection often requires significant resources, and commonly involves more than simple maintenance issues. This approach is often associated with developing an ADA Transition Plan (described in the section for Choosing an Inspection Program) or outstanding needs that have not been addressed over a long period of time. Communities with relatively few sidewalks can inspect all their sidewalks annually, but this is difficult for larger communities with extensive sidewalk systems, in which case the data collected from a community-wide inspection can become quickly outdated.

Communities may use an initial inventory of sidewalk conditions as a basis for a prioritization plan. A community-wide effort to assess sidewalks can serve as a planning phase to develop an operational plan aimed at making repairs by zones. Boulder, Colorado, for example, takes this approach. The City's inventory was conducted using a van to video sidewalk conditions and identify defects. The City established zones and a list of criteria that enabled them to prioritize the most critical needs by zone and guide an annual schedule for repairs (FHWA, 2013b). This example demonstrates how a community can transition from a community-wide

inspection approach to a zone-by-zone inspection approach.

Zone Inspection

By splitting the community into zones, maintenance efforts and funding can be more targeted and consistent. Cost efficiencies can be achieved by keeping crews within a tighter geographic area, reducing mobilization and coordination costs.

Many communities are using this process of inspection and repair. In a survey of communities, about half use this zone-by-zone approach or a variant of it (FHWA, 2013b). For instance, the City of Minneapolis has organized their sidewalk inspections and repair program into geographic zones and targets their annual sidewalk repair budget into one of these zones each year, thereby inspecting and maintaining their public sidewalks on a 15-year cycle (FHWA, 2013b). Similarly, almost all surveyed communities had either informal or formal arrangements to focus inspection and repairs in their downtown areas, where pedestrian traffic is high. For example, in Rochester, Minnesota the central downtown area around the Mayo Clinic is examined monthly and the greater downtown area is inspected on a yearly basis. The rest of the City, which is primarily single-family residential (but has some areas of multifamily use as well), is inspected at 5 percent per year; the City will also respond to any complaints or

Micromobility Parking and Accessibility

Parking/Placement When Not in Use: Parking regulations for micromobility devices differ based on State, regional, and local regulations. Maintenance responsibilities for parking vary and can fall on local agencies or private shared micromobility operators. In some jurisdictions, micromobility devices can be parked anywhere where operation is permitted. Micromobility devices can create access issues for pedestrians, cyclists, and drivers if allowed to park anywhere. Pedestrian access routes must not be obstructed by parked micromobility devices (28 CFR § 35.133(a)). Devices parked on sidewalks can create dangerous and inaccessible conditions for pedestrians with and without disabilities.

Sidewalk or On-Street Parking: Most devices can be locked to existing bicycle parking infrastructure – there may also be a need to provide additional bicycle parking to accommodate growing use of micromobility devices. Some cities have also demarcated specific areas in the sidewalk furniture zone or in on-street parking spaces for device parking with symbols, paint, tape, or thermoplastic, which involves increased maintenance needs as paint deteriorates and thermoplastic experiences wear and tear. Vertical elements installed for on-street parking corrals (flex posts, wheel stops, fencing, etc.) may get struck by vehicles and require replacement.

safety risks on a community-wide basis. The targeted downtown area is roughly 0.25 miles in radius while the greater downtown area is roughly 0.5 to 0.75 miles in diameter.

Spot Inspection

Spot inspection occurs when an obstruction is identified and reported by the public or staff. This type of inspection also occurs when a fall or slip is reported due to an obstruction. Before any repair is made, an employee of the agency needs to verify that a problem exists. In many smaller communities, repair crews are authorized to inspect the reported problem and follow-up with an immediate repair based on their inspection. Several communities researched relied entirely on spot inspection and the subsequent repair of sidewalks and paths (FHWA, 2013b). Upon completion of inspection and after determining the extent of a problem, some form of work order is usually issued, leading to one of the following maintenance strategies: wedging, grinding, patching, or sidewalk replacement. It could also lead to sweeping, vegetation removal, or trimming. For a path, an asphalt patch, crack filling, or overlay may also be considered.

Some communities involved in zone-by-zone inspection also conducted spot inspections and were better equipped to do so because they already have trained inspectors and inspection teams (FHWA, 2013b).

Actions Following a Complaint or Injury

Depending on State, local, and Tribal laws and ordinances, it may be prudent for a community to establish standard operating procedures when handling inspection of a pedestrian facility or path in the event of an injury.

Inspecting Shared Use Paths

Madison, Wisconsin

Madison, Wisconsin, has an extensive path inspection system. All paths are visually inspected on a regular basis and individually rated for pavement condition on an annual basis. Condition reports are reviewed every year and a number of paths are selected for resurfacing or repaving based on condition rating, path usage, and other factors. Between major resurfacing projects, surface problems are addressed based on reports of hazards, with pothole patching or other repairs being completed as necessary and priority given to problems with safety implications (FHWA, 2013b).

The following steps are recommended (League of Minnesota Cities, 2022a):

- An incident report should be completed by the agency. The report should include the incident location, what occurred, and the presence of any identified defects.
- Ownership and maintenance of the pedestrian facility should be verified. Often there are several different agencies having control over pedestrian facilities within a single community.
- The pedestrian facility should be inspected immediately after the incident becomes known and details are available (through the incident report). An inspector should describe the condition of the pedestrian facility, including any defects and obstructions, take photographs, take measurements, and compare the post-crash sidewalk condition with the condition at the time of the last inspection.
- At the same time, the inspector should determine if the defect or obstruction that caused the issue meets the criteria for a spot improvement using the agency's adopted inspection criteria. A spot improvement could include a temporary repair or even minor sidewalk replacement.
- Documentation is important and should include strong and clear support for a decision when no repairs are made.

In the event of a claim or lawsuit, documentation can demonstrate the existence of a jurisdiction's inspection practices and adherence to adopted practices and policies.

Reporting by the Public

Every agency should have more than one means of learning about maintenance-related concerns. In addition to staff inspections, the public should be enlisted to help identify risks/obstacles and offered multiple reporting methods (e.g., phone, mobile applications (apps), texting, online forms, etc.). Reporting methods should be accessible to people with vision disabilities and limited English proficiency. Propel ATL, a pedestrian and bicyclist advocacy group in metropolitan Atlanta, has established an online obstruction reporting system that is checked by the City of Atlanta and many Atlanta suburbs. People are encouraged to report sidewalk or bike lane closures or obstructions using a map-based online tool (Propel ATL, 2022).

Cities, agencies, and private organizations have instituted crowdsource phone apps to help streamline the previously disparate reports that different departments were receiving into one unified system. While residents can still call the public agencies or submit comments via websites, a mobile app's ability to allow users to take pictures makes them more helpful in some ways. These apps are called different things in different places (such as *Find it Fix it* in Seattle, *MyLA311* in Los Angeles, *CHI 311* in Chicago, etc.). Most of the apps allow users to submit both a description and photograph of the maintenance concern, and the system will automatically send the

user status updates as the concern is evaluated and addressed.

These programs can be used to report any number of public concerns relevant to active transportation infrastructure maintenance, including snow removal issues, sidewalk obstructions, street-light outages, damaged pedestrian signals, etc.

Another avenue of crowdsourced data are programs like *Project Sidewalk* (Saha et al., 2019), where users virtually explore a city and identify accessibility issues and rate them in terms of severity. These cover issues involving curb ramps, sidewalk obstacles, missing sidewalk, and uneven sidewalk surfaces. To combat user error or bias, the program also has users validate other users work. The goal of the program (currently working in Seattle, Washington; Columbus, Ohio; Newburg, Oregon, Oradell, New Jersey, and Pittsburgh, Pennsylvania) is to map all the streets in these cities to create accurate routing maps for differently abled users, better inform DOTs, and train machine learning algorithms so that they can be used to do this type of data gathering in the future.

Preferably, all types of inspections and obstacle reports will go to one centralized location. If that is not feasible, it is important to have a unit responsible for overall coordination of reporting. Complexity grows when various reporting methods are used because reports may be received by different agencies, such as the Parks Department for path issues, the Public Works Department for sidewalk obstructions, and the Streets Department for crosswalk and signal issues. As noted above, a unified, comprehensive program can bring together all manners of reporting issues into one system.

Choosing an Inspection Program

The type of inspection program selected depends largely on the resources available: community-wide inspection requires the most resources, while a spot inspection program requires the least; a zone inspection program falls in-between. The resources required to carry out an inspection program varies not just with the type of program selected, but also with the age of the infrastructure being inspected. In newer communities, it may be possible to inspect large areas very quickly, as sidewalk systems and shared use paths have been built to current guidance and have not had extensive damage from tree roots. Inspection and recording of problems of older sidewalk systems can take considerable time, especially in areas where curb ramps have not been brought up to ADA standards or mature trees have damaged sidewalks.

Chapter 11 of *Designing Sidewalks and Trails for Access – Part II* includes a discussion about developing a complete sidewalk assessment system (Kirschbaum et al., 2001). This is used for more extensive inspection processes for community-wide assessments and often for ADA transition plans and sidewalk replacement programs being conducted on a zone-by-zone basis within a community. Features of such an assessment go beyond routine inspection procedures with the following measurements being involved: sidewalk cross slopes (including cross slopes at driveways), running grades, changes in level, changes in grade, minimum clear width, surface defects, minimum

vertical and horizontal clearances, and the distance protruding objects intrude into the pedestrian path. Curb ramps and crosswalks are also part of the pedestrian network and should also be inspected based on accepted accessibility criteria.

In earlier research conducted for this Guide, it was found that the majority of communities lack a coordinated sidewalk and path inspection program and often respond to concerns that could have been caught earlier with inspections (FHWA, 2013b). Creating a coordinated sidewalk and path inspection program should be an early priority for a sidewalk maintenance plan. At a bare minimum, a basic inspection system should consist of spot inspections as described above. This is the least formal and robust approach to inspection but is necessary to respond to immediate maintenance issues caused by a variety of factors.

Unlike sidewalks, there tends to be less ambiguity about who is responsible for maintaining shared use paths. Despite this, only a few communities contacted had any formal and proactive inspection processes for shared use paths, even ones with robust inspection and repair programs for sidewalks (FHWA, 2013b).

5.1.6. Documentation of Inspection Results and New Technologies

An important aspect of sidewalk and path inspection is the management of collected data. Inspection of all types—from spot inspections to comprehensive assessments—should be documented. During an inspection a form is typically completed for each location. If a spot inspection is conducted due to a reported problem, only one or two locations may be inspected. For more comprehensive inspections, notes and forms should be completed assessing the defective sidewalk sections, the types of defects found, and the length and width of the anticipated repair. These field notes can then be used to generate inspection reports. In communities where maintenance has been delegated to the adjacent property owner, the report may be sent to the property owner. Communities can streamline sidewalk inspections by using specific sidewalk and path inspection tools and management systems. These include:

- Check sheets.
- Measuring tape/wheel to determine dimensions.
- Smart levels to measure cross slopes and running grades.
- Profile gauges to measure small changes in level.
- Global position system- (GPS-) enabled devices that seamlessly integrate with electronic management systems.

Other more sophisticated measurement and data collection devices are also being used. In Atlanta, a smartphone application operates on a tablet that records video, GPS, accelerometer, and gyroscope data. The tablet is attached to a wheelchair and automatically records the video and collects the data necessary to identify sidewalks that may be in need of repair or reconstruction. This data collection system is low-cost due to the use of a standard, manual wheelchair and computer tablet device, and in 2012 it was being tested and supported through the Georgia Tech College of Engineering, Georgia DOT, and

the City of Atlanta (FHWA, 2013b). There are several other tools that work similarly, with the measurement tool being pushed along like a baby carriage or ridden like a motorized scooter or wheelchair. The newer version can add lasers, radar, and Lidar, although those additions increase the cost. The benefit of these tools is that they can include the ability to upload the data to a mapping program automatically.

Emerging technologies using machine learning are making inspection and reporting easier and more automated. By analyzing imagery from a smartphone, artificial intelligence is being used to detect sidewalk obstructions quickly and easily.

As these technologies continue to develop, more agencies are likely to find them cost competitive and very useful for inspection and maintenance management.

Many agencies are using electronic asset management systems to record sidewalk, curb ramp, path, and other infrastructure data. Agencies should keep in mind that data collection and documentation efforts require the use of limited resources, so choosing the right technology is an important step. A major benefit of using GPS-enabled devices is that spot problems can be identified with a high level of accuracy. Sidewalks can be identified and cross-referenced by parcel number and street address. This level of sophistication is often used to conduct a comprehensive sidewalk and curb ramp inventory. Once in place, inspectors can use the same tools and inventory as they respond to issues and update the inventory. Section 6.7 *Asset Management* has more information on asset management systems.

Without an electronic inventory of

Using Technology to Aid Inspections

Fond du Lac, Wisconsin

The City of Fond du Lac, Wisconsin, was one of the first communities in the country to use a more sophisticated data management system for sidewalk inspections. Fond du Lac created a custom database application using computer software to help manage the vast amount of data associated with the City's sidewalk program. This database application stores all of the sidewalk data in one central location and automatically generates several reports. The electronic database allows the City to not only manage the data in one place, but to automatically calculate quantities for estimating sidewalk replacement costs and bid quantities (FHWA, 2013b).

A mobile geographic information system (GIS) application consisting of a handheld computer with GIS software and GPS is used in the field and synchronized with the sidewalk database as inspections occur. A GIS parcel map is used to note defects in the sidewalk and create points in the database using the inspector's GPS location. Digital photographs are also taken of the defects during the inspection and are added to the parcel information in the database (FHWA, 2013b).

facilities, it is still possible for inspectors to make use of new technologies. For example, an inspector can issue work orders by address or parcel number from the field using a GPS-enabled device. Although that would be using only a small part of the available technology, it may be just the right level of technology for communities that have not gone through an extensive inventory process.

Having trained inspectors is crucial to the delivery of a sound inspection program. This training should be extended to all personnel making decisions in the field and applying professional judgment when a spot repair is going to be made or a sidewalk section replaced. For smaller agencies, first line public works employees may be summoned to inspect and repair reported sidewalk and path defects. In many communities there will not be a dedicated inspector, so street or public works employees can be trained on standards and requirements.

This produces the benefit of having the same employees consistently inspecting, documenting, and making or supervising the repair. Empowering inspectors and other field personnel to make decisions on the spot is often the most efficient and reliable means of dealing with reported defects.

5.2. Compliance

In most places, maintenance of sidewalks is a cooperative effort between a jurisdiction and its residents. Most agencies require adjacent property owners to attend to year-round, day-to-day maintenance of sidewalks and curb ramps (FHWA, 2013b). This includes sweeping, vegetation control, and snow and ice removal. In many communities, property owners are also held responsible for making or paying for repairs on sidewalk segments in front of their homes and businesses. Jurisdictions committed to maintaining an accessible sidewalk network should create systems where responsibilities are spelled out with property owners and they themselves hold up their set of commitments. This usually involves inspection regiments and administrative and compliance actions.

In communities where the governmental agency conducts and pays for all sidewalk repairs and replacements, the main compliance issue is day-to-day maintenance. Compliance with regulations on removal of snow, ice, and debris still requires an inspection and reporting system.

5.2.1. Principles for Compliance

There are several principles that should be considered for the effective use of administrative, compliance, and enforcement measures. Laws, ordinances, and directives need to be understandable, clear, and reasonable. Any enforcement actions arising from the ordinances or laws should also be fair, prompt, consistent, and predictable.

5.2.2. Compliance with Sidewalk Repair and Replacement Ordinances

In the series of discussions which were conducted with agencies as part of the research for this Guide, several indicated they had difficulty in applying sidewalk repair ordinances (FHWA, 2013b).

Many communities expressed concern that enforcement of sidewalk repair ordinances

could result in untenable costs to residents and community backlash. This can be compounded when there is a perception that the burden of sidewalk replacement falls more heavily on lower-income neighborhoods, or that higher-income residents are able to pressure city officials to avoid citations. Other respondents mentioned that often the responsibility for sidewalk repair is unclear (such as when city-maintained street trees crack sidewalks).

In some communities, this gap between the intent of an ordinance and effective enforcement means sidewalks are falling into disrepair. A community that recognizes this issue has several options. The ordinance can be revised, which is particularly helpful when simple changes would help address the issues. Some communities are taking more responsibility for sidewalk repair and replacement by lowering assessments and finding other funding sources for repairs. In some cases, advocacy and community groups are helping raise the visibility of the issue so that sidewalk repair gets a higher priority (FHWA, 2013b). Most importantly, the public works staff should systematically document the condition of the sidewalk network, and provide this information to the community's leadership, so those leaders will have the tools to effectively address the issue.

In communities that do enforce delinquent sidewalk repairs, common compliance mechanisms include fines and assessment for work completed by an agency.

Paying for Sidewalk Repair and Replacement

According to the research for this report, agencies most common approach was making simple repairs (patching and wedging) themselves. If sidewalks had to be replaced, a set of procedures were set in motion requiring adjacent property owners to pay for all or part of the cost of an agency to use its own crews or a hired contractor to replace the sidewalks (FHWA, 2013b). Recognizing the difficulties and inequities of holding adjacent property owners fully accountable for paying for sidewalk repair and replacement, some agencies are exploring other options, including cost-sharing programs, grant programs, and assuming full responsibility (FHWA, 2022h).

The following are example agency programs to help defray the burden of sidewalk maintenance from individual property owners, ultimately helping to maintain an accessible and continuous surface for pedestrians.

Agencies with cost-sharing programs for sidewalk maintenance:

- City of San Diego, California (The City of San Diego, 2021):
    - The City pays for 50 percent of the eligible replacement cost and the property owner pays the remaining 50 percent. The fee is based on a per ft^2 cost and is the same for all neighborhoods throughout the city.
- The City of Naperville, Illinois (City of Naperville, 2021):
    - For sidewalks adjacent to residential properties, the City pays

60 percent and the resident pays 40 percent.

- For sidewalks adjacent to multifamily and commercial properties, the cost is split 50-50 between the City and property owner.
- For multi-frontage residential lots, the City pays 60 percent for the shorter frontage and 75 percent of the longer frontage; the homeowner pays the balance.

- Salt Lake City, Utah (Salt Lake City, n.d.):
  - Property owners can hire a contractor to accomplish the necessary concrete repairs, which requires a permit to work in the public way, or property owners can take advantage of the 50-50 concrete program (where the City splits 50 percent of actual replacement costs).

Equity Spotlight

In many cities, adjacent property owners are responsible for sidewalk repair costs regardless of their ability to pay. Although property owners have been delegated responsibility for the cost of repairs, the City is still responsible for making the repairs, regardless of the property owners' ability to pay. This can mean that low-income property owners will pay a larger percentage of their income than higher-income property owners for the same amount of public benefit (Minnesota DOT, 2018). This inequity may be further exacerbated in historically-disinvested places that have the greatest need for repairs, or in areas where most people rely on sidewalk access for transportation due to lower rates of car ownership (Minnesota DOT, 2018).

In a study done in the City of Albuquerque (Corning-Padilla, 2020), three potential sidewalk maintenance funding methods were examined: gross receipts tax (similar to a sales tax but which applies to many services), property tax, and gasoline tax. These options were deemed more equitable than the status quo because they are relatively less regressive, they distribute costs more evenly, and they are more likely to result in adequate sidewalk maintenance.

The City of Syracuse is an example where a municipality took on the responsibility of sidewalk maintenance. Under their former policy, property owners were responsible for maintenance and repair of adjacent sidewalks. In the summer of 2021, the City began the Municipal Sidewalk Maintenance Program. The program established four funding districts that issued bonds to finance maintenance in the first year of the program. Beginning in year two, annual fees began to be assessed on property owners (City of Syracuse, 2021). To help low-income people who can’t afford the fees, $500,000 was set aside under the program (Magnarelli, 2021).

- City of Missoula, Montana (FHWA, 2013b)
    - The City created a bonded cost system where the City pays the upfront cost of the sidewalk and then the property is assessed and the property owner pays the City back over 8, 12, or 20 years at a low interest rate (FHWA, 2013b).

Roadway agencies that have a grant program for sidewalk maintenance:

- The City of Madras, Oregon (The City of Madras, 2023):
    - Recognizing the cost to repair sidewalks due to damage caused by street trees created a significant financial burden to businesses, the City implemented the Downtown Sidewalk Repair Grant to help defray those costs.
    - Eligible Uses of Grant Funds:
        - Applications will only be accepted for commercial properties in the downtown where there is a street tree planted.
        - Property owners may only apply for one grant for one property in a calendar year.
        - First time applicants will be given priority over previous applicants. Applications must be received and approved by the City prior to any work being performed. Retroactive applications will not be accepted.

Austin, Texas and Washington D.C. are two cities that maintain their own sidewalks without any direct financial contribution from adjacent property owners.

Meeting ADA to the Maximum Extent Feasible

It is important to note that if a pedestrian facility is impacted by an alteration project (see section 4.1.3 *Brick and Pavers*), cost is not a reason for a public agency not to bring a pedestrian facility up to ADA standards.

"Each facility or part of a facility altered by, on behalf of, or for the use of a public entity in a manner that affects or could affect the usability of the facility or part of the facility shall, to the maximum extent feasible, be altered in such manner that the altered portion of the facility is readily accessible to and usable by individuals with disabilities, if the alteration was commenced after January 26, 1992" (28 CFR 35.151).

"Maximum extent feasible" in this context relates to technical infeasibility only, not cost.

Sidewalk Repair Supported by Laws and Ordinances

Several local agency compliance programs were identified for sidewalk repair and replacement as part of the research for this Guide (FHWA, 2013b). Repairs are triggered by complaints, requests, incidents, or by a sidewalk inspection program. An agency's sidewalk program will then issue a sidewalk notice of repair or defect. In some cases, an abutting property owner has an option to repair or replace a sidewalk panel, and they are typically given a window of time (e.g., 14 to 60 days) to address the issue. If the sidewalk repair is not made, the agency will often do the repair and charge the

property owner for the work. Often if the charge is not paid within a grace period, the charge becomes a lien against the property. Adjacent property owners are provided opportunities to contest repairs and the costs associated with the repairs (FHWA, 2013b).

A much longer time period is established when a sidewalk must be repaired or replaced to provide time for the repair to be made. Clear procedures should be in place if the repair work is done by the agency but assessed in full or in part to the abutting property owner.

Federal or State laws or policies may govern local sidewalk maintenance compliance plans. For example, current maintenance provisions of the USDOT require that pedestrian facilities built with Federal funds be maintained just like other roadway facilities in the area (Wlaschin, 2008). State agencies often have some of the same conditions when they construct sidewalks along State highways. In some situations, State agencies will provide maintenance for sidewalks along the roadways they control and will not expect this to done by a local agency.

Some jurisdictions that have adopted a Complete Streets policy or have otherwise reexamined their commitment to improving their sidewalk infrastructure have concluded that they need to take more direct responsibility for sidewalk repair and replacement. A Complete Streets policy sees the sidewalk as an important part of the right-of-way, rather than an extension of an individual property, and agencies implementing such a policy may find that putting the burden on property owners results in an uneven sidewalk quality, as quality of construction will depend greatly on the financial resources of the property owners.

Source: Toole Design

Figure 22. Photo. An accessible sidewalk detour.

5.2.3. Compliance with the MUTCD

According to the MUTCD, "A wide range of pedestrians may be affected by temporary traffic control (TTC) zones, including the young, elderly, and people with disabilities. The MUTCD also notes that "Pedestrians need a clearly delineated and usable travel path" (FHWA, 2023A; MUTCD Section 6C.02). The Final PROWAG includes provisions for alternate routes and work zones (U.S. Access Board, 2023). When maintenance activities, construction, incidents, and special events affect the movements of pedestrians, adequate pedestrian access and walkways shall be provided (figure 22) (MUTCD, § 6C.02, ¶ 3 (FHWA, 2023b)). This issue will be especially commonplace when sidewalk or path sections are temporarily closed for maintenance or removed and replaced. The MUTCD includes provisions on TTC zones (FHWA, 2023b). The MUTCD is the national standard for all traffic control devices installed on any street, highway, bikeway, or

site roadway open to public travel within the United States (23 CFR § 655.603). Refer to MUTCD Chapter 6C Pedestrian and Worker Safety for Standards and Guidance on traffic control devices to direct pedestrians safely through work zones (FHWA, 2023b).

The standards from the MUTCD include several key provisions:

- The needs and control of all road users (motorists, bicyclists, and pedestrians within the highway, or on a roadway open to public travel including persons with disabilities) through a TTC zone shall be an essential part of highway construction, utility work, maintenance operations, and the management of traffic incidents (FHWA, 2023b; MUTCD).
- Where pedestrian routes are closed, alternate pedestrian routes shall be provided for maintenance (FHWA, 2023b; MUTCD).
- Prior to closing a sidewalk or other pedestrian facility, the maintaining agency should advise users of the future closure (FHWA, 2023b; MUTCD).
- When existing pedestrian facilities are disrupted, closed, or relocated in a TTC zone, the temporary facilities shall be detectable and shall include accessibility features consistent with the features present in the existing pedestrian facility (FHWA, 2023b; MUTCD).
- Blocked routes, alternate crossings, and sign and signal information should be communicated to pedestrians with vision disabilities by providing devices such as audible information devices or barriers and channelizing devices that are detectable to the pedestrians traveling with the aid of a long cane or who have vision disabilities (FHWA, 2023b; MUTCD).

Additional guidance provided in the MUTCD includes:

- Whenever possible, work should be done in a manner that does not create a need to detour pedestrians from existing routes or crossings (FHWA, 2023b; MUTCD).
- TTC zones should be designed to minimize conflicts between vehicular and pedestrian movements. Consideration should be made to separate pedestrian movements from both worksite activity and vehicular traffic (FHWA, 2023b; MUTCD).
- A smooth, continuous hard surface should be provided throughout the entire length of the temporary pedestrian facility (FHWA, 2023b; MUTCD).

5.2.4. Routine Maintenance Supported by Laws and Ordinances

Any enforcement effort should be backed by an ordinance or law that is easy to understand and provides clear direction to the people who are responsible for enforcement. The ordinances and laws can establish a fine or fee schedule for issuance to people for failing to comply. Often, they will establish a short grace or notification period in which the property owner can respond to reported issues, especially for vegetation removal.

Compliance for Clearing Snow and Debris

A goal for any agency is to have compliance with as little enforcement as possible, particularly when it comes to clearing sidewalks of snow and other debris. If an agency can keep sidewalks clear with little enforcement, they will likely be saving money while avoiding potentially negative interactions with residents. The jurisdiction can work to establish a community norm that supports the importance of sidewalk maintenance among residents as part of good citizenship and which encourages people to help neighbors if they are struggling. An agency can formally or informally organize volunteers to help keep sidewalks clear where older or disabled residents cannot remove snow, ice, vegetation overgrowth, or sweep on their own. In larger communities, this strategy is often part of a larger snow removal plan or program. For instance, Fort Collins, Colorado, has an *"Adopt-a-Neighbor"* program (figure 23) which coordinates volunteers to shovel for someone who cannot do so on their own. The Cambridge, MA Department of Public Works will clear the sidewalks at no cost if residents in need of assistance add their name to the annual exemption list (FHWA, 2013b). In some smaller communities, especially those located in warmer climates that have less severe snow events, informal volunteerism may be relied upon.

5.2.5.Types of Enforcement Efforts

When property owners are required by law to maintain pedestrian facilities, enforcement through fines or other punitive measures should be used as a last resort. Fines will be one of the tools for enforcement but should not be viewed or portrayed as a means of raising funds. The costs associated with a robust enforcement program are likely to be higher than the funds raised through fines. There are a number of strategies that can help establish and retain an effective enforcement effort. As with any enforcement effort, it is essential that enforcement information and protocols be clearly communicated to the public and within the agency. This should include which department (and contact person) within an agency is responsible for receiving reports and monitoring enforcement, the fines and notification periods for different types of maintenance, the standards expected for maintenance, and the options available for people who cannot perform maintenance.

Figure 23. Graphic. Some cities like Fort Collins, CO, have programs to pair neighbors with needs like shoveling sidewalks with volunteers willing to help (City of Fort Collins, 2022).

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In many communities a tiered enforcement approach is put into effect that makes use of warnings, but also cracks-down on chronic issues. For example, in Boulder, Colorado, a property owner is given a warning for the first incidence of noncompliance (per year/season) and then a ticket for the second noncompliance event. If the location is identified as a chronic issue, the City may take more severe measures including conducting the maintenance themselves (or by contract) and billing the property owner for the work. Although this can work for many forms of property owner maintenance, providing a notification period for snow and ice removal is not recommended because of the immediate risk confronted by pedestrians (FHWA, 2013a).

Enforcement for pedestrian maintenance can be aided by other employees of the agency. This involves the identification of concerns by a range of public employees. Communities can train parking meter readers, parks employees or police, public works staff, and inspectors to be alert to and to report sidewalk accessibility issues. It is usually best if a public works employee—usually an inspector—then visits the property. The inspector can decide in the field if a citation or fine is necessary, talk to the property owner, and process the paperwork for a citation or fine if necessary. There can also be more proactive inspections after a major snowfall or on a schedule to identify problems that need an immediate response. By using the range of employees and reporting mechanisms, hazards can be reported and attended to sooner.

Reactive enforcement involves specified employees being called upon to issue a citation or fine for a recently-reported problem. This often involves a two-step process when an inspector assesses the issue and, depending on its nature, some time may be given for an adjacent property owner to address it, such as when a sidewalk needs to be repaired or replaced. Conversely, if a sidewalk is impassable because of snow and ice, an inspector or a public works employee might issue a fine on the spot.

Communication is a key element of an enforcement strategy. The strategy should contain methods that enhance on-going communication on how citizens and

employees will resolve issues. Lines of communication can be formalized with neighborhood groups and business associations. The annual timing of messages is also important. For instance, communication should begin in the fall of the year regarding snow and ice removal while repair of sidewalks and vegetation control are subjects for the spring and summer seasons. This line and type of communication will help to remind longer-term residents but will also inform new residents for the first time. The goal is compliance without instituting more time-consuming enforcement practices or relying on fines to affect maintenance efforts. More information on communication is available in section 6.4 *Communication.*

Fines

A common enforcement tool for getting compliance from property owners is with fines and is used primarily with day-to-day maintenance efforts. Charges can accrue daily for failure to comply with an order, or it may be effective enough for the fine to simply cover the cost of crews to clear the sidewalk or make a repair. In other cases, because the goal is to move toward compliance, increasing fines over time can prompt residents to reason that they would rather shovel snow or trim bushes than face higher fines. A fee structure can include different fines for residential and commercial properties or for single family and multifamily housing. Recurring charges resulting in a lien on the property can be an effective strategy for encouraging property owners and managers to comply with requirements.

Although enforcement is a key element for compliance, agencies should make reasonable exceptions and always tie education with enforcement. For instance, exceptions and longer compliance windows may be necessary for significant snowfalls or ice storms. Communities that combine education efforts with enforcement efforts are generally more successful at having sidewalks attended to. See section 7.7.3 *Snow and Ice Removal* for examples of education programs related to snow removal by adjoining property owners.

5.3. Policies and Ordinances

The process of inspecting pedestrian facilities, deciding on actions to take, and working with (or issuing fines to) the public, requires strong policies and ordinances that clarify how facilities will be maintained and if adjacent property owners will be required to conduct maintenance on their own.

Most communities with pedestrian facilities will have at least some written maintenance policies, often through ordinances or as part of a maintenance plan. Policies should cover the funding of sidewalks, inspection procedures and criteria, and responsibilities of property owners and the community. The policies will establish the overarching principles with direction to agency staff to carry out the specifics. A complete set of adopted policies can have the same effect in directing pedestrian facility maintenance actions as a plan.

One of the most important topics to cover in a policy is the general criteria used to determine when to repair and replace pedestrian facilities or address

noncompliance of a standard level of service. These criteria will dictate when a repair should be made, a sidewalk replaced, vegetation trimmed, or snow and ice removed. The policy should address who is responsible for making repairs, and for regular chores such as clearing snow, ice, vegetation overgrowth, and debris.

Policies may be written into ordinances and enacted by a jurisdiction. Sidewalk ordinances from the Cities of Eau Claire, Wisconsin and Des Moines, Iowa are included as examples in appendices C and D. These ordinances cover the placement of sidewalks, inspection, construction standards, and obligations that these municipalities place on adjacent property owners for maintenance.

6. Planning and Tracking Maintenance

In general, plans are the best way to cover all facets of active transportation maintenance. Plans that address pedestrian and bicycle facilities can provide important direction on timeliness, techniques, and priorities for maintenance (City of Richmond, 2015; New Jersey Safe Routes Program, 2014; Massachusetts DOT, 2015). ADA transition plans are another opportunity to incorporate pedestrian facility maintenance needs. Typically, such plans are officially adopted by the jurisdiction that completes them. Developing these plans provides an opportunity to involve the public in the planning process, including residents, homeowner associations, neighborhood groups, and business development associations and interests.

Active transportation maintenance plans provide both short-range and long-range direction for communities. They can help manage the resources available for maintenance of facilities and may contain a range of recommendations covering good practices associated with policies, ADA compliance, inspection, prioritizing maintenance activities, and funding.

Active transportation plans which address facility maintenance at the municipal level can communicate the agency's responsibilities as well as lay out what is expected of property owners. Additionally, they can cover the coordination necessary between jurisdictions and agencies for effective and timely maintenance. The following sections (6.1 through 6.7) describe the main topics a facility maintenance plan might include.

6.1. Goals, Objectives, and Performance Measures

This section describes the guidelines and vision for the plan and is usually informed by previous plans and information garnered over the course of the planning process, including public involvement and input from advisory groups and agency staff. It is critical that plans have actionable goals and benchmarks so that the plan can be implemented, and progress evaluated. Goals usually represent an achievable outcome that is generally broad and longer term such as expanding the walking network, increasing the connectivity of a bicycle network, or improving all streets to a certain pavement quality. Objectives are more short term and define measurable actions to achieve an overall goal. Performance measures are used to evaluate and report progress being made.

6.2. Inspection Criteria and Procedures

It is critical for a plan to establish how inspections will be done. This includes criteria that will be used to determine when to repair and replace pedestrian and bicycle facilities, such as degree of displacements, cracking, holes, and other surfacing issues; when pavement markings are replaced; etc. A plan should also address who will inspect potential problems associated with snow, ice, vegetation overgrowth, and walkway and path debris.

The City of Alameda Embeds Maintenance into its Active Transportation Plan

The City of Alameda's *Active Transportation Plan* (City of Alameda, 2022) addresses maintenance of active transportation facilities by identifying specific ways in which both existing and new efforts can improve maintenance, including:

- Seeking funding sources to dedicate to maintenance of active transportation facilities.
- Identifying maintenance needs regularly and executing solutions.
- Developing maintenance turn-over processes for new infrastructure and ensuring that as-built plans for new bicycle and pedestrian facilities are included in the City's asset management system.
- Maintaining an adequate inventory of standard materials used for bikeways and pedestrian facilities (e.g., bollards and in-pavement pedestrian crossing signs).
- Maintaining on-call contracts for infrastructure that cannot be maintained by City forces (e.g., thermoplastic markings for high-visibility crosswalks).
- Coordinating maintenance needs with roadway and shared use path owners such as the California DOT or the East Bay Regional Park District.
- Maintaining Public Works staffing capacity to proactively lead maintenance efforts, effectively respond to maintenance requests, and regularly coordinate with partner agencies.

6.3. Prioritization and Funding

Each community will need to balance its needs and funding for maintaining pedestrian and bicycle facilities. Agencies should have a clear policy for how they expect to schedule and fund active transportation infrastructure, especially if special assessments will be used to repair or replace sidewalks. One option is to identify specific sidewalk sections and curb ramps that need to be repaired or replaced, while another approach is to create a system for prioritizing repair and maintenance of pedestrian facilities. Similar approaches can be taken for bicycle networks.

If a plan is new, the first step should be to conduct an inventory of facilities. The inventory should collect and organize critical information on the condition of pedestrian and bicycle facilities, including sidewalks, curb ramps, paths, crosswalks, median crossings, pedestrian signals, bike lanes, and bike network features like bike boxes. Such an inventory can also be used to update or prepare ADA transition plans. Conversely, the development of an ADA

transition plan can be an opportunity to conduct a comprehensive inventory and establish priorities for maintenance. Ideally, information collected on active transportation infrastructure is entered into an asset management system (see section 6.7 *Asset Management*).

Communities use two main options for funding pedestrian facility repairs. The preferred method is to fund such repairs through general road repair funds or the general fund. If the road in question is a State highway, the existence of a State Complete Streets policy can be used to negotiate a cost-share or full-funding arrangement—with the potential use of Federal transportation funds—that brings pedestrian and bicycle facilities into alignment with State maintenance of the roadway. In some States, it is common for local governments to assess the repair costs of sidewalks to adjacent property owners. See section 5.2.2 *Compliance with Sidewalk Repair and Replacement Ordinances* for more discussion of how communities approach paying for sidewalk repair and maintenance. Funding priorities should be addressed in policies or ordinance. For more information on funding see Chapter 9 *Funding*.

The Bipartisan Infrastructure Law, enacted as the Infrastructure Investment and Jobs Act (IIJA) in November 2021 (Pub. L. No. 117-58), authorized and reauthorized several programs that can be used to correct deficiencies in public rights-of-way, including sidewalks, curb ramps, and off-road pedestrian facilities, that are identified in the State's ADA/Section 504 transition plan (IIJA, 2021). Agencies can find additional *Pedestrian and Bicycle Funding Opportunities* on FHWA's website (FHWA, 2022c).

6.4. Communication

A plan can be an important way to communicate to the public and internally to an agency's own employees about the importance of maintaining pedestrian and bicycle facilities, roles and responsibilities, and procedures for facility maintenance. Procedures should cover how a community repairs facilities, pays for them (especially if assessing them to property owners), informs affected residents, does inspections, establishes projects annually, and schedules repairs. Formal maintenance plans can be used to address and communicate to the public what is expected of them for clearing snow and removing overgrown vegetation.

Finally, a plan should establish a mechanism for how the jurisdiction deals with unforeseen circumstances and changes in conditions. This is especially important as more communities' experience more frequent severe weather events associated with climate change, which can lead to unplanned budget expenditures. For example, resources might be stretched because of a severe winter that requires a greater use of maintenance funds for snow clearance than anticipated. Rather than making drastic cuts to other important maintenance activities, a discussion and process should be followed to address these changes. The plan could include a planned response, such as a reduction of sidewalk replacements coupled with greater attention to temporary repairs (hole and crack filling, wedging, grinding, horizontal cutting) to

ensure the network remains safe and accessible until replacements can resume. The plan can also include provisions for responding to more unusual circumstances by specifying when a public works board or the city council itself should be called upon to adjust the plan.

6.5. Documentation

The plan should outline documentation procedures. It is always helpful to document the reasons why actions were taken the way they were. Even when cuts in funding or staff have led to a diminution of services, if appropriate documentation shows a thoughtful and deliberate consideration of the reprioritization of resources, this will serve the community in a better way than if no documentation was made.

6.6. Equipment

A plan can identify equipment needs for walkways and paths for the following purposes: repair and replacement of pavements, and the removal of snow, ice, vegetation, and brush. This is especially important for communities that are taking on responsibilities for removing snow and ice on paths and sidewalks, or that have constructed separated bike lanes where specialized equipment may be needed. Since equipment has an established expected life, and new equipment can add significantly to a budget, a plan can establish the timing for replacement or purchase of equipment that is not already in place. For example, smaller-sized equipment or pick-up trucks mounted with plows can be used for paths. Those purchases (and the equipment to be attached to them) should also be identified and budgeted for, especially to respond to a change in policy or an expansion of snow removal responsibilities.

6.7. Asset Management

Asset management is a strategic and systematic process of operating, maintaining, upgrading, and expanding physical assets effectively throughout their lifecycle (American Association of State Highway and Transportation Officials [AASHTO], 2022). Asset management enables better decision-making by improving the quality of available information. The maintenance of pedestrian and bicycle facilities falls squarely within this definition and is no different than other components of the transportation system.

Cities and States may have separate asset management systems where sidewalks and bicycle lanes may be separate from streets and bridges. This can cause disconnects between departments and priorities. The Virginia DOT's *Asset Management Best Practices Manual* states it is necessary to include bicycle and pedestrian accommodations during the development of an Asset Management Plan. Similarly, Minnesota DOT's *Transportation Asset Management Program* includes pedestrian and bicycle infrastructure. The Seattle DOT's *Asset Management System* goes beyond sidewalk and bicycle facilities to include all of their bicycle and pedestrian system infrastructure, such as bicycle racks and map kiosks.

Sidewalks are known to last well over 50 years in most environments (Alan M.

Voorhees Transportation Center, 2006; Rajani and Zhan, 1997). The recent drive for asset management for transportation facilities has called attention to how the maintenance of sidewalks fits into an asset management approach. Maintenance is a means of protecting and extending the initial investment in sidewalks and pedestrian facilities. Although a new name and a more sophisticated process has been applied to managing transportation assets, communities that have been carefully maintaining active transportation facilities have already learned the benefits of asset management. Here are a few examples of how asset management and active transportation facility maintenance are linked:

Protect initial investment. The initial construction of sidewalks requires a significant outlay of capital. A maintenance program continues to protect that investment. Relatively small outlays of maintenance funds can elongate the life of pedestrian facilities and, in some cases, avert significant future outlays.

Level of service. The maintenance of pedestrian and bicycle facilities is inextricably tied to the level of service they offer. Asset management practices focus not only on the simple function of a facility, but on the level of service or performance they provide.

Information management and analysis. An important aspect of the maintenance of active transportation facilities—and asset management—is the on-going inspection of the facilities. Careful monitoring of facility condition can lead to the timely repair and the day-to-day maintenance of the facilities. This not only protects the investment but keeps the facilities in a safer condition for users.

7. Maintenance Measures

Source: Toole Design

Figure 24. Photo. Grinding or horizontal cutting is a low-cost maintenance method that can address accessibility barriers and extend the life of a sidewalk if done properly.

This chapter summarizes the common repair and seasonal maintenance practices for pedestrian and bicycle facilities, including a summary of repair methods, and how they are used for the range of facilities. Common day-to-day seasonal maintenance methods along with recommended practices are also covered in this chapter.

7.1. When is Maintenance Necessary for Pedestrian Facilities?

Chapter 4 of this Guide outlined the issues that drive the need to maintain pedestrian facilities. The range of potential needs requiring servicing is expansive. Generally, when surface conditions degrade to a point where obstacles exist or worsening running or cross slope conditions are making routes inaccessible, maintenance should occur (figure 24). Maintenance is also necessary to respond to seasonal conditions such as snow or overgrown vegetation (see *Vegetation Overgrowth and Debris Accumulation* in section 4.3*)*. Every community should establish thresholds that trigger a response to these issues. Those thresholds should be informed by accessibility guidance using the criteria contained in the U.S. Access Board's PROWAG. Chapter 4 *Common Maintenance Issues* outlines the thresholds, standards, and inspection techniques that should be in place.

In summary, maintenance is necessary for sidewalks, curb ramps, crosswalks, signals, and paths when an acceptable threshold is exceeded in the following categories:

- Displacements.
- Surfacing issues such as cracks, holes, or surface deterioration.
- Grades and cross slopes.
- Other issues (detectable warning surfaces, curb ramp defects, etc.).
- Malfunctioning accessible pedestrian signals.

7.2. When is Maintenance Necessary for Bicycle Facilities?

Bicycle facilities face similar issues to pedestrian facilities as well as issues that are specific to bicycle facilities, all of which are also covered in chapter 3 *Overview of Maintenance Programs in the United States*. While many of the issues related to surface and infrastructure issues can be solved similarly between bicycle and pedestrian infrastructure and are described within this chapter jointly, the usage pattern and facility design features of bicycle facilities require some specific programs and processes. Most bicycle facilities are included within the street space and maintenance responsibility falls to the jurisdiction that upkeeps it. Surface conditions follow similar timelines and maintenance patterns as vehicle lanes, like street sweeping, and regular upkeep like resurfacing and patching. However, because bike lanes are usually placed at the edge of the roadway, it may be important to monitor conditions more regularly since debris from the road tends to shift towards the gutters and can build up within the bike facility.

7.2.1. Pavement

As discussed in chapter 4, pavement quality and upkeep are important to provide a usable and safe surface for people riding bicycles and other micromobility devices. Maintaining a smooth and clear pavement area improves the comfort and safety for these active transportation modes. Pavement in bike facilities also typically has a longer lifecycle than pavement in general purpose lanes because it doesn't experience the same vehicle volumes and loading. However, because bike lanes are often part of the curb-to-curb roadway space, and share the same roadway construction sections and materials, issues that start in the vehicular lanes may encroach into the bike lane, such as cracking, subsurface base issues, and potholes. Bicycle lanes also often run along the gutter line and additional issues related to drainage can impact these areas more intensely, such as pavement raveling at the joint between gutter and roadway surface, root uplift, and uneven settling of the gutter and roadway pavement creating a lip. Bike lanes placed at the edge of the roadway can also have pavement issues due to heavier vehicle loading, like at bus stops, where asphalt pavement can warp over time under the vehicle loads.

Monitoring and maintaining the quality of pavement in bicycle lanes can extend the life of the pavement. For example, sealing cracks and filling potholes prevents water infiltration into the subbase and further degradation. Additionally, roadway surface refreshes like sealcoat or chip seal

treatment can be a short-term treatment before full roadway mill and overlays. Where chip seal treatments are used, a smaller aggregate size should be considered in the bike lane to provide a smoother riding experience. When full overlays are performed on roads, the resurfacing should be placed to keep seams out of the bike lane and away from the bicycle wheel paths.

Proper drainage prevents ponding on the roadway surface, which can lead to other pavement issues such as potholing. Inlets and catch basins placed in the bike lane should be designed or retrofitted to include bike friendly grate covers, which provide adequate water collection, while providing a finer cross hatch or bars placed perpendicular to the path of travel to prevent bike wheels from being caught. Typically, streets are crowned with a water sheet flowing from the center of the roadway toward the gutter line, where water collects and flows to inlets or catch basins. When water flow lines are disrupted prior to reaching the gutter line and inlets, sediment can collect. In areas like this, traction for people riding bicycles is diminished which can cause the cyclist to fall or prevent them from stopping. Ensuring positive grades to promote drainage across and along the roadway is key to reducing locations with sediment build-up.

Street sweeping can slow sediment build-up as well as clear other debris that may migrate into the bike lane from vehicle lanes. With conventional or buffered bike lanes, standard street sweeping equipment can be used. For separated bike lanes, special equipment may need to be procured and new processes put into place. One common option is for jurisdictions to add smaller street sweeping vehicles to their fleet that can fit within the separated bike space. Designers should be aware of the minimum width requirement to accommodate these new vehicles when designing a bikeway. If special equipment is used for sweeping bike lanes, a specific policy or program may be needed to ensure that these facilities get swept regularly, since it may be done separate from regular street sweeping. Additionally, smaller sweepers may need to be transported to the site, since they may not be able to drive on larger roadways or highways to reach facilities located further from where they are stored.

7.2.2. Pavement Markings

Pavement markings delineate roadway space for people riding bikes and provides guidance for people driving. It is important that markings are visible and maintained over time, particularly on standard bike lanes where the marking is the only thing separating bikes from vehicles. Pavement markings can be broken down into three categories based on installation: long-line, short-line, and symbols or specialty markings.

- Long-line markings consist of longitudinal lines along the roadway, such as bike and vehicle lane lines or center lines and are usually installed using a striping truck.
- Short-line markings consist of gore markings (also called “hatching”) and detailed lane lines, like smaller curves, and are usually installed using hand

pushed instruments.

- Symbols and specialty markings such as bike symbols, shared lane markings, and colored pavement at conflict points require detailed installation at each location and are usually placed by hand.

Long-line markings for bike lanes, especially those adjacent to vehicle lanes should be prioritized for refreshing on a regular interval as well as after seasonal weather events.

Material choice in pavement markings corresponds to durability and longevity. Typically, long-line markings are installed with paint, which wears the fastest and fades over time, but has the lowest cost. Short-line markings and symbols are often installed with thermoplastic, which is more durable and tends not to fade. Colored pavement can also be installed using thermoplastic, MMA, or epoxy, which are all durable but have higher relative costs than paint. Though these non-paint options are more durable and less prone to fading, they can be covered overtime by grease and other roadway substances that diminish visibility, so planned refreshes are necessary.

Maintaining pavement markings, especially thermoplastic, can lead to a rougher riding experience. New thermoplastic markings installed over existing markings adds to the depth of the marking reveal, while removal of existing thermoplastic markings, usually by grinding, can damage the asphalt surface. Both create an uneven surface that riders with thinner bike tires are more susceptible to feeling. In some cases, layers of thermoplastic markings can cause discomfort or even an accessibility challenge for people using mobility aids (figure 25). Alternatives to grinding, like water blasting, are an option for marking removal but requires special equipment.

7.2.3. Physical Separation Features

Separated bike lanes are being adopted and implemented in communities around the country. Separated bicycle lanes are differentiated from other bicycle lanes as they are physically separated from motor vehicle traffic with a vertical element.

Source: Toole Design

Figure 25. Photo. New thermoplastic markings installed over existing markings can cause accessibility challenges due to depth of the marking reveal.

The vertical element can take many forms, including a raised curb median or raising the bikeway to sidewalk level completely, or a quick-build option like flexible delineator posts, planter boxes, and parking wheel stops. Maintenance concerns mostly occur with quick-build elements because they tend not to be continuous and individual objects can be struck, broken, or dislodged. Proper placement and installation of these elements can help to prolong their life; noteworthy practices include centering them in the buffer, making sure they are placed to be outside the turning path of vehicles at intersections and driveways, and installing them at a consistent frequency to discourage vehicles from driving into or through them. Foundation and base application can also be a factor in their longevity, with options like epoxy glue, bolt down, and cored bases all providing benefits and drawbacks that require consideration.

Replacement of broken or dislodged vertical elements is often an inevitable attribute of their use. Jurisdictions should create a replacement schedule to maintain the integrity of their existing bike network. Objects like flex posts, cones, or plastic barrels should be examined/replaced significantly more frequently than more permanent features such as jersey barriers, planters, and concrete curb medians. Agencies should consider the durability of vertical elements, as well as the frequency at which they will be struck. It can be more efficient if replacements are done systematically (e.g., by neighborhood, zone, or corridor), since often it can only be a few replacements needed per roadway. Using a consistent vertical element across the bike network can also ensure that inventory will be in stock for replacement rather than needing to go through special procurements each time a replacement is needed.

Bikeway vertical elements often include a reflective feature that is important to maintain, especially for nighttime and low-visibility conditions like rain or fog. Replacement may be necessary over time, but cleaning can also remove build-up. Curbs and other fixed elements painted with retroreflective paint should be regularly repainted or cleaned.

Planter boxes used as bikeway vertical elements or within pedestrian facilities such as curb extensions have specific maintenance needs. Regular watering is needed since usually planter boxes are not connected to irrigation systems. Self-watering planters can reduce the frequency of watering. Maintaining the vegetation and replanting seasonally are necessary to keep the planter box aesthetically pleasing and plants out of the bikeway and roadway. Planter boxes are often kept in place with their own weight or are bolted down or braced by a curb stop. If struck, they can become dislodged or tip over, blocking part of the bikeway or adjacent lane. It is important to monitor planter boxes regularly to ensure they are kept in place and adjusted as necessary.

7.3. Maintenance Repair Methods for Sidewalks and Paths

Maintenance practices involving active transportation infrastructure can be categorized into three main groups: temporary measures; short-term measures; and long-term measures. Temporary measures are taken to address locations with trip/fall risks and last less than a year. Short-term measures typically last one to five years and are intended to extend the life of the sidewalk segment until it is replaced. Long-term measures include sidewalk or path replacement. When sidewalks are replaced as part of a street project, the work may be considered higher order than simple maintenance, thus falling under the definition of alterations under the ADA.

Temporary Maintenance Measures

Temporary repair measures may include wedging or patching a sidewalk with asphalt or a quick-mix cement. The temporary repair should alleviate the most hazardous concerns until a more permanent repair is performed later.

Short-Term Maintenance Measures (Repairs)

Several maintenance techniques will last one to five years for sidewalks and paths. These include patching (section 0), wedging (section 7.3.3), grinding and horizontal cutting (section 0), mud-jacking (section 7.3.5), and overlays.

Long-Term Maintenance Measures (Replacement)

The primary long-term maintenance technique is sidewalk replacement. However, many communities have had success with grinding (section 0) and mud-jacking (section 7.3.5) as longer-term solutions. Horizontal cutting (section 0) is a newer technique that is like grinding and should have the same success rate. An issue to consider regarding grinding, mud-jacking, and horizontal cutting as longer-term solutions is that the underlying problems associated with these fixes may continue to be a concern. For example, if a sidewalk sags and mud-jacking is used to correct the problem, the original unstable base may cause continued sagging. Also, some repairs will degrade the overall quality of the sidewalk. For example, grinding and horizontal cutting may be a lasting solution to a location with a trip/fall risk, but may leave one or two sidewalk panels with a cross slope of greater than 2 percent or with warped transitions between panels.

The following pages present common maintenance responses to on-going infrastructure problems along with recommendations for their use. Not every community will have the same toolbox or use maintenance measures in the same way. Much depends on the current stock of facilities in a community. For example, brick sidewalks will require different repair methods than concrete. Additionally, many communities are focused on sidewalk and path preservation. Different treatments and standards are used for preserving pavements versus taking corrective measures.

Source: FHWA

Figure 26: Photo. Missing areas of concrete have been marked for repair (FHWA, 2013a).

Source: FHWA

Figure 27: Photo. The areas have been temporarily repaired with asphalt patches. Note the patching material overlaid on the concrete extending beyond the hole (FHWA, 2013a).

7.3.1. Patching

Patching is a common and often effective repair when small sidewalk corners have broken off or minor gaps have formed between sidewalk panels (figure 26). It is temporary and most often done in asphalt (figure 27). When a concrete filler is used, it is best to undercut the hole to allow the patch to bond more permanently with the existing sidewalk. As seen in table 4, asphalt patching (as well as wedging) leaves a lip that is at least as significant as the size of aggregate that is used in the material. Choosing asphalt as a patching and wedging material is seldom done in the southwest parts of the United States because of the incompatibility of the material with high sustained temperatures.

Table 4. Patching (FHWA, 2013a).

Category	Description
Material:	Asphalt, but sometimes a concrete-type filler (mortar or composite material consisting of vinyl or epoxy mix).
Most suitable:	Small holes of less than 1 ft.
Least suitable:	Large holes or large surface areas.
Durability:	Varies significantly based on repair method, material, depth of hole or crack, and underlying stress placed on the sidewalk. Generally, lasts less than several years (FHWA, 2019b).
Characteristics:	Hot mix asphalt is easy to use as a filler but has a very short life. Cold mix asphalt is an even more temporary repair material most often only suitable for a winter to spring seasonal repair. Mortar or concrete-type filler has a longer life but is time-consuming to apply and is rarely used by municipalities (FHWA, 2019b).
Recommendations:	Suitable as a temporary repair. Highly recommended as a quick-response corrective measure when tripping hazards are reported until a more permanent repair can be made.
Technique:	Clean hole extremely well to provide the best bond. When using asphalt or a concrete-type filler, it is best to square off the sides of the hole. For concrete-type filler, undercutting the sides of the hole is recommended and will elongate the life of the patch. A bonding material or concrete adhesive such as an acrylic resin—a milky fluid—can be used to help with bonding a concrete filler or a mortar mix to the existing concrete. The material should be leveled-off and tamped down for asphalt and finished smooth using a trowel for concrete. If a large hole is filled for a sidewalk connected to a driveway apron and a concrete patch is used, the mix should contain aggregate to give the patch more compact strength because of vehicle loads crossing on top of the sidewalk.

7.3.2. Cracking Repairs

Cracking of concrete sidewalks can take many forms. Because of the deformation forces constantly at work below the grade of sidewalks and paths (discussed in Overview of *Maintenance Programs in the United States*), expansion joints are used to control cracking; but this is only partially effective. Common types of cracks are edge, alligator, and longitudinal cracking. Alligator cracking is characterized as typically fine, longitudinal hairline cracks running parallel to each other with no or few interconnecting cracks. These are very difficult to treat with a filler unless a laborious routing procedure is used. Longitudinal cracking occurs along the length of the sidewalk, usually in the middle third of the sidewalk, and can extend through several expansion or control joints. Transverse cracks occur across the width of the sidewalk due to nonuniform subgrade compaction, especially where sidewalks are subjected to high vehicle loads such as driveways across sidewalks. Longitudinal and transverse cracks are wider and thus somewhat easier to rout and fill than alligator cracking.

Evaluating the type of cracking and the cause will determine the success rate for crack repairs (table 5). If a sidewalk has alligator cracking because of poor subbase drainage or serious structural damage, crack sealing is not a lasting option. Sealants used for other forms of cracking should be thought of as only preventive in nature. Although new sealants have strong bonding power, they will not hold two sidewalk segments together; they are only effective in keeping water and moisture from descending into the void. If cracks are currently creating a location with a trip/fall risk or will very soon, sidewalk replacement is a better option. Under the best of scenarios, sealing cracks provides an agency with time to come to a more permanent solution and helps defer more costly repairs.

Source: FHWA

Figure 28. Photo. Cracking can cause trip hazards as well as hazards for bicyclists and wheelchair users. This crack is on a shared use path (FHWA, 2013a).

Asphalt crack (figure 28) maintenance is like concrete maintenance but uses different material types that adhere to the asphalt better. Asphalt crack filling and crack sealing both fill an existing crack to prevent water or other sediment from infiltrating the pavement and base materials. Depending on the amount of movement the cracks exhibit via expansion and contraction, different materials and treatment should be considered.

Table 5. Cracking (FHWA, 2013a).

Category	Description
Material:	Polymer-modified and asphalt rubber sealants for concrete and asphalt sidewalks and paths. Also, mortar mix for larger cracks in concrete sidewalks.
Most suitable:	Cracks that are 0.25 inches or greater but less than 0.5 inches.
Least suitable:	Large cracks of more than 0.5 inches. Cracks with widths greater than this create accessibility concerns, so if the crack material settles or pops out, the problem should be addressed promptly.
Durability:	Varies significantly based on repair method, depth of crack, and underlying stress placed on the sidewalk. Generally, lasts a few years and will only prevent water infiltration.
Characteristics:	Crack sealants themselves can last years, however, their efficacy is based not only on the material life, but how well they hold their bond to the concrete or asphalt. Sealants that are manufactured today for roadway applications are highly-engineered products formulated to perform in a range of climatic conditions—they need to remain solid in the summer and still be flexible in freezing temperatures.
Recommendations:	Crack sealing and repair is rarely used by agencies for sidewalks. However, crack sealing is more commonly used for asphalt paths. Costs associated with routing out cracks to prepare them for mortar or a sealant is higher cost and temporary especially compared to the cost of sidewalk replacement efforts.
Technique:	Cracks are commonly routed to accept a sealant or a masonry material, but the cracks must be completely clean and dry when a sealant or masonry material is used. Two techniques are used. For deep cracks, a backer rod may be necessary. For sealants, the material is simply applied to the clean, dry, and routed crack. The other way, for use with concrete only, is to undercut the crack and use a concrete or masonry material. This will help make a structural bond that *could* aid in the shifting and uplifting of the concrete pieces. Despite the laborious nature of these repairs, most often these repairs are only temporary and are recommended only as such.

Source: FHWA

Figure 29. Photo. Wedge has been placed to mitigate the trip/fall risk caused by a raised sidewalk slab. Note the extensive and appropriate ramping of the wedge (FHWA, 2013a).

Source: FHWA

Figure 30. Photo. A small wedge may still create an obstruction or be difficult to navigate in a wheelchair. This wedge had deteriorated over time (FHWA, 2013a).

7.3.3. Wedging

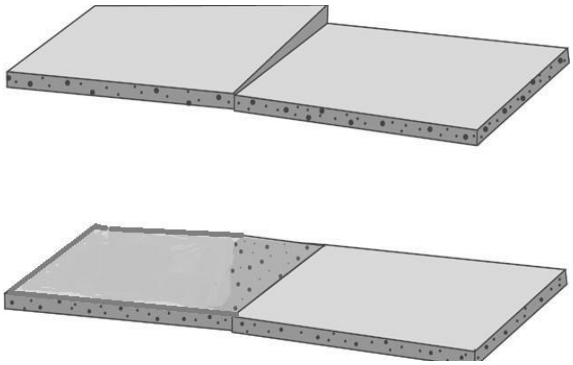
Wedging entails the placement of an asphalt or concrete filler in advance of a heaved or displaced section of a sidewalk or shared use path to essentially provide a ramp and remove a location with a trip/fall risk (table 6). This is most often applied where there is a formed or saw joint in a concrete sidewalk and the concrete has uniformly lifted at the joint. If done, it can be made ADA accessible. The wedge depicted in figure 29 is just a few days old, while the wedge shown in figure 30 is likely to be several years old with significant deterioration illustrating the short-term nature of this technique. Also note the gradual grade with the wedge in figure 29 is consistent with a grade of 5 percent or less and in keeping with the PROWAG guidelines for accessible pedestrian routes (U.S. Access Board, 2023).

Table 6. Wedging (FHWA, 2013a).

Category	Description
Material:	Asphalt, but sometimes a concrete-type filler (mortar or composite material consisting of vinyl or epoxy mix). Cold asphalt mix is applied as a very temporary seasonal repair because the material often lacks adequate bonding capabilities.
Most suitable:	For temporary repairs when sidewalks lift by more than 0.5 inches to less than 2 inches.
Least suitable:	As a long-term repair, when sidewalks displace by less than 0.5 inches, or when the sidewalk displacement is more than a couple of inches. This will require a very long ramp (2 ft or greater) leading to the displacement.
Durability:	Varies somewhat on repair method, material, how well the asphalt material is compressed (hot mix), any continued shifting of the sidewalk pieces, and winter maintenance (especially plows mounted on pick-up trucks running over the wedge).
Characteristics:	Asphalt is easy to use as a wedge filler but has a very short life and it will be noticeable in appearance because the material has a texture and color that will not match concrete. Cold asphalt mix is an even more temporary repair most often only suitable for a winter to spring repair. Mortar or concrete-type filler has a longer life but is time-consuming to apply and has a comparatively long set-up time.
Recommendations:	Suitable as a temporary repair. Highly recommended as a quick, corrective measure when tripping hazards are reported until a more permanent repair can be made later in the season or within a year depending on the slope and integrity of the wedge.
Technique:	The sidewalk area to be filled with the wedge material should be cleaned of any loose material. Often a stiff broom or blower is used to clean debris from the sidewalk. Level off and tamp down for asphalt hot mix. A mechanical tamper should be used, but if the wedge is very small in length (less than 1 ft), a hand tamping tool can be used.

Source: FHWA

Figure 31. Photo. A raised sidewalk block has been ground down to provide a smoother transition (FHWA, 2013a).



Source: FHWA

Figure 32. Graphic. The diagram shows how an unevenly raised slab can be ground to provide a smoother transition (FHWA, 2013a).

7.3.4.Grinding and Horizontal Cutting

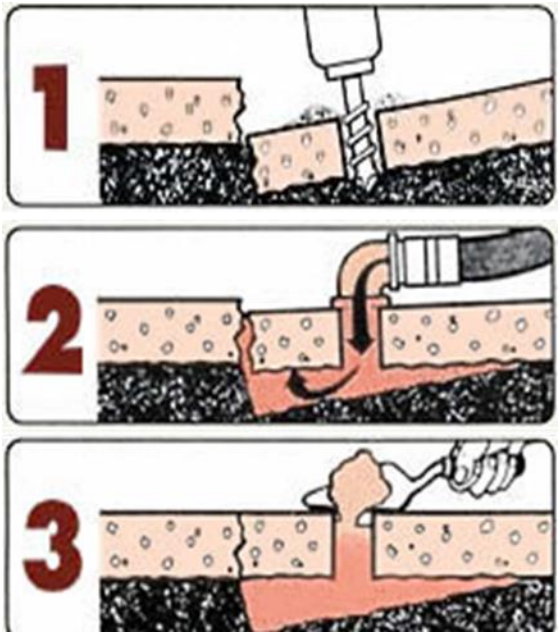
Another set of treatments that can be used for heaved concrete sidewalk and path segments is grinding and cutting (table 7). Displacement of concrete sidewalks and paths will often occur at the joints. More and more communities are using grinding and cutting methods to make more permanent repairs to these types of displacements.

Grinding and horizontal cutting are similar treatments. New cutting technology allows tighter tolerances with horizontal cutting saws. Figure 31 shows a horizontal cut at a sidewalk panel displacement at a joint. Note that the panel has uniformly lifted allowing a straight cut across the width of the panel. The panel being cut has not settled from one side to the other, just lengthwise. Therefore, there is no change in the cross slope, making cutting or grinding an appropriate treatment for this sidewalk displacement. Figure 32 shows uneven settling, so grinding or cutting will eliminate the trip/fall risk but will likely leave a warped condition. Grinding and cutting for displacements between 0.25 inches and 0.5 inches are acceptable per PROWAG guidelines (US Access Board, 2023). If over 0.5 inches up to 6 inches, the maximum slope resulting from the grinding should be a maximum of 1:12 (8.3 percent). Changes in level greater than 6 inches should comply with the PROWAG guidance for ramps (U.S. Access Board, 2023). For instance, if the heaved sidewalk segment leaves a displacement of 0.75 inches at the joint, the grind or cut would have to taper back approximately 9 inches for the repair to be ADA compliant and considered permanent.

Grinding is also done to asphalt. On paths and sidewalks, root pop-ups and minor heaves are often ground down.

Table 7. Grinding and horizontal cutting (FHWA, 2013a).

Category	Description
Material:	Grinding can occur with either asphalt or concrete, but is much more common with concrete. Horizontal cutting occurs almost exclusively with concrete.
Most suitable:	For permanent repairs when sidewalks displace by 0.25 inches to 0.5 inches or for a temporary repair when sidewalks displace between 0.5 inches and 1 inch. Repairs 0.5 inches or less can be provided at a one-to-one taper.
Least suitable:	As a long-term repair when sidewalks displace by more than 0.5 inches. Any displacement of more than 0.5 inches up to 6 inches in height will require a longer ramp at 8.3 percent.
Durability:	The aggregate in the sidewalk is exposed and the thickness of the slab reduced, but the sidewalk and cut will still maintain its integrity. Repairs done appropriately and expertly can be considered permanent fixes.
Characteristics:	A horizontal cut will leave the appearance of a very smooth cut surface with exposed aggregate. Grinding will leave a much rougher texture and will show the grinding pattern of the apparatus used.
Recommendations:	Suitable as a temporary repair and even permanent repair based on the size and angle of displacement. Highly recommended as a permanent corrective measure when the displacement is between 0.25 inches and 0.5 inches. The sidewalk being ground down should be maintained at 2 percent or less cross-slope. Care should also be taken not to grind concrete slabs past minimum recommended thickness so as not to compromise the slab's integrity.
Technique:	This is a machine-based operation. There are numerous pieces of equipment on the market that will grind and cut, but the technique is straightforward—grind the lip of a heaved section down or use a specially designed concrete saw to cut horizontal to the grade of the sidewalk to lop off the offending sidewalk lip.



Source: FHWA

Figure 33. Graphic detail of how the mud-jacking process works (FHWA, 2013a).

Source: FHWA

Figure 34. Photo. These panels were mud-jacked more than 20 years ago and are still in good condition, showing that if done properly, this can be a permanent fix (FHWA, 2013a).

7.3.5. Mud-jacking, Concrete Raising, or Slab-jacking

This repair method lifts concrete sidewalk slabs back to their original position by pressure injecting cement or noncement material under the sidewalk (table 8). Holes are drilled through the slab and grout is injected to raise the concrete slab or to fill the voids under them (figure 33). It is important to identify the reason for the voids so that mud is not inadvertently pushed into storm sewers or other utilities. Although it is less costly than replacement, it is only effective on sunken sidewalks. The photo in figure 34 of a mud-jacked sidewalk segment in Madison, Wisconsin, has maintained compliance to standards for more than 20 years.

Table 8. Mud jacking (FHWA, 2013a).

Category	Description
Material:	Mud jacking is done only to concrete sidewalks and paths. A concrete type "mud" or mixture is used as the material injected under the concrete slabs.
Most suitable:	For sunken sidewalk segments where confidence is high that the slabs will not simply sink again.
Least suitable:	When the sunken sidewalk segments have a short life and will need to be replaced soon anyway or the underlying structural problem cannot be counteracted.
Durability:	Repairs done appropriately and expertly can be considered permanent fixes.
Characteristics:	Small holes are detectable after mud jacking, otherwise the repair leaves the sidewalk appearing at a constant running grade and cross slope matching adjacent and untouched sections.
Recommendations:	Suitable as a long-term repair, although typically mud jacking is relatively expensive, often approaching the cost of sidewalk replacement, so mud jacking older sidewalk segments should be avoided unless communities can use this technique at a very modest cost. Recommended as a permanent corrective measure when the sidewalk is sunken by more than 0.5 inches and the panel can be lifted back into place with the correct side slope. Care should be taken to identify the cause of settlement and ensure that the issue has been addressed prior to mud jacking.
Technique:	The concrete sidewalk slab is lifted back to its original position by pressure injecting a concrete-like material under the sidewalk. Holes are drilled through the slab and the liquid material is injected to raise the concrete slab or to fill the voids under them. It is also possible to hydraulically lift sidewalk segments with a series of jacks.

7.3.6. Sidewalk and Path Replacement

Although many repairs can provide temporary solutions to sidewalk and path issues, especially obstructions that pose a trip/fall risk, at some point it becomes necessary to completely replace sidewalks or path sections (panels). This involves the entire removal and replacement of sidewalk sections or small path segments. When individual sidewalk sections or perhaps even a couple panels are being replaced at a time, this activity is considered a maintenance effort (table 9).

It is imperative that agencies understand the underlying causes of sidewalk failure. Section 4.2.1 *Infrastructure Issues Leading to Increased Maintenance* identified the deformation forces that cause sidewalk failures. Many of the failures for sidewalks are caused by poor subgrade or tree roots. Without addressing the underlying issues, the sidewalk being replaced will have a shortened life.

Table 9. Sidewalk and path replacement (FHWA, 2013a).

Category	Description
Material:	The replacement material used should match the material used for the connecting sidewalk or path segments. Replacement material for most sidewalks is concrete and asphalt for paths.
Most suitable:	Replacement is the best and longest-term repair solution for displaced sidewalks and paths. Although temporary repairs can be used to delay sidewalk and path repairs, only replacement ensures that the issues with displaced sidewalks are addressed and more easily permits the use of appropriate grades for the cross-slope and running slope of the sidewalk or path.
Least suitable:	When simple repairs, such as grinding and horizontal cutting, can result in significantly elongating the life of the sidewalk or path and are considered effective.
Durability:	Replacement of sidewalks and paths are considered permanent fixes.
Characteristics:	Smaller segments of sidewalk, path, or curb ramps removed and replaced with new concrete or asphalt (only concrete for curb ramps).
Recommend-ations:	The complete replacement of material for sidewalks and paths allows the best possible result for meeting standards and for providing the longest lasting repair. It is recommended where sidewalks and paths cannot be repaired through less expensive means, or the displacement of the sidewalk or path is so significant that replacement is the only feasible measure. Replacement is also recommended where smaller defects may appear (that may not present a trip/fall risk such as surface cracking), but a circulating sidewalk replacement program is focusing on that area of the community for that year.
Technique:	The damaged sections are removed either by hand or by a small skid-steer loader after they are broken up by a jack hammer. For projects where many concrete sidewalk pieces are being removed, a heavy piece of equipment is used which makes use of a strong, telescoping boom with an attached digging bucket that can lift individual sidewalk panels from the sidewalk grade. After removal, steel or wooden forms are pinned in place. The existing grade is adjusted, and, in some cases, additional fill is used to level off the grade. Tree roots are very carefully cut if absolutely necessary. The base surface is mechanically tamped if fill is added (with sidewalk replacement programs, the sections of sidewalk removed are too small to make use of a roller). Concrete is then placed into the grade between the two forms and the existing functional sidewalks. A strike-off board is used to level off the concrete from one existing sidewalk to the other where the old sidewalk exists. Finishers trowel the surface of the concrete to push the aggregate from the surface and to move more of the mortar or “slurry” to the top. This provides for a smooth finish and aids in the final step of finishing which entails the use of a broom to finish the concrete with light brush marks made perpendicular to the direction of pedestrian travel. When asphalt is used, the removal is similar, but if the size of the removed section is limited, the replaced pavement can be completed by hand using shovels and an asphalt lute to level the asphalt. A hand tamping machine or roller is used to compact the asphalt. If the segments are longer, as is often the case with paths, paving equipment is used. This provides a far superior surface. Dump trucks are backed to the paving equipment which has a hopper for the asphalt. When paving equipment is being used, rollers will be used to compact the material.

Source: FHWA

Figure 35. Photo. Damaged pavers have been repaired with asphalt to alleviate a trip/fall risk (FHWA, 2013a).

7.3.7. Bricks and Pavers

Bricks and pavers (figure 35) are materials which are considered a "segmental material" because each paver is separate and is often not tied or bonded together the way a concrete slab is formed and functions (table 10). When there is an underlying deficiency in the subgrade, it is not unusual to have just one or two bricks become displaced, creating a localized trip/fall risk. In contrast, concrete sidewalks might be able to withstand smaller more localized pressures until the entire slab faults or cracks. Gaps between bricks and pavers might also cause problems in greater frequency than with concrete and asphalt sidewalks simply because of the greater number of potential gaps that exist.

Bricks and pavers should be initially installed so they are easy to reset or replace. Of importance from an accessibility standpoint, bricks and pavers can cause vibrations that are painful for pedestrians who use mobility aids such as wheelchairs. Again, the design of the sidewalk can reduce this issue based on the pattern of the bricks/pavers, the edges used for the bricks/pavers, and the joint width that is used. Because of these issues, when the time has come for sidewalk replacement, many communities are replacing bricks and pavers with concrete and then using bricks for sidewalk borders.

Table 10. Bricks and pavers (FHWA, 2013a).

Category	Description
Material:	Bricks are made from fired clay and most pavers are made from a concrete mix but can also be made from clay. Often, bricks and pavers can be salvaged and replaced, and this is a common spot maintenance practice for brick and paver sidewalks. Occasionally, asphalt is used to temporarily fill a gap, but this is not considered a permanent solution.
Most suitable:	Bricks and pavers are used in certain environments for their aesthetic appeal. The best repair for minor displacement of one to a few bricks or pavers is to replace or reset them. This is one of the major benefits cited for brick and paver maintenance. The grade will have to be adjusted before the material is replaced.
Least suitable:	Spot replacement and adjustment of bricks and pavers is not feasible when the underlying grade is impacted by tree roots. Deformation forces can also impact large segments of brick or paver sidewalks necessitating a larger scale repair.
Durability:	Repairs done appropriately and expertly can be considered permanent fixes but are very dependent on the stability of the subgrade and avoidance of tree roots.
Characteristics:	Bricks and pavers are replaced or reset. Temporary measures can include asphalt ramps and wedges.
Recommendations:	The replacement of bricks and pavers is strongly recommended when they become an obstruction. When trip/fall risks are reported, the community may respond with a temporary fix such as an asphalt wedge or a patch if the brick or paver is extracted or missing. When bricks and pavers must be replaced, the subsurface should be regraded. In other situations, vegetation may need to be properly controlled. Tree roots will often lift bricks and pavers. The preparation of an adequate base course is one of the most important aspects of installing and replacing bricks and pavers, and future maintenance needs can be reduced with keen attention to this construction detail. Repair of bricks and pavers—even the small maintenance tasks—require experienced workers. It is not recommended that untrained laborers begin making these types of repairs without proper training.
Technique:	Small spot repairs can be made by resetting the material in place. This is advantageous for repairing trip/fall risks. Larger areas can also be replaced, but the effort becomes much more involved. However, the larger the effort becomes, the easier it is to address subbase issues. Another temporary measure is the use of asphalt as a patch or wedge.

Source: Toole Design

Figure 36: Photo. Curb ramp maintenance is critical to enabling accessibility.

7.3.8.Curb Ramp Maintenance and Repair

Curb ramps or other sloped areas are required at every intersection where a newly constructed or altered pedestrian walkway crosses a curb or other barrier, such as a raised median, or where a new or altered street, road, or highway intersects with a pedestrian walkway, to allow access to crosswalks for people with disabilities (figure 36) (28 CFR 35.151(i)). Once curb ramps are in place, their maintenance is critical to enabling accessibility (table 11). This section discusses curb ramp repairs while section 7.7 *Seasonal Maintenance* provides guidance on seasonal maintenance of curb ramps.

Curb ramps should meet the same general thresholds for repair as sidewalks. Complicating the need for repairs for curb ramps are tight tolerances for running grade and cross-slope (see section 7.4 *Maintenance of Crosswalks*). Curb ramps built to the maximum slopes can easily fall out of compliance with just a slight displacement. The repair methods for sidewalks are generally not applicable to curb ramps. Replacement is the preferred solution to provide a planar surface with a uniform running grade and cross slope.

Detectable warning surfaces at curbs ramp also must be properly maintained (28 CFR 35.133(a)). Depending on the initial type of detectable warning surface put in place, further annual maintenance may be necessary. In many parts of the United States where the truncated dome panel will not be subjected to plow blades or inclement winter weather, a viable short-term repair for the panel is to fasten or refasten them with glue or screws. This can be done with little effort and may hold up until the curb ramp is reconstructed.

Table 11. Curb ramp maintenance and repair (FHWA, 2013a).

Category	Description
Material:	Replacement material for curb ramps is concrete with truncated domes as the detectable warning surface. Occasionally, the curb ramp may have a brick or paver border.
Most suitable:	Curb ramp replacement is the best and longest-term repair solution for curb ramps. Although temporary repairs are often necessary, only curb ramp replacement ensures the best method of installing appropriate grades for the curb ramp. It also allows for the inclusion of the latest forms of detectable warning surfaces.
Least suitable:	When simple repairs, such as grinding and horizontal cutting, can result in significantly elongating the life of the curb ramp and the current detectable warning surface is in place and considered effective.
Durability:	Replacement of curb ramps can be considered permanent fixes.
Characteristics:	Curb ramp is removed and replaced with a new concrete curb ramp.
Recommendations:	Given the need to create a very consistent and usable transition between a sidewalk and a street crossing, replacing deficient curb ramps with new replacement curb ramps is often the best long-term solution. This may involve replacing the level landing and a few adjacent sidewalk panels to bring the curb ramp into ADA compliance.
Technique:	The damaged curb ramps are removed either by hand or a skid-steer loader after they are broken up. A heavy piece of equipment that makes use of a strong, telescoping boom attached to a digging bucket can also lift individual curb ramps from the grade. Steel or wooden forms are pinned in place. The existing grade is adjusted, and, in some cases, additional fill is used to level the grade. The base surface is mechanically tamped if fill is added. Concrete is poured into the grade between the two forms and the remaining pieces of concrete (back of gutter and the level landing). A strike-off board is used to level the concrete as the void is filled where the old curb ramp existed. Finishers often insert premanufactured truncated domes into the fresh concrete and finish it in place or use specially made forms to press in the domes (this method has created widely questionable results). Finishers trowel the surface of the concrete to push the aggregate from the surface and to move more of the mortar or “slurry” to the top. This provides for a smooth finish and aids in the final step of finishing which entails the use of a broom to finish the concrete with light brush marks made perpendicular to the direction of pedestrian travel down and up the curb ramp.

Source: Toole Design

Figure 37. Photo. Rubber pavers provide a flexible solution for maintaining accessibility while promoting mature tree health.

7.3.9. New Materials

Pavers or surface treatments made from recycled rubber and plastic are being used more frequently by agencies as a substitute for traditional sidewalk pavements in certain applications (figure 37). The pavers option are modular systems that have uniform and tight-fitting joints or are linked together with tabs and are pinned in place. Alternatively, a uniform surface treatment is poured in place and formed, allowing for unique or site-specific placement that may not be accommodated by pavers. These treatments are swept and cleaned like conventional concrete sidewalks and if porous features are incorporated or desired, additional maintenance requirements may be needed, which are discussed below.

As a maintenance measure, some communities have been attracted to these flexible paving options for applications around trees where tree roots have caused concrete sidewalks to heave. They are half the depth of concrete sidewalks and can be cut or formed to fit around trees. They are typically more expensive than concrete in most applications. One of the additional maintenance benefits of the paver option is that they can be reset just like other pavers. If they begin to pitch because of tree roots or subbase issues, the base can be regraded, or the tree roots trimmed, and the pavers reset. Additionally, if a panel needs to be replaced, a new one can be clipped and pinned into place. Manufacturers of these products have detailed specifications and directions on

how the base course should be prepared for the pavers and how the pavers should be installed. Several of the manufacturers offer 5-year warranties but indicate that with proper care, their products can last far longer than that.

Other products include those that increase permeability of walkways. This includes both porous concrete, asphalt, and flexible paving as well as assorted pavers products that are either porous themselves or divert water to gaps in the pavers. They have unique maintenance requirements such as annual vacuuming to clean out the voids in the material that can be filled with fine material such as silt or sand. Some of these new surfacing types provide good water infiltration to feed roots. These pavement types are covered in more detail in chapter 8 on new construction practices to reduce maintenance.

7.4. Maintenance of Crosswalks

Marked crosswalks indicate locations for pedestrians to cross. Crosswalks signify to motorists where they need to yield to pedestrians; however, it is important to note that drivers have to stop/yield to pedestrians in both marked and unmarked crosswalks. Crosswalk markings are often installed at signalized intersections, prominent mid-block locations, and other selected locations. It is critical that crosswalks be visible to motorists, particularly at night. Ladder, longitudinal bar, and bar pair crossings using wide bars of retroreflective material are the most visible. This also places a greater maintenance responsibility on agencies in charge of maintaining crosswalks.

The focus of this section is on the maintenance of crosswalk markings; however, it is important to note that maintenance should include the actual street surface where crosswalks are located, and not just the pavement markings. Crosswalks represent the accessible path within the street and require a higher level of maintenance than the surrounding roadway because pedestrians are less tolerant of defects than motorists. A minor pothole may not present an issue for most motorists but can present a significant issue for pedestrians. Crosswalks should meet the same accessibility surface requirements as sidewalks and paths. Surface defects in crosswalks should be noted when crosswalks are inspected or remarked, and repairs should be completed quickly.

7.4.1. Crosswalk Marking Material

Agencies use a number of different materials for marking crosswalks, including paint (water- or oil-based), epoxy, polyurea, thermoplastic, and preformed marking tape. Often these marking materials are divided into two categories, with paint being considered nondurable and all other markings considered durable. Transportation agencies weigh several factors when determining which marking material is most appropriate including costs, durability, retroreflectivity, friction coefficient (avoiding slip/fall risks), and whether the material can be applied using existing agency labor and equipment. Most communities contacted for this Guide use thermoplastic, which is recommended for its longevity (FHWA, 2013b). Many also frequently use paint, particularly on

existing roads or when there is an immediate need (FHWA, 2013b). Epoxy was also mentioned by several communities. Thermoplastic and epoxy markings are used most often on repaving projects (FHWA, 2013b).

7.4.2. Relative Comparison of Crosswalk Marking Materials

FHWA's MUTCD includes provisions for *pavement marking retroreflectivity* (FHWA, 2023A; MUTCD Section 3A.05). Table 12 displays characteristics of four common crosswalk marking materials. It should be noted that costs vary widely across the country and the ranges provided are approximate.

Table 12. Relative comparison of crosswalk marking materials.

Material	Relative Cost $=Low $$$$=High	Lifespan (months)	Retroreflectivity ⚡=Low ⚡⚡⚡=High
Paint	$ Low	3 – 24	⚡ Low
Epoxy Paint	$$ Medium	24 – 48	⚡⚡ Medium
Thermoplastic (sprayed)	$$$ Medium-High	48 – 72*	⚡⚡ Medium
Preformed Tape	$$$$ High	36 – 96*	⚡⚡⚡ High

Note: Estimates based on minimum standard crosswalk treatment and updated to reflect 2013 comparative costs (Cuelho et al., 2003; Montebello and Schroeder, 2000).

* Thermoplastic and tape have shortened lifespans in snowy areas where they are often damaged by snowplows. Inlaid thermoplastic or preformed tape may last significantly longer than standard surface applications.

7.4.3. Crosswalk Marking Considerations

Life-Cycle Costs

While unit costs for crosswalk marking materials vary considerably across the country, given the durability issues discussed above, life-cycle costs are an essential consideration. A National Cooperative Highway Research Program (NCHRP) Synthesis 306: *Long-Term Pavement Marking Practices* provides cost comparisons and a life-cycle cost table (Migletz and Graham, 2002). In general, thermoplastics provide a life of two to three times that of paint for long line markings, however, costs averaged almost five times that of paint (epoxy markings had a life of two to three times that of paint but had a cost of four times that of paint) (Migletz and Graham, 2002). Thus, when the life-cycle cost was calculated,

Source: FHWA

Figure 38. Photo. Old crosswalk markings removed for new crosswalk marking tape (FHWA, 2013a).

paint was half the cost of thermoplastic. It is important to note that costs and durability ranged significantly in Migletz and Graham's (2002) study. There is a clear trade-off between the durability of thermoplastic and the lower cost of paint. Communities that use paint to mark crosswalks indicated that they have to repaint crosswalks (figure 38) two to three times per year, whereas thermoplastic markings typically last two to three years.

Agencies should perform life-cycle cost analysis for different materials based on their local product costs, labor costs, the cost of diverting traffic, and real-world observations of product lifespans, given local maintenance conditions. The following factors will also affect such a local analysis.

Traffic

Traffic has a significant impact on the longevity of crosswalk markings. Also, frequently repainting crosswalks in high-traffic areas incurs traffic control costs that agencies should consider as an important cost factor. Products that may be more expensive up front may be less expensive over time if they need to be replaced less frequently. Communities can minimize the impact of traffic by spacing the bars of a crosswalk ladder design or a continental design so that the wheel wear occurs between the bars.

Equipment and Labor

Costs will be dramatically affected by the availability of equipment and labor. For instance, if thermoplastic equipment has already been purchased by an agency and in-house labor is trained and available for crosswalk marking, costs will be minimized. For communities that do not invest in such equipment, some applications of markings such as applying tapes (cold or heated) may be lower cost. Another equipment issue is whether a community commonly uses snowplows. Thermoplastic and preformed tape may not be appropriate in areas using snowplows unless the markings are inlaid in the pavement, which makes it less likely that a plow blade will pull the material off the street.

Pavement Type and Previous Markings

When considering the type of crosswalk marking material, pavement type—asphalt or concrete—is a consideration along with the type of material that was previously used as the marking material if an agency is simply remarking the crosswalk.

One of the benefits of marking replacement with paint is that the new paint can be sprayed on top of the old paint after the surface is cleaned and any flaking paint is removed. Liquid thermoplastics can generally be placed over worn paint or liquid-applied thermoplastic markings. However, liquid thermoplastics cannot be easily applied over tapes unless at least 70 to 90 percent of the former marking material has been removed through grinding or water blasting.

Similarly, tapes cannot be reapplied over existing tapes unless a minimum of 80 to 95 percent of the former tape has been removed through grinding or water blasting. The performance of marking material is significantly affected by application over existing materials; it is important that agencies talk to vendors about this issue.

Crosswalk Marking Material Selection

Santa Monica, California

In early 2012, the City of Santa Monica staff conducted an inspection of crosswalk materials along the major streets in the City. Conventional thermoplastic markings appeared to deteriorate much faster when applied on concrete streets compared to asphalt applications. Although preformed thermoplastic tape cost on average 30-percent more for the City than the conventional thermoplastics, the City decided to use the newer materials for concrete intersections. City staff developed a plan to restripe crosswalks on concrete using preformed thermoplastic while restriping asphalt crosswalks with the conventional thermoplastic. By using this approach, the less expensive thermoplastics could be used on asphalt while the more expensive preformed thermoplastic tapes will be used on concrete where increased longevity is expected to outweigh the additional costs (FHWA, 2013a).

In new applications on asphalt surfaces, agencies typically use inlay tapes, hot-applied thermoplastics, or high build grade applications of paint-based markings for the markings to be visible. Markings generally last longer on asphalt than concrete, especially for a relatively new surface. Tapes can also be rolled in when new asphalt is being rolled; this is generally an effective way of improving the durability of the tapes during the winter and plowing applications. For new concrete surfaces, marking applications are somewhat more limited and preparation of the surface is even more important than asphalt. Grooving concrete for inlay tapes is higher cost but provides superior durability during the winter months where snowplows are in use.

Many agencies use higher cost inlay markings on new street, reconstruction, and repaving projects when these materials are covered by construction budgets. The cost of remarking crosswalks usually comes out of the maintenance budget, which may not allow for easy reapplication using the same materials.

Maintenance budgets tend to be tight, whereas including higher cost marking materials in a construction project represents just a small part of a larger project budget. Importantly, some applications of higher cost tapes can only be applied initially at the time of resurfacing or reconstruction.

Although there is a certain economy of scale and simplicity for agencies to use one marking type for initial marking and another for remarking, it is more important to make decisions about remarking with additional factors in mind. Traffic volumes, pavement surfacing type, initial marking material that will be marked over, cost, and availability of application equipment will be factors in the how agencies will need to consider a mix of treatments for remarking crosswalks. Agencies will need to be flexible in their approaches to remarking crosswalks. For example, it may be cost effective to use paint for remarking of a crosswalk on a lower-volume street, while higher cost, preformed thermoplastic material might be used for other crosswalks in a higher volume downtown location, even when the old material must be ground off for reapplication.

7.5. Maintenance of Pedestrian Signals

7.5.1. Background

Pedestrian signals are generally durable with the most serious maintenance issues related to signal “take-downs” due to vehicle crashes (FHWA, 2013b). Nonetheless, push buttons and signal heads need occasional maintenance and accessible pedestrian signals should be inspected regularly.

7.5.2.Maintenance Recommendations for Pedestrian Signals

Timely Response

A malfunctioning signal can be a serious barrier for pedestrians, and people should be strongly encouraged to report malfunctions. Agencies should establish a protocol that results in a response soon after the report is received (especially in high pedestrian and traffic volume areas).

FHWA encourages agencies to adopt Automated Traffic Signal Performance Measures, defined as a suite of performance measures, data collection, and data analysis tools, to support performance-based approaches to traffic signals to improve the safety, mobility, and efficiency of signalized intersections for all users.

Inspection

If a community has a sidewalk inspection program, push button signal actuators should be inspected for functionality concurrently when adjacent sidewalks are inspected. Pedestrian signals should also be inspected at the same time as vehicular signal heads at the same intersection. For inspection, these are conditions that should be monitored:

- Cracked or broken pushbutton hardware.
- Pedestrian signal heads or push buttons that are turned askew.
- LEDs in pedestrian signal heads that are fading in conspicuity.
- Vegetation or obstacles obscuring access to pushbuttons or pedestrian signal heads.
- Audible and vibrotactile features of Accessible Pedestrian Signals (APS) are not working correctly.

Inspection processes provide a perfect opportunity to check button mounting locations and how current accessibility standards are being maintained. Although more of an operations issue, agencies should remember to change signal timings for pedestrian signals when they change cycle length timings as part of intersection signalization updates and upgrades.

Inspection routines may need to be changed with the installation of APS (see below).

Accessible Pedestrian Signals

APS are used to effectively communicate the pedestrian phase information to pedestrians with vision disabilities. The NCHRP report *Accessible Pedestrian Signals: A Guide to Best Practices* indicates that agencies should monitor these devices for malfunctions relating to the audible and vibrotactile WALK indication, locator tone, and signal interaction, so that pedestrians with vision impairments have the proper guidance to cross the street (Harkey et al., 2011). The overseeing agency should conduct an audit or checkup of APS installations on a regular basis, and more frequently if the weather is harsh. At a minimum, APS should be inspected every six months; after repairs to the intersection signals, poles, or controller; and after changes to signal timing.

Occasionally, an agency may receive a complaint that a locator tone on an APS is too loud or needs maintenance. The volume of the tones and messages can be adjusted and should only be audible 6 to 12 ft from the signal pole (FHWA, 2023b; MUTCD). The volume should adjust according to ambient noises, but if the environment around the pole changes significantly, the volume settings may need to be adjusted. Pushbutton manufacturers should be contacted with questions or ongoing problems.

Newer technologies—most associated with APS—may improve the day-to-day performance of pedestrian signals. Agencies

should become acquainted with these technologies by surveying new devices offered by many vendors.

LED Technology

The replacement of signal heads with LEDs has significantly reduced the need for replacement of light fixtures in signal heads.

However, there are new maintenance considerations with LED lights. First, LEDs generate so little heat that they do not melt off accumulated snow and ice as readily as incandescent systems. Second, because LEDs last much longer than incandescent bulbs, regular lens cleaning and LED fading may become an issue. The frequently asked questions on the MUTCD website address this issue:

> *"Agencies using LED-based signals should be aware that these signals need to be monitored for adequate brightness of the signals and for needed replacement, typically well before the signals fail totally. LEDs have a long life before total failure, but the LEDs gradually become dimmer over time and may become so dim that they cannot be adequately seen under all lighting conditions. In other cases, individual LEDs or portions of the LED signal indication may "burn out" completely while other portions of the same LED signal indication are still functioning properly. This contrasts with signals using incandescent bulbs, which usually remain sufficiently bright over their full lifetime and then fail completely by "burning out." Agencies thus quickly become aware of and replace failed incandescent signals. Agencies need a different strategy for monitoring and replacing LED signals"*
> (FHWA, 2022g).

7.6. Maintenance of Pedestrian Signs

Wear and tear on signs result in discoloration and loss of retroreflectivity. Unlike markings, signs have a much longer life—often more than 10 years. Several factors tend to lessen the life of signs—ultraviolet radiation and airborne pollutants can dramatically degrade a sign's useful life. Vandalism is also a significant maintenance problem for signs in general. Sign replacement for pedestrian-related signs (wayfinding, street signs, etc.) tends to take a lower priority to the maintenance of signs for regulatory purposes, such as stop and yield signs.

According to the MUTCD, maintenance activities should consider proper position, cleanliness, legibility, and daytime and nighttime visibility (FHWA, 2023b). The MUTCD requires that signs be conspicuous and legible (FHWA, 2023b). Agencies should anticipate costs associated with keeping signs well maintained. If maintenance needs trigger a replacement, the new sign shall comply with the MUTCD. The only exception to this is if there is one compliant device amid a series of adjacent non-compliant devices which could be confusing to road users, and/or if the schedule for replacement of the whole series of non-compliant devices will result in achieving timely compliance with the MUTCD.

To assure adequate maintenance of pedestrian signs the following actions should be taken:

- **Scheduled inspections.** These should occur during daylight hours, but also during nighttime hours to check retroreflectivity.
- **Clean signs.** This includes power washing signs to maintain their visibility.
- **Enlist help from other public employees.** All public employees (including law enforcement, public works employees, highway department employees, etc.) who are traveling the roadways should be encouraged to report any damaged, deteriorated, or obscured signs at the first opportunity.
- **Replace signs.** Signs generally have a service life of 10 years and should be replaced on that cycle or close to that cycle. Damaged or vandalized signs also need to be replaced in compliance with the MUTCD.
- **Vegetation removal.** Trees, bushes, and weeds need to be removed or trimmed so they do not block the visibility of signs in compliance with the MUTCD.

Retroreflectivity is one of the most important aspects for sign maintenance. The MUTCD requires agencies to use an assessment or management method that is designed to maintain sign retroreflectivity at or above minimum levels cited in the MUTCD (FHWA, 2023b). The MUTCD states that, "One or more of the methods described in *Maintaining Traffic Sign Retroreflectivity* (FHWA-SA-07-020, Revised 2013), FHWA, or a method developed based on an engineering study, should be used to maintain sign retroreflectivity at or above the minimum levels in Table 2A-5." (FHWA, 2023b). Per Section 9A.02, while all MUTCD compliant signs on a shared use path are required to be retroreflective, including warning, regulatory, and wayfinding signs, non-standard signs are not required to be retroreflective, such as information signs, map kiosks, park name signs, etc. (FHWA, 2023b). Another resource for information on retroreflectivity can be found at FHWA's *Sign Retroreflectivity* website.

Vegetation Maintenance

Wilsonville, Oregon

Wilsonville, Oregon, exemplifies the typical approach that small jurisdictions take toward vegetation maintenance. The City has one full-time arborist on staff in the public works department who is responsible for inspecting sidewalk vegetation overgrowth that impedes sightlines or sidewalk passage. If vegetation on private property has overgrown the sidewalk, the arborist will give the property owner notice to remove the vegetation. The City has the authority to remove the overgrowth and bill the property owner, but that rarely occurs. Generally, communities are less likely to enforce compliance through fines than they are through the issuance of a warning (City of Wilsonville, 2022).

7.7. Seasonal Maintenance

Seasonal maintenance entails sweeping, vegetation removal and control, and snow and ice removal. Such maintenance is apparent to property owners living adjacent to sidewalks because most State laws and municipal ordinances make this day-to-day maintenance their responsibility. This section discusses the common types of everyday maintenance and the techniques that are used.

7.7.1. Vegetation Removal and Control

Street trees and other plants adjacent to the sidewalk are a beneficial street amenity for a variety of reasons, as they provide shade, stormwater control, and visual interest; reduce carbon dioxide; and may increase property value. However, vegetative growth encroaching upon sidewalks or paths is a serious condition that requires maintenance. Vegetation should not be allowed to protrude into the sidewalk. Sightlines to driveways and intersections should also be maintained for pedestrian safety. In addition, the surface of the sidewalk should be kept free of vegetative debris. Many communities require adjacent property owners to keep a sidewalk free of vegetation and in many cases property owners are doing so on their own volition. See the section on *Vegetation Overgrowth and Debris Accumulation* for more information about the main maintenance issues associated with vegetation.

Recommended Practices

Vegetation within the public right-of-way is managed in a variety of ways. Some communities require adjacent property owners to maintain vegetation planted between the sidewalk and the curb. Other jurisdictions require property owners to obtain a permit to plant anything other than grass between the sidewalk and the curb so that proper sightlines and the pedestrian clear zone are maintained. Many communities employ arborists who provide expert assistance on inspection and trimming of trees which can help in the maintenance of this planting strip.

While many communities, especially moderate- to large-sized cities, have ordinances regarding the maintenance of vegetation, there may be compliance and reporting issues. Agencies should enforce those ordinances to maintain vegetation along the sidewalk on private property and in the public right-of-way, especially since some issues may be an ADA violation for which the municipality is ultimately responsible.

There are several demonstrated techniques to control vegetation: edging, limb trimming, vegetation debris management, and vegetative planting.

Edging

Certain types of grasses or a combination of grass and soil will build up on the outer edges of the sidewalk. Edging is a technique that cuts back the vegetation to the outside limits of the sidewalk. Edgers are both motor powered and hand powered. A wheel rests on the sidewalk as the devices are used on the edges of the pavement. These machines can trim the vegetation all the way back to the edge of the sidewalk and are especially effective if this task is done routinely. Vegetative build-up on sidewalk edges is often an

under-identified problem but can result in issues on narrow sidewalks or where drainage is affected.

Limb Trimming

Branches can quickly grow into the pedestrian access route of a sidewalk or path (figure 39). According to PROWAG, objects protruding more than 4 inches into the pedestrian circulation path should be at least 80-inches above the surface of the walkway. Objects closer than that should be trimmed back. The minimum vertical clearance for shared use paths should be 92 inches (AASHTO, 2012). A variety of tools can be used to trim branches such as long handled pruners, pruning shears, and saws.

Vegetation Material Management

An important task related to cleaning up vegetation is the removal and collection of leaves in the fall. Leaves can lead to very slippery conditions when wet and they can easily cover up obstructions that pose a trip/fall risk. Leaves can also clog drain grates and catch basins resulting in localized flooding that can impede access to active transportation facilities.

Communities and property owners rely on the obvious tools to maintain sidewalks including rakes and leaf blowers. Agencies often have specially equipped trucks with baskets to collect piled leaves.

Source: Toole Design

Figure 39. Photo. Trimming vegetation is important for maintaining sidewalk accessibility.

7.7.2. Sidewalk Sweeping

While most communities sweep streets free of debris, very few have an active citywide, sidewalk-sweeping program (FHWA, 2013b). It is much more common to have communities support sidewalk sweeping through business improvement districts aimed at downtowns and commercial business districts. For example, the City of Perry, Georgia, sweeps sidewalks in the core business district three times per year (FHWA, 2013b).

On State Street in Madison, Wisconsin, sweeping is conducted weekly (FHWA, 2013b). The City of Concord, New Hampshire, sweeps sidewalks citywide every spring (FHWA, 2013b). In the absence of a coordinated citywide or Business Improvement District approach to sweeping, adjacent property owners more commonly perform this work and are often required to by a community ordinance.

The typical tools for sweeping sidewalks depend on the scale of the effort. Communities will often use a power-driven rotating broom mounted on a tractor or skid-steer loader if sidewalks are swept clean on an area or community-wide basis. Although this tends to be a fast way to clear the sidewalk, the swept material is very difficult to control and is usually just simply pushed to another location. This option may be preferred if the material, such as soil or sand, is simply being returned to a tree buffer where it was initially situated. Vacuum sweepers are being more commonly used and have the advantage of minimizing particulates in the air. Small scale efforts include using leaf blowers to corral dirt and refuse into a pile or windrow to be swept up later. A simple broom is often the tool of choice for adjacent property owners who occasionally need to sweep a messy sidewalk.

There are several conditions that communities should pay special attention to when considering sweeping needs. Curb ramps and low sections of sidewalks or multiuse paths where water settles

Community-Wide Snow Removal

Halifax, Nova Scotia

The Halifax Regional Municipality in Nova Scotia, Canada, maintains 400 miles of sidewalk with an operating budget for sidewalk snow removal of $4.2 million dollars and average snowfall of 81 inches per year. In an effort to make the cost of snow removal more predictable, a performance-based contract was developed that required contractors to provide costs for snow removal based on performance standards rather than the number and intensity of snow events. Performance expectations such as final sidewalk condition and time frames for snow and ice removal are required in each contract. Contractors are also tasked with inspection, compliance tracking, and conditions monitoring. Per the contract, the City assumes liability for slips and falls unless gross negligence is documented on the part of the contractor. The Halifax Regional Municipality has seen a cost saving of C$ 4,600 (approximately the same in 2012 US dollars) per kilometer of sidewalk. The benefit of this strategy is consistent competitive costs for snow removal no matter how many snow events occur over the contract length (CTV News, 2020).

provide conditions for dirt to settle. When still wet, the silt can be slippery. Secondly, paths should be closely observed for sweeping needs or swept on a weekly or biweekly basis. Broken glass is a significant issue on some paths and is especially troublesome for wheelchair user's and bicyclists' tires. Given the unpredictable nature of debris or refuse left on paths, relying on reports from users is often a viable maintenance approach, assuming communities respond quickly to reports.

7.7.3. Snow and Ice Removal

Following a snowfall, snow and ice must be cleared from sidewalks, curb ramps, and crosswalks promptly to provide safe and accessible passage for pedestrians (28 CFR 35.133(a)). Common challenges to pedestrian travel after snowfall include street plowing that pushes snow onto sidewalks or blocks crosswalks, clogged or obstructed drains that create puddles at curb ramps, patches of ice that create slip/fall risks, and stretches of snow and ice covering sidewalks. Jurisdictions should have policy and action plans that address these key issues.

Bicycle facilities also face challenges. Following a snowfall, snow storage for roads can end up blocking the bicycle lane and clogging or obstructing drains, creating puddles in the bicycle lane and at intersections. Poor drainage can lead to patches of ice within the bicycle facility which may cause cyclists to fall or be unable to stop.

While the PROWAG states that sidewalks should have at least 48 inches of clear passageway (U.S. Access Board, 2023), different municipal ordinances have varying degrees of detail for how best to achieve a safe space for pedestrian travel after a snowfall. For example, some ordinances require clear widths for snow removal. Other ordinances allow the use of aids such as sand, ash, or salt on ice to reduce the chances of users slipping and falling, while others require the breaking out of ice. Some ordinances specify the maximum allowable height of snowbanks and forbidden zones for snow piles, to maintain proper visibility of pedestrians. Some jurisdictions require snow removal from specific features such as fire hydrants, benches, driveways, and curb ramps.

There is no national guideline on bicycle lane snow removal, but different municipalities have snow removal policies for these facilities. For example, the City of Minneapolis's *Pedestrian and Bicycle Winter Maintenance Study* identifies winter maintenance options for clearing snow and ice from sidewalks and bike lanes.

In the event of a snowfall, there are common strategies that communities employ to make streets and sidewalks passable to pedestrians. Removing snow and ice should be thought of as a community responsibility that covers the entire public right-of-way, and since sidewalks are part of the public right-of-way, efforts to remove snow and ice should occur in a reasonable time period following a snowfall. Elements of an effective snow and ice removal program include: timeframe for removal, responsibility for removal, ordinances, compliance efforts, and planning and

outreach strategies.

Timeframe

Removing snow and ice within a 24- to 48-hour period following the culmination of a snowfall is considered a reasonable timeframe for removal (Montgomery County, Maryland, 2022). In regions where snowfall is infrequent and the climate is very temperate, many communities rely on a quick melting method or a "melt strategy" for responding to snowfall events. Rather than remove snow and ice, a community may rely on warmer temperatures shortly after a storm to melt snow and ice before mobility becomes an issue (FHWA, 2013b). Although this may be a reasonable approach for light snowfalls or those that occur in relatively warm weather, it may be helpful for communities to have a contingency plan in place (or have it clearly covered in an ordinance) to deal with snow and ice that remains longer than the 24- to 48-hour period. Snow that falls in the coldest and darkest months will have a much greater tendency to stay frozen (or thaw and freeze) and presents more issues compared to snowfalls in November, March, and April.

In parts of the country where snowfall is more frequent, communities should prepare to respond to all snowfalls. Expecting snow to melt without impacting pedestrian travel is not realistic. It is also common and appropriate to require a shorter timeframe to respond to snowfalls in high pedestrian zones such as in business districts, around college campuses, school areas, and where pedestrians need to access transit. Rather than establish a time period for removal (i.e., 24- to 48-hours after snowfall culmination), another strategy to consider is to set a specific time for when all snow must be cleared. For instance, a time of day can be set. Ann Arbor, Michigan, requires that any snowfall accumulation before 6:00 AM must be removed by noon (City of Ann Arbor, 2022), while Alexandria, Virginia, requires different timeframes depending on the category of storm (City of Alexandria, 2022), and more time is allotted for snow removal after larger storms. All timeframes should balance the needs of pedestrians and provide a reasonable amount of time for the agency and property owners to remove snow.

Section 5.2 *Compliance* discusses different approaches for snow and ice clearance from a legal perspective. Having adjacent property owners assume responsibility for clearing sidewalks is a common and economically efficient (for the community) technique for snow removal as long as abutting owners are informed and held responsible for removal. Furthermore, the community should be prepared to step in to remove snow and ice when property owners fail to do so, as well as remove snow from intersections and its own sidewalk and path property. Although this is a common practice, there are equity considerations because it taps the resources of adjacent property owners for maintaining sidewalks when the street itself (in the same public right-of-way) is maintained by the community. While communities remove snow and ice from adjacent streets using general or transportation fund dollars, adjacent property owners with sidewalks are responsible for removal using their own

resources. Property owners who do not have sidewalks have no such responsibility or burden yet benefit from the use of cleared sidewalks in the parts of the community that do have sidewalks.

Jurisdictions that take on the full responsibility of snow removal from sidewalks will assume increased levels of efforts or cost in exchange for more consistent and potentially convenient snow removal programs. When communities take on snow removal, they can do so with relatively few pieces of equipment, in contrast to requiring every property owner with sidewalks to have to respond to snowfalls with their own equipment. There are several measures that will streamline the process: having appropriate equipment for removal, parking restrictions to expedite simultaneous plowing of streets and sidewalks (when sidewalks are immediately adjacent to the parking lane or agencies need to remove snow from buffer zones in commercial areas), and the use of performance-based contracts to balance the costs of annual sidewalk snow removal when contractors are used. Some of the additional benefits to communities in providing community-wide snow and ice removal are: increased confidence among pedestrians who can expect uniform level of service (having just a couple of property owners who do not remove snow and ice can significantly disrupt a trip), curb ramps and medians can also be cleared at the same time, and agencies can anticipate and inform constituents of clearance completion schedules helping residents with their own trip and transit planning. Agencies can consider using a smartphone application to inform constituents of clearance completion schedules.

When property owners are required to remove snow from abutting properties, communities are still responsible to remove snow from sidewalks adjacent to public lands. This should be a shared responsibility between the jurisdiction, county, State, transit, and private agencies and institutions. Responsibility can often be a point of confusion that may lead to uncleared sidewalks. Clearly defined responsibilities are important to a successful snow removal program. Many communities deploy crews or hire contractors to clear snow and ice from sidewalks adjacent to public lands or buildings. Often, this is a shared responsibility between Parks Departments and Public Works Departments. Some smaller communities require school, fire, and police staff to clear snow from sidewalks around buildings. A snow removal plan that outlines clear responsibilities and assigns those responsibilities through written agreements are important when coordination is required between agencies, institutions, and organizations.

Prioritization

Very few communities have a prioritized system for sidewalks to be cleared of snow and ice by city crews, even though it is a good practice. Either as part of or after streets are plowed, some communities focus their attention on clearing sidewalks near schools, transit stops, and business districts. This scheme of establishing priority routes for clearing sidewalks can function when communities themselves are solely responsible for the clearing of

snow from pedestrian facilities or when adjacent property owners are responsible. For the latter, the community would ensure that all sidewalks are suitably cleared of snow and ice and if they were not, the community's crew would clear the sidewalks and charge the adjacent property owner. For example, the City of Alexandria, Virginia, prioritizes sidewalks into three groups: 1) school walking areas, accessible curb ramps and sidewalks near transit stops, and retail zones; 2) walks extending out from schools, parks, and municipal locations; and 3) trails, pathways internal to parks, and bike paths (City of Alexandria, 2022).

Business Improvement Districts and Special Improvement Districts can be effective mechanisms for providing basic maintenance of walkways including snow and ice removal. In these districts, businesses are typically responsible for a special tax that, among other things, funds maintenance activities such as snow and ice removal from sidewalks by a hired contractor. This is also a way for communities in low snowfall areas to ensure removal of snow from sidewalks in the busiest pedestrian areas.

Citywide Public Snow Clearance

Burlington, Vermont

Burlington, Vermont, with more than triple the average amount of snow in the United States and a snow season that lasts almost five months, has a robust system for seasonal maintenance. The Burlington Public Works Department is responsible for all snow and ice removal from City streets and sidewalks. Despite an ordinance that assigns snow removal to property owners, the City takes responsibility for all snow clearance in the right-of-way, including sidewalks and bike lanes, which maintains equitable coverage throughout the City. In addition to ensuring City-wide provision of snow clearing services, other equity considerations for the town include a focus on snow clearance from curb ramps. To achieve equitable plowing, snow clearance follows a prescribed order: priority areas to be cleared first are any area with school kids walking, hospitals, then the downtown hub area with businesses, focusing on the most pedestrianized areas, arterials, and then going off into lesser-used neighborhoods. Depending on the amount of snow, the City decides whether to plow or clear snow to a dedicated snow storage area. To ensure adequate staffing, the department has 17 full-time employees and borrows employees from other departments when the snow necessitates it. Seasonal maintenance and snow removal are considered at all phases of the design process. Burlington's convention is that when building new sidewalk, there is a minimum of 2 ft between the sidewalk and street as a minimum for snow storage, and bike lanes are extra-wide to accommodate plowed snow. Seasonal maintenance is largely supported by the City's general fund budget, which pays for snow plowing, salting, (4,000 tons of salt costing over $270,000), 17 full-time employees, and an overtime-heavy budget which reaches $2 million annually. Although the Public Works Department does not get paid for snow plowing, they receive $100,000 from the transportation department for cleaning meters, which is also leveraged as an opportunity to clear bike lanes (City of Burlington, 2022).

Work Plan

A snow removal plan or policy is a strategy for determining the priorities and actions a jurisdiction will take in response to a snow event. The development of an action plan is important for a successful snow removal program. Often, sidewalks are a secondary priority to snow removal on streets. However, plans that address sidewalks can provide important guidance on timeliness, techniques, priorities, and coordination between jurisdictions and agencies to ensure that the needs of pedestrians are met. A successful plan acknowledges that pedestrian needs are important year-round. Successful action plans have the following elements relating to sidewalk snow removal policies (Amsler, 2014):

- Stress the need for continuous improvements and performance measurements.
- Mitigate risks and manage costs.
- Use electronic communications and social media to enhance outreach.
- Ensure compliance with Federal and State laws.
- Incorporate innovative and environmental sustainability practices that provide cost savings measures, foster efficiency of operations, and aid in efforts to preserve air and water quality.
- Identify and program major snow removal equipment.
- Consider historical inequities and address all areas equitably.

Clearing Snow from Paths

Not all agencies will remove snow and ice from shared use paths. However, there are many communities which have exemplary snow and ice removal programs for this type of maintenance. The City of Minneapolis, Minnesota will remove snow and ice on paths on a comparable schedule to that of snow removal on streets. The Park Board is responsible for removal on most of the longer paths in the City (City of Minneapolis, 2018).

The City of Madison, Wisconsin uses one of three departments to remove snow and ice from paths. When assigning a department and unit, the location of the path is considered. This enables two efficiencies: the clustering of paths under specific units and the assignment of rather remote sections of paths to a Streets Department unit rather than expecting only the Department of Parks and Recreation to handle the entire system. This helps expedite snow-removal and, in many cases, improves upon response times when compared to removal on residential streets (City of Madison, 2020).

The Columbia Association of Maryland is one of the largest homeowners associations in the country and manages and maintains over 93 miles of pathways and 25 miles of sidewalks. This includes the winter maintenance of all of these facilities (Columbia Association, 2022a).

Jurisdictions should include the most comprehensive information available when developing or updating a plan. Agencies may also make the plan an all-season plan by including vegetation removal for sidewalks and paths. Often, sidewalk ordinances include year-round maintenance provisions, and the compliance efforts will be the same whether the issue is snow or vegetation. Two comprehensive guides for developing snow removal plans were reviewed for this study and are recommended in the development of a plan that specifically addresses pedestrian needs:

The *Winter Maintenance of Pedestrian Facilities in Delaware: A Guide for Local Governments* outlines sources of information for winter maintenance management plans (Scott and Rudd, 2012).

- *Snow and Ice Control: Handbook for Snowplow Operators* is a workbook that provides a comprehensive overview of the elements of a snow removal plan in Minnesota (Schaefer et al., 2022).

Section 5.2 *Compliance* has information regarding outreach, reporting, and programs to assist low-income households, seniors, or people with disabilities to comply with snow removal ordinances.

Source: Toole Design

Figure 40. Photo. Agencies should prioritize maintaining access to transit.

7.7.4. Snow Removal from Shared Use Paths

Shared use paths are often treated differently than sidewalks after snow events. In many communities they are either not plowed or have a very low priority of being plowed. Seldom do communities require adjacent property owners to maintain them. Some communities, counties, and States deliberately do not clear pathways to allow for winter activities such as skiing or snowmobiling. Decades ago, very few paths were maintained for year-round use. However, as more and more paths became true transportation facilities and are funded with transportation funding, that practice has changed. Several factors should be considered when deciding on removal of snow from paths.

- **Bicyclist and pedestrian demand for the facility.** Facilities located in remote areas will have little winter demand while those located within urban areas will see continued demand throughout the winter, especially from pedestrians.
- **Presence of nearby pedestrian facilities.** If there are no nearby sidewalks that are parallel to the path with comparable accessibility that can act as an alternate facility, having a path maintained year-round becomes more important.
- **Community support.** Are neighborhoods, bicyclists, and pedestrians asking that the facility be cleared of snow and ice? Are there many requests for maintaining the path for winter use? Are there wheel tracks or footprints through uncleared snow or debris?
- **Connectivity.** The more neighborhoods and commercial areas the path connects to, the more valuable the path will be for year-round use.

Paths that are located within the public right-of- way often substitute for a sidewalk and should be cleared of snow and ice in the same timeframe as sidewalks. Since paths are wider than sidewalks, wider pieces of equipment can service it, such as pick-up trucks with mounted plows. This is also a reason why paths should be designed with appropriate widths and loading characteristics to accommodate light-duty equipment (see sections 8.2 *Subgrade* and 8.3 *Pavement Thickness*).

Snow and Ice Removal – Conclusion

Depending on the region, snow and ice removal can be a major seasonal effort for communities of all sizes. The preceding sections include the basic elements of a snow removal program. Most of these elements can at least in part be employed in communities of all sizes.

Community-sponsored programs to remove snow and ice from sidewalks and paths are more equitable than requiring adjacent property owners to do so. This will better ensure a consistent removal of snow and ice. In many States, the local community is ultimately responsible for snow removal, but the initial responsibility belongs to the adjacent property owner. Although community sponsorship of snow removal is a more equitable approach likely to result in more uniform removal, many communities likely will still require adjacent property owners to remove snow and ice.

When that is the case, communities should:

- Clear snow and ice from their own sidewalk facilities, crosswalks, median crossings, and splitter islands.
- Ensure thorough compliance measures that snow is being removed.
- Remove snow and ice from sidewalks, bridges, and curb ramps where adjacent property owners fail to do so.
- Provide educational programs on importance of removal and proper ways of removing snow and ice.
- Coordinate with other public entities to make sure all jurisdictions are providing removal on their publicly-owned facilities.
- Provide a reporting system both on-line and via phone.
- Sponsor assistance programs for people who cannot remove snow and ice themselves.

8. Construction Techniques to Lessen Maintenance for Sidewalks and Paths

The best way to maintain sidewalks and other pedestrian facilities is to start by building them to last. Some common types of sidewalk damage can be prevented or slowed using good practices in initial sidewalk construction. Close attention to specific design details can result in sidewalks that require low or lower levels of maintenance over their lifespan, thereby improving access in a community and reducing municipal and property owner costs. This chapter highlights specific construction techniques that can lengthen the standard lifespan of pedestrian facilities.

Initial design and construction methods greatly influence the long-term maintenance and lifespan of sidewalks. Historically, concrete has been the material of choice by many jurisdictions because of its ease of installation, durability, reliability, and availability of materials. The thickness of the sidewalk material, use of reinforcing bars or mesh, use of aggregate base, depth of subbase below the sidewalk, distance from trees, and other design details impact how well a sidewalk will age over time. If noteworthy practices are followed, the expected sidewalk materials service life can be extended, as noted below (FHWA, 2013b):

- **Concrete**: Approximately 80 years.
- **Bricks and interlocking concrete pavers**: Approximately 80 years.
- **Asphalt**: Approximately 40 years.
- **Rubber**: Approximately 3-20 years (lifespan varies by manufacturer).

Although these lifespans are achievable, many cities consider 25 years to be an expected lifespan for concrete sidewalks (FHWA, 2013b).

8.1. Sidewalk Failure

As discussed in chapter 4, sidewalks and paths fail for a variety of reasons including damage due to:

- Poor base soils and subbase preparation causing differential settlement.
- Nearby tree roots causing displacement or cracks.
- Heavy vehicle loading on sidewalks not designed to take such loads.
- Insufficient concrete thickness or lack of reinforcement where design dictates.

Much of this damage can be avoided or delayed by using proper construction techniques that consider the type of soils underlying the sidewalk, seasonal conditions that impact soils underlying sidewalks, tree type, and placement and sidewalk design (thickness, use of aggregate, subdrainage, and reinforcement).

8.2. Subgrade

The type of soil underlying a sidewalk may be the greatest determinant if the sidewalk will fail before the end of its projected lifespan. A comprehensive study in Cincinnati, Ohio showed a greater correlation between sidewalk failure and the underlying soil type than between sidewalks and the presence of nearby trees (Sydnor, 2000). Providing an adequate subgrade below sidewalks may deter many of these failures by providing stability and good drainage, helping the sidewalk be

more resistant to seasonal changes. Subgrade design and preparation should be carefully considered and based on local soil conditions and policies. Although there is not one specific design solution for every situation, Canadian national guidance provides the following general noteworthy practices (Federation of Canadian Municipalities and National Research Council, 2004):

- Subgrade that has been uniformly compacted to a minimum 98-percent standard Proctor density.
- Four to 6 inches (100 – 150 mm) of free-draining granular material under sidewalks for base material. Eight inches (200 mm) for pavers over slow draining soils or frost zones.
- Minimum base material compaction of 95-percent standard Proctor density for concrete and asphalt. Minimum compaction of 98-percent standard Proctor density for pavers.

Providing an adequate subgrade of free-draining material may also reduce issues from nearby tree roots, as detailed in section 8.7 *Street Trees.*

8.3. Pavement Thickness

8.3.1. Concrete

Sidewalk thickness is another aspect of the overall sidewalk "pavement" design, and agencies should take into consideration expected loading, local soil conditions, and policies. In the United States, concrete sidewalk thicknesses in warm climates that do not need to support heavy vehicles may be as low as 4 inches; areas that experience a winter freeze and must accommodate heavy vehicles (known as vehicle loading) may require thicknesses of 6 inches or more (Pedestrian Safety Guide and Countermeasure Selection System, 2013). In theory, the thicker the sidewalk, the less likely it will fail prematurely; however, adequate research does not exist to support this claim in the case of frost heave or tree roots. It is important to ensure that sidewalks are constructed with enough thickness to support expected vehicle loading, which may include maintenance vehicles or more substantial loads at driveway crossings. In some cases, reinforcement (usually with a welded wire mesh or rebar) can be used to increase the loading capacity of sidewalks. Similar to subgrade design, there is not one specific design solution for every situation; however, the following provides general practices for concrete sidewalk thickness.

- Four inches for light axle loading over sand/gravel.
- Five inches for light axle loading over silt/clay.
- Five to 6 inches for heavy axle loading over sand/gravel.
- Six inches or slightly greater for heavy axle loading over silt/clay.

Agencies commonly follow these cited practices by requiring the following sidewalk thicknesses: 5 inches standard depth, 6 inches at driveways, and 7 inches at commercial driveways. State DOTs require thicknesses of 4 or 5 inches for most sidewalk sections and 6 to 8 inches for sidewalk sections crossing driveways (consistent with the depth of the driveway aprons) (FHWA, 2013b). Additional

thickness may also need to be considered where off tracking by trucks occurs on curb ramps.

8.3.2. Asphalt

Asphalt is commonly used on paths and for shoulders that are used as pedestrian facilities. Asphalt thicknesses for shared use paths that will see only very light duty equipment can be as low as 2 inches if laid on top of an adequate aggregate depth of 4 inches. If laying asphalt without a base and an expectation that only medium duty trucks may use the facilities, 8 inches may be needed. According to a report by the Illinois Center for Transportation, *Best Practices for Bicycle Trail Pavement Construction and Maintenance in Illinois*, a minimum hot-mix asphalt thickness for paths that must support regular- and heavy-duty trucks is 3 inches over a 4-inch aggregate (Simpson et al., 2012). Depths for asphalt sidewalks are not very well documented, but at a minimum should be 2 inches with an adequate aggregate depth similar to the minimum depth of an asphalt path. It is also important for the paths to be at least 10-ft wide to support truck wheels at the edges. Larger maintenance vehicles—especially when the edge of the path cannot be seen very well by drivers—can cause significant edge damage if wheels ride at the edges, particularly where shoulders are inadequate (figure 41). The types of equipment used to clear snow and vegetation should be considered when designing path pavement.

Source: FHWA

Figure 41. Photo. Inadequate shoulders on a path resulting in edge damage (FHWA, 2013a).

8.4. Drainage

Proper sidewalk drainage is important for maintenance purposes and to provide a safe and comfortable experience for users.

It is important to provide a slight cross slope on sidewalks to ensure proper drainage and prevent pooling of water, especially in climates where ice can form. Sidewalk cross slopes should not exceed 1:48 (2.1 percent) (U.S. Access Board, 2023). This provides adequate drainage but does not adversely impact access for people with disabilities. For sidewalks and paths with significant running slope, cross slope can be reduced. Water will still drain, and people using mobility devices who are already working to negotiate the grade will not need to exert as much effort.

Sidewalk immediately behind the curb should be considered for installation of a subdrain system parallel to the curb to facilitate drainage away from the base and reduce frost heave in cold climates. Additionally, providing a subgrade of quick-draining material as noted above will help reduce frost heave in areas with soils that drain poorly.

8.5. Control Joints and Scoring Patterns

Control and expansion joints should be provided in all concrete sidewalks and paths to minimize heaving and cracking and guide cracking should it occur. However, decorative jointing/scoring should be minimized to avoid jarring bumps for pedestrians using wheelchairs. Saw cutting control/contraction joints provide a smoother surface than troweling joints into the surface. Joints should be level and as narrow as possible. For interlocking pavers, the maximum variation in height should be 0.079 inches (2 mm) (Federation of Canadian Municipalities and National Research Council, 2004).

Full depth expansion joints should be placed at regular intervals based on an agency's policy and adjacent to existing rigid structures such as poles, walls, hydrants, and buildings. Isolation joints should also be located at the beginning and end of curved sections of sidewalk and at all intersections.

Control joints, also known as contraction joints or construction joints, allow shrinkage to occur during drying in a way that does not affect the appearance of the sidewalk. Control joints should generally be spaced a maximum distance of 24 to 30 times the thickness of the concrete. The transverse contraction joint should extend to a depth of one quarter to one third of the depth of the concrete sidewalk and be a maximum width of 0.20 inches (5 mm). If the sidewalk width is 8 ft (2.5 m) or greater, a control joint should also be formed along the center line of the walk. Control joints should be saw cut instead of troweled. Asphalt sidewalks typically do not need joints or scoring patterns.

8.6. Curb Ramps & Detectable Warning Surfaces

Curb ramps and detectable warning surfaces present unique maintenance needs. The primary issues with detectable warning surfaces are debris collection, detachment from the sidewalk, or damage to the truncated domes themselves. Detectable warning surfaces can collect dirt and debris between raised domes where pooling occurs during rain events. The accumulation can impact the ability for a person who is blind, or has low vision, to detect the panels. During the design, it is important to maintain a gutter slope that allows water entering the curb ramp to drain and carry away the debris. The primary solution to this issue is good design and adequate drainage. When this is not possible, frequent sweeping may be needed. Seasonal pressure washing of detectable warning surfaces may also be of value and may help retain the color contrast between the detectable warning surface and the surrounding sidewalk.

Physical damage to detectable warning surfaces and their domes is common in areas that require snow removal. Detectable warning surfaces can be damaged by snowplows that clear some paths and sidewalks and can even be damaged by snowblowers. Extending the life of these surfaces can be accomplished by material selection. A few manufacturers are now providing cast iron detectable warning surfaces that are significantly heavier and stronger than those manufactured from stainless steel,

alloy, concrete pavers, thermoplastic, or pressed directly into the concrete.

8.7. Street Trees

While trees offer many benefits, it is important to understand their needs, vulnerabilities, and growth patterns to minimize maintenance impacts and ensure accessible active transportation facilities. Street trees can cause damage to sidewalks and walkways when either the trees or sidewalks are incorrectly installed. In many communities, damage from roots is the main cause of sidewalk maintenance issues; conversely, stresses from pavement and compacted soils can damage and kill trees, leading to costly replacements. Appropriate site conditions, soils, and species selection can help trees to thrive in their location and minimize potential damage to nearby sidewalks, streets, and underground utilities.

Additional national-level information on trees and pedestrian facilities is available in the *AASHTO Guide for Planning, Design, and Operation of Pedestrian Facilities* and ITE's Designing Walkable Urban Thoroughfares: A Context Sensitive Approach. Many State, local, and Tribal agencies have developed manuals on urban design and street tree standards in specific districts or municipalities. Whenever possible, consult local tree planting guidance and local arboriculture experts on tree installation and maintenance.

The following tree-care guidance is presented in the context of constructing and maintaining pedestrian facilities. For that reason, the focus of this chapter is on noteworthy practices for integrating trees into the design of streets and sidewalks, minimizing the potential for future maintenance issues, and promoting the longevity of both hardscape and trees.

It is critical however, to be aware that there are numerous other factors involved in maintaining a tree throughout its lifetime. Qualified professionals, such as arborists or landscape architects, should be involved in tree care, especially for important decisions and processes such as:

- Selecting and approving nursery stock.
- Planting guidance.
- Staking or underground guying of newly-installed trees.
- Pruning large (over 1.5-inch) roots and branches.
- Diagnosing and treating disease or injury
- Assessing tree health for preservation or removal.
- Protecting existing trees during construction.

8.7.1. Soils

The best way to support tree health and minimize sidewalk damage is to plant trees in sufficient volumes of high-quality soil with adequate clearance from the edge of the pedestrian facility. With the competition for the limited space in the right-of-way, it is often challenging to provide these conditions. In addition to their structural role in supporting the tree, roots are the tree's means of accessing water, and they require oxygen to grow and survive. Compacted or waterlogged soils prevent the uptake of water or oxygen, damaging the overall health and life prospects of a tree, and leading to root growth strategies that can negatively impact paving around street trees. Roots in compacted soil will migrate toward the surface seeking water and air, lifting paving, and causing cracking or heaving. To avoid costly maintenance issues (including tree replacement), it is important to understand the basic needs of trees and their responses when these needs are not met, as well as to understand the range of current noteworthy practices for planting and maintaining trees in urban settings. Over the last few decades, as both the needs and benefits of street trees have become more widely understood, the issues with traditional tree pits have become more prominent, and a range of technical solutions has been developed to establish better growing conditions for urban trees. A broad range of resources are available that provide information on addressing the problems common to urban tree plantings.

8.7.2. Calculating Soil Volume

In the existing street right-of-way, it can be challenging and costly to install large volumes of planting soil, but sufficient soil volume is a critical investment that enables trees to develop healthy canopies and lessens the chance that roots will damage sidewalks or underground utilities. For example, 1,000 ft^3 per tree is the minimum recommendation for a tree with mature diameter at breast height of 16 inches (Urban, 2008). More soil volume is preferable if it can be achieved. Where multiple trees are planted in a continuous soil volume, up to 25 percent of that volume may be shared, but this is a compromise, and it remains preferable to maximize soil volume per tree wherever possible. Trees can grow with paved surfaces over their root systems, provided this paving allows for water infiltration and gas exchange; there are ways to add soil volume in new construction, and often via retrofits, without reducing sidewalk space.

8.7.3. Tree Pits

Tree pits, a familiar feature of urban streets, have become a less-favored approach to tree planting, as they typically do not provide adequate soil volume and are highly susceptible to drought and compaction. Wherever possible for new construction, alternatives to traditional tree pits should be used.

As a rule, trees need 1 to 2 ft^3 of soil for every ft^2 of projected mature crown area. This means that a tree with a mature crown spread of 35-40 ft would need approximately 960-1,260 ft^3 of soil, a quantity that is rarely achievable in tree pits. An urban tree pit is essentially an underground planter for the tree: a small volume of planting soil surrounded by

heavily compacted subgrade that limits root growth beyond the pit. This limited space can compel roots to grow upward and damage pavement, or to die off and cause the tree to suffer and decline. In some cases, existing tree pit soils can be improved by air spading to remove existing soil and replace it with amended soil.

If tree pits are the only option, they should be as large as possible to provide maximum rooting volume while maintaining appropriate clear width for sidewalks.

Tree pits can be covered by grates to minimize soil compaction, but grates are increasingly unpopular due to negative impacts on trees, maintenance demands, and risk of users tripping and falling. The PROWAG advises that openings should not permit the passage of a sphere more than 0.5 inches in diameter. Some municipalities prohibit the use of grates, so it is important to consult local regulations on tree pit protection. Bark or woodchip mulch, stone mulch, or flexible porous surfacing are often acceptable alternatives to grates for protecting pits. Low fencing may also be installed around the pit to protect the soils from compaction and animal waste. To minimize damage to the tree and maintain an accessible pedestrian way, flexible or modular rubber paving can be installed around the pit to allow for root growth while reducing obstructions which pose a trip/fall risk by providing a rounded rather than buckled surface. Where sidewalk widths allow, tree pits can be widened by narrowing the walking surface for a short distance. A 4-ft minimum sidewalk should always be provided in such cases.

Source: Toole Design

Figure 42. Photo. Open tree trench.

8.7.4. Techniques for Supporting Adequate Soil Volume

The following techniques may be highly preferred over tree pits as they can provide sufficient soil volume for rooting, either in open continuous soil areas or by using alternative means of supporting pavement that allow for rooting space below the hardscape. Closed trench type assemblies include permeable paving, and the soil volume can often support some degree of stormwater detention.

Open Tree Trenches

Tree trenches are a simple way to provide more soil space for trees. A tree trench is a continuous volume of soil shared by a row of trees along a street or roadway. Open trenches (figure 42) are planted with lawn or groundcover, rather than being covered with paving. They should have a minimum width of 5 ft, though smaller trees can be planted in a 4-ft-wide planter. As noted above, it is preferable to provide at least 1,000 ft^3 of soil per tree, but, if necessary, up to 25 percent of a multitree soil volume can be shared (Urban, 2008). Consult with an arborist or other qualified arboriculture professional regarding shared soil volume recommendations.

In settings with high levels of curbside activity, open trenches may be too much at risk for soil compaction and injury to trunks from people accessing vehicles and crossing the planting strip. While paved pedestrian step-out zones along the curb and walkways crossing the trench can be included in the design, a covered trench may be the preferred option for areas with high levels of curbside activity.

Covered Tree Trenches

Covered trenches are also continuous soil volumes shared by a row of street trees, but they include specialized paving and soil systems that allow for uncompacted subgrade while supporting pedestrian, bike, and light to moderate vehicular uses. This is a higher cost option but one that typically requires less day-to-day maintenance than open tree trenches, which need management of vegetation, trash removal, and protection from pedestrian traffic.

Covered tree trenches are a solution for urban conditions with high pedestrian volumes, curbside use, and limited options for open landscape space.

Covered trenches achieve the dual function of root space and hardscape via two main strategies:

- **Structural Soil**. Integrating structural support into the soil with graded aggregate maintaining pore space for root and water movement.
- **Suspended Pavement**. A system of open risers or columns that hold up pavement while allowing for large volumes of planting soil.

Structural Soils

Structural soils are engineered mixtures of roughly 80-percent aggregate and 20-percent organic soil that retain abundant pore space for root growth when compacted. Because of this proportion of aggregate to soil, structural soil installations must include about five times the volume

required for conventional planting soil, or 5,000 ft^3 per tree. These large volume requirements mean that structural soils are primarily used for new construction or major reconstruction projects and are not cost effective for all project types. Structural

Source: Toole Design

Figure 43: Photo. Deep Root Silva Cells installed along urban streetscape (Deep Root Green Infrastructure, LLC., 2017).

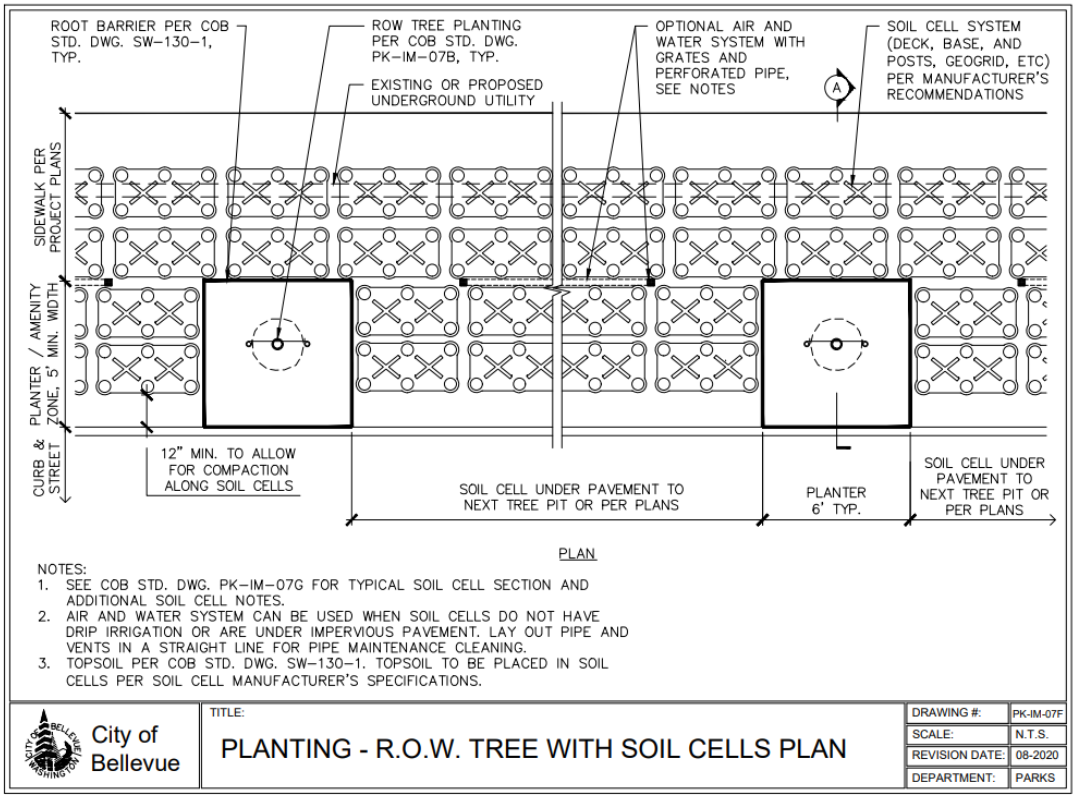


Figure 44: Graphic. Plan of right-of-way tree planting with soil cells (City of Bellevue, WA, 2020).

soils can be used for plantings on streets with or without curb and gutter.

Suspended Pavement

In suspended pavement systems, rather than integrating pavement support into the soil mix, subgrade structures such as risers or columns are used to hold up pavement and maintain large open volumes of planting soil beneath hardscape. Soil cells are a prominent strategy for achieving this condition (figure 43 and figure 44) offering flexibility as a modular system for new construction and retrofits.

Soil cells are prefabricated, modular, stackable, and interlocking plastic risers that can support light to moderate vehicular loads while allowing for extensive volumes of planting soil below pavement. Because of the pore space and ponding space provided in soil cell systems, they may also be used to detain or infiltrate stormwater and help meet regional stormwater requirements.

Directing Roots

Root Paths

These subgrade trenches can be provided to guide root growth into nearby open soil areas when space for planting soil is limited immediately adjacent to the tree. They should be a minimum of 4-inches wide by 12-inches deep, filled with amended soil and lined with strip drain board. Root paths are low cost and are often a retrofit application. Root paths can also be created by installing a row of soil cells to connect the tree pit to an open soil area.

Root Barriers

Where appropriate soil volume is provided, vertical root barriers may be installed to restrict root growth to that soil area and prevent root encroachment beyond the intended zone.

Gravel Subbase

Providing a gravel subbase below sidewalks near street trees has been shown to reduce pavement damage from root growth immediately below pavement on well-drained sites.

8.7.5. Tree Selection

Street trees should be carefully selected to ensure that they will be compatible with their surroundings and will minimize the potential for damage to sidewalks (figure 45). Since appropriate tree species depends on the site location, it is important to work with an arborist, horticulture specialist, landscape architect, or other qualified professional to help assess the site and select trees to install. The following are some points for identifying desirable features:

Climate Suitability

Tree species should be able to tolerate a site's climate. This includes being adapted to tolerate the local precipitation cycle, winds, extreme winter and summer temperatures, radiant and reflected heat from nearby structures and surfaces, and the unique stresses of a roadside environment, such as wind from traffic, salt from winter maintenance, and drought. Because an individual city, and more commonly a county or State, may span several climatic zones, it is critical that a qualified professional assist with street tree species selection, and provide guidance on installation and maintenance.

Structure and Habit

Mature trees vary by species in the characteristics that determine their suitability for street planting, such as structural integrity of wood, form of root system, branching height, amount of organic litter drop (flowers/fruits/leaves), and degree of sensitivity to urban environmental stresses. Refer to regional resources and consult qualified professionals to select species.

Diversity and Urban Forest Resilience

Although use of a single tree species can provide a strong identity to a corridor or neighborhood, a monoculture of trees is susceptible to dramatic damage from pests or disease. Agencies should plant a diverse array of street tree species, including hardy natives, to support the overall resiliency of the urban forest.

Utilities

Providing adequate clearance between trees and infrastructure, including street lighting, signing, signals, and between trees and above- and below-ground utilities, is important to creating safer streets and pedestrian facilities. Agencies should follow local agency guidance on clearance requirements when locating new trees to avoid obscuring overhead lighting and damage to above- and below-ground utilities. Where overhead utility wires are already present, tree plantings should be compatible with that infrastructure. Many municipalities maintain a list of recommended underwire species that do not exceed a certain mature height. It is worth noting that utility conflicts with street trees can be minimized throughout a district if the jurisdiction places power lines underground or runs them through alleys. Pruning trees around utility wires is not ideal and requires guidance from qualified professionals. Species vary widely in their tolerance to pruning, and replacement may

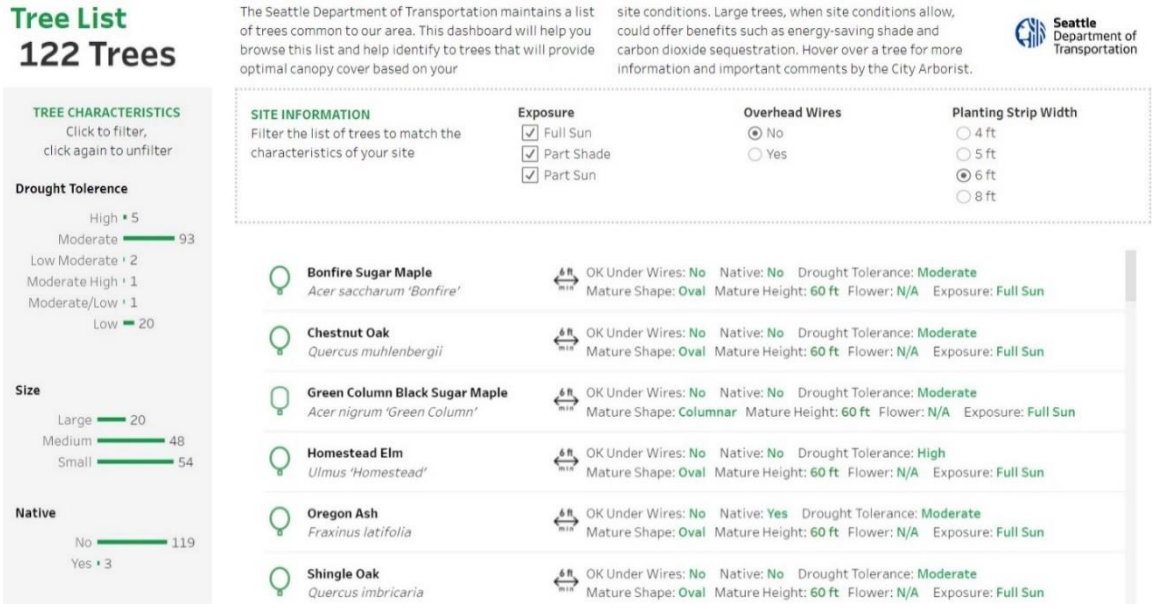


Figure 45. Graphic. Screenshot of Seattle DOT's online Tree Selection Tool (Seattle DOT, 2023).

be preferable to significant pruning in some situations. Topping trees is not advisable as it compromises the tree health and is prohibited in many localities. The section on *Vegetation Overgrowth and Debris Accumulation* has more information on vegetation control.

Tree Litter

In urban environments where trees are planted adjacent to pedestrian facilities and bike lanes, it is important to select tree species that produce minimal amounts of organic litter drop to reduce obstacles and hazards for people in wheelchairs and using other wheeled devices. Prompt clearing of leaf drop and other tree litter is also important for maintaining proper drainage and ensuring that active transportation facilities are not impeded by localized flooding. Routine seasonal maintenance, as discussed previously in section 7.7 *Seasonal Maintenance*, is critical for enhanced safety of active transportation facilities.

Sightlines and Clear Zones

Trees should be properly set back from intersections and driveways to provide clear sightlines between people in vehicles and people on foot or wheels. Continual pruning is needed to keep trees from blocking signs and signals or from extending into sidewalks and bike lanes. In lower speed urban and suburban environments with curbed streets, a minimum 4-ft lateral offset should be provided between mature trees with a 4-inch diameter or greater in sidewalk buffers and the edge of the roadway while providing adequate offset to the sidewalk (AASHTO, 2011). Lateral offsets to fixed objects in these environments may be less than the roadway clear zone minimum (AASHTO, 2018). In higher-speed environments or where curbs are not present, larger mature trees should be setback further from the edge of the roadway to provide sufficient clearance.

8.7.6. Tree Establishment

Watering

Trees require regular watering during the establishment period to keep them alive.

Source: Toole Design

Figure 46. Photo. Tree watering bag, staking and mulch during establishment period.

The establishment period is typically two to three years depending on the species and the climate. A watering plan, which may include automatic irrigation or hand watering, should be in place to ensure trees receive adequate water during the growing season.

If watering by hand, a 15-to-20-gallon tree watering bag should be placed on the tree to provide slow and deep watering (figure 46). The tree bags should be filled with water approximately two times per week. If automatic irrigation is provided, consider adding tree bubblers or using tree watering bags to provide additional water to the tree roots during the establishment period. With an automatic irrigation system, approximately 1.5-inches of water should be provided to the trees each week, taking rainfall into account.

Mulch

Mulch at the base of the tree helps to prevent weeds and keep moisture in the soil. Mulch should be reapplied to maintain a depth of approximately 3 inches. The mulch should be pulled back 6 inches from the tree trunk to prevent decay.

Tree Stakes

Tree stakes provide support and anchoring for larger trees. Smaller trees, approximately 1-inch caliper and smaller, generally do not require staking. The ties connecting the tree to the stakes should be installed with about 1-inch slack around the tree trunk to allow for tree growth and prevent girdling of the trunk. One year after installation or when the root ball is firmly in place, which can be checked by gently shaking the base of the trunk, the tree stakes and ties should be removed.

9. Funding

9.1. Methods of Funding Inspection and Maintenance Programs

A variety of sources are available to fund active transportation facility inspection and maintenance programs. In general, funding strategies can be split into two categories: programs that are funded by abutting property owners (primarily for sidewalks), and programs funded by community taxes, funds, and fees. While there may be some overlap, funding programs for pedestrian and bicycle facility maintenance are often distinct. Sidewalks have historically been maintained separately from the adjacent roadway, with adjacent property owners often playing a financial role in their maintenance in many communities.

9.1.1. Community-Funded Repair and Maintenance Programs

Many communities treat pedestrian and bicycle facilities as a community-wide asset and fund their repair and maintenance directly. Typically, these funds come from a municipality's general fund or transportation fund. For sidewalks, a community-paid program eases administrative costs compared to assessment programs and spreads the costs for pedestrian facility maintenance over the entire community. Fees and taxes that are commonly used to fund pedestrian and bicycle facility maintenance programs are briefly discussed below.

General Fund

Sidewalk repair and replacement and bicycle facility maintenance are commonly paid for through a community's general fund, which is typically funded by property and sales tax revenues. This is consistent with the way many agencies consider the funding of street repairs. Generally, sidewalk maintenance is considered separately from road repair funding; in some cases, several sidewalk maintenance projects (e.g., typically sidewalk replacement) may be lumped together and included as a line item in the capital improvement program. While sidewalk repair and replacement projects often compete with other projects and funding obligations, they should have the same priority of other types of street repairs and should not fall victim to budget cuts or shifting priorities.

Winter maintenance is also commonly funded through the general fund. Typically, cities set aside a discrete amount for snow and ice removal. With the uncertainty of the need for snow and ice removal each winter, cities may end up with a surplus or may need to pull additional money from the general fund. Most cities return surpluses back to the general fund or carry the funds over for the following year (FHWA, 2013b).

Improvement Districts

Many communities have downtown or other business district areas (i.e., Business Improvement Districts, Community Improvement Districts, Business Improvement Area, transportation improvement districts, etc.) that have assumed responsibility of sidewalk and routine bicycle facility maintenance, including winter maintenance. These special districts may fund sidewalk maintenance through their general funds or may assess local property owners for general sidewalk maintenance as well as

necessary repairs and replacements.

Homeowners' Associations

Homeowners' associations are formal legal entities created to maintain common areas. These common areas often include sidewalks and paths that are open to the public. Homeowners' associations are usually created when a new development is opened.

Their means of financing activities is similar to improvement districts or business improvement districts—typically through some form of assessment based on valuation. For example, the Columbia Association of Columbia, Maryland assesses an annual fee of 68 cents on $100 of fair market valuation, but just on 50 percent of the total valuation of a property (Columbia Association, 2022b). This association offers a complete set of community services; as part of those services, it provides maintenance for 95 miles of paths and walkways. While other services may require an additional user fee, the infrastructure for pedestrians is considered a public commodity that is included in the base assessment paid by all residents and businesses. Other homeowner associations provide a much more limited set of services, but it is common for these associations to completely fund maintenance services for pedestrian facilities if walkways have been included in the development.

State-Aid Funds

State-aid funds are aimed at distributing a portion of State fuel taxes and vehicle license fees and taxes to local governments for transportation projects. In some cases, such funding is only available for transportation projects within State-aid eligible rights-of-way. In other cases, such funds are set-aside for communities to draw on for specific transportation purposes such as safety projects. In other cases, such funds are set up as reimbursement programs in which a portion of costs that local jurisdictions incur in fixing sidewalks may be reimbursable by the State.

The availability of this type of program to local communities varies from State to State and may not be available for maintenance activities.

Special Communitywide Assessments

Some communities can target the funding of pedestrian facilities with voter-approved levies or special property tax assessments. Not all States have State-level enabling legislation making such levies or district assessments possible. The levies typically involve asking voters to approve a temporary fee or tax that will be dedicated to a specific use. While such assessments typically fund new infrastructure, it is not uncommon for sidewalk repair and replacement to be funded this way. Benefit assessment districts can be established in some States and funding can be used for general sidewalk maintenance and repair, ADA compliance, pedestrian safety improvements, or other specific programs. The City of Ithaca, New York's *Sidewalk Policy*, passed through legislation in 2014, created sidewalk improvement districts covering most properties in the city. The fee structure was as follows:

- For a "low foot traffic lot" (one-family or two-family dwelling), the fee was

$70/year.

- For most other lots, the fees were:
  - $140/year maintenance fee.
  - $0.015/ per gross ft^2 of the buildings on the property.
  - A frontage fee based on street frontage ($30 for every 55 ft of street frontage).

This money was used toward sidewalk replacement and construction, including corner curb cuts.

In August 2022, the City of Ithaca proposed increasing the flat fee by $10 for both categories and increasing the frontage fee by $20 to keep up with the increase in sidewalk construction costs (City of Ithaca, 2022).

Bonds

Governments often use bonds to address significant funding gaps and leverage existing revenues to pay for large capital expenditures. Communities in some States use bonds (e.g., Kansas City, Missouri) to fund sidewalk repair or replacement programs, usually for an entire neighborhood or large section of the community. These bonds often must be approved by residents through a referendum.

Utility Fees

Utility fees are used by some municipalities to fund street and sidewalk maintenance. Often, such fees are voter approved. Typically, the utility fee an individual household pays is relatively small, but the steady funding source enables municipalities to plan and execute maintenance activities in a systematic way.

Utility fees may be specific line items, such as a sidewalk maintenance fee collected directly by the municipality or may be a tax on electric or natural gas service collected by the utility.

Sales Tax

Many communities indirectly use sales tax revenues to fund pedestrian and bicycle facility maintenance by way of the general fund. Additionally, many States allow local municipalities or counties to impose a small local sales tax that could be earmarked for pedestrian or bicycle facility maintenance. Sales tax revenue, direct or indirect, is a common source of funding for street maintenance and there are communities that use these revenues to also fund sidewalk repair and replacement programs.

The availability of this program to local communities is typically covered by State law and varies from State to State.

Gas Tax

State gas tax revenues are a common component of sidewalk maintenance funding. Though not common, some States give local governments authority to levy local fuel taxes, typically in the range of one to three cents per gallon, to pay for roadway improvements including sidewalks. More commonly, many States share a portion of State-generated gas tax revenues with local communities to fund street improvements, often through State-aid programs as described earlier. The availability of this program to local communities is typically covered by State law and varies from State to State.

Local Fees and Taxes

Funding pedestrian facility maintenance using revenues from vehicle license fees or parking fees is not common based on information gathered from agency discussions (FHWA, 2013b). In Washington State, cities and counties are authorized to form transportation benefit districts, quasi-municipal corporations, and independent taxing districts that can raise revenue for specific transportation projects, usually through vehicle license fees or sales taxes. Transportation benefit district revenue may be used for construction, maintenance, and operation costs (Municipal Research and Services Center, 2022). The State of Arizona's *Highway User Revenue Fund*, a portion of which is distributed among the State's cities and counties, receives funding from vehicle license fees. Some States, such as Wisconsin, allow for the collection of a wheel tax at the time of vehicle registration with the stipulation that that tax revenue be used for "transportation" purposes (Wisconsin DOT, 2022). Seattle was the only community surveyed that explicitly mentioned using vehicle license fees to partially fund its ADA program, which includes replacing curb ramps (FHWA, 2013b).

Citation Revenue

Funding pedestrian and bicycle facility maintenance using revenues from Automated Traffic Enforcement (ATE) cameras is not common based on information gathered from agency discussions. However, communities may choose to dedicate some of the revenue from ATE to active transportation safety projects, which may include maintenance and repair for improved safety.

Federal Funds

Federal transportation funds are a common source for financing pedestrian facility construction and facility preservation. Such funding may be used to supplement other available financial resources, and typically is used for targeted projects such as replacing large segments of sidewalks, installing accessible curb ramps, and installing and upgrading pedestrian signals. Common Federal grant funding sources used for pedestrian facilities by communities include Community Development Block Grants and the Federal-aid Highway Program. A comprehensive Federal website that lists grant opportunities is www.grants.gov. Note that this is a resource for discretionary grants; however, it does not include all grant sources (e.g., FHWA formula grants). See *Pedestrian and Bicycle Funding Opportunities* for several USDOT programs that can support pedestrian projects.

Two of the more common programs to correct accessibility deficiencies are the Surface Transportation Block Grant (STBG) program and the Transportation Alternatives Set-Aside from the STBG. Funds apportioned under these programs may be used to correct deficiencies for facilities in the public-rights-of-way (e.g., sidewalks and curb ramps) and on shared use paths and other off-road trails. These may be identified in the State's or local government's ADA transition plan.

The *Highway Safety Improvement Program* (HSIP) can be another key funding source

for maintaining facilities. HSIP funds can be used on improvements for pedestrian or bicyclist safety or safety of persons with disabilities (23 U.S.C. 148(a)(4)(B)(v)). As with all Federal funding sources, rules and restrictions may limit some usage.

In some urban areas, Environmental Protection Agency funding for air quality and green infrastructure (stormwater management) can be used to build or make improvements that also benefit active transportation users. For example, with green infrastructure projects, building curb extensions for new drainage methods can at the same time improve a pedestrian crossing.

Tax Incremental Financing (TIF)

Some communities use TIF to address pedestrian facility maintenance needs in commercial areas undergoing extensive development or redevelopment. TIF is a method to use future expected gains in taxes to subsidize current improvements. TIF districts operate in most States and are typically targeted toward making improvements in distressed, underdeveloped, or underused parts of a jurisdiction to encourage new development.

Piggy-Back Funding

One of the best ways to maintain pedestrian and bicycle facilities is to piggy-back maintenance needs with other improvements within the public right-of-way. For example, a municipality may require utilities to install or replace sidewalk segments within a certain distance of a project that involves digging up the right-of-way. The cost of replacing sidewalks can also be folded into large projects such as utility line replacements and street resurfacing. Also, accessibility-related improvements could target sidewalks, curb ramps, and paths most in need of repair.

9.1.2. Property Owner Assessment for Repair

As discussed in detail in section 5.2 *Compliance*, assessment programs assess abutting property owners for the costs of maintaining or replacing pedestrian facilities. Property owners may be held responsible for the full cost of the maintenance, or the jurisdiction may pay part of the cost. This is a common means of financing sidewalk replacements in some States but is nearly nonexistent in other States.

The primary benefit of an assessment program is that it allows a community to directly recover costs for pedestrian facility maintenance as maintenance is performed. Assessments also allow property owners to see and directly benefit from payments that they are making to the municipality; general fees or taxes that may fund transportation improvements are not as visible to those paying the fee or tax. However, systems that assess abutting property owners for the costs of pedestrian facility maintenance raise equity, political, and compliance concerns as discussed in section 5.2 *Compliance*.

9.2. Methods of Funding Bicycle Facility Maintenance

Ongoing maintenance is crucial for a safe bikeway system. Unlike sidewalks or paths, on-street bikeways are often assumed to

be part of the roadway when it comes to maintenance unless otherwise specified. This means that the regular upkeep of the bikeway and the funding to support it are the responsibility of the community or jurisdiction that owns the roadway. Standard bike lanes and bike boulevards can get rolled into the maintenance schedule and funding of the road, with minor cost increases for upkeep of the additional markings, symbols, and detection associated with the bikeway. However, when implementing separated bike lanes, the upkeep and maintenance may be an additional cost that needs to be identified in the planning and design phase. Active transportation programs or safety divisions of transportation departments should set aside funding specifically for maintenance of new and existing bikeways. Additionally, jurisdictions may set up licensing and maintenance agreements with developers or community partners and nonprofits when the facilities are built that assign ongoing maintenance and upkeep responsibility. The additional maintenance costs associated with connected and safe bicycle networks should not be a deterrent to implementation, and jurisdictions should identify these costs and adjust their programs accordingly.

9.3. Funding Summary

Communities often struggle with a backlog of maintenance needs, and this tends to be especially true for active transportation facilities. However, to better achieve safety, equity, livability, and climate action goals, it is important for communities to adequately fund their maintenance programs to ensure their active transportation facilities are well-maintained and accessible to all people. Communities should be creative in drawing on a variety of funding sources to keep their active transportation facilities in good repair.

10. Conclusion

The maintenance of active transportation infrastructure is integral to pedestrian and bicyclist safety, ensures accessibility, and creates more equitable transportation systems. FHWA is committed to Complete Streets, which addresses the transportation needs of all users. To ensure that Complete Streets remain safe and accessible, ongoing maintenance of sidewalks, curb ramps, crosswalks, signals, street trees, signs, and bikeways is critically important. Communities may take different approaches to maintaining their active transportation infrastructure but proactively planning, inspecting, and addressing maintenance needs helps to improve safety, reduce liability, fully leverage available funding, and manage what can often seem an insurmountable task. This Guide is intended to provide a framework for agencies responsible for maintaining active transportation infrastructure, as well as details for determining when maintenance is needed and appropriate methods for addressing a variety of maintenance issues.

11. Appendix

Disclaimer: The policies and ordinances that appear in this section are intended to be examples only.

Appendix A: Sidewalk Inspection and Maintenance, LMC Model Policy

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Introduction

The city of _____, Minnesota has _____ miles of public sidewalks. Public sidewalks vary in age and in quality of condition. Not every mere inequality or irregularity in the surface of the sidewalk rises to the level of a defect. The city recognizes that some sidewalk conditions create unreasonable hazards for pedestrians and other sidewalk users.

The city has limited employee and financial resources and cannot reasonably replace all sidewalks needing replacement or repair in the same year the sidewalk is identified as needing replacement and repair. Sidewalk replacement and repair can be costly. Comprehensive sidewalk surveys are higher cost and require the use of limited city personnel and other resources. Under appropriate circumstances, some or all of the cost of sidewalk replacement may be passed to the adjacent property owner.

Accordingly, the city and its Public Works Department must exercise both discretion and professional judgment in determining whether and when sidewalks need to be replaced or repaired. The city expects that its agents, employees, and city officials will exercise discretion in identifying conditions requiring replacement and repair, in the scheduling of replacement and repair and in establishing priorities for replacement and repair.

Sidewalk Inspection Procedures

The _____ *(Insert Street Superintendent / Director of Public Works / City Engineer or other applicable staff member)* shall establish procedures for regular sidewalk inspection. Those procedures will include:

- An initial city-wide sidewalk survey to be completed by_____ (Insert date)
- A schedule for routine sidewalk inspections on a regular basis
- Criteria for determining whether a particular sidewalk condition is in need of replacement or repair. Those criteria will include, but not necessarily be limited to, a deviation or difference in elevation greater than_____ (Insert measurement, e.g. ½, ¾, 1) inch, as determined at the time of inspection.

Sidewalk Replacement and Repair Policy

Upon completion of the initial sidewalk survey, the _____ *(Insert Street Superintendent / Director of Public Works / City Engineer or other applicable staff member)* shall establish a replacement and repair schedule. This schedule is subject to modification based both on sidewalk conditions and the availability of resources for sidewalk replacement and repair.

The sidewalk replacement and repair schedule will:

- Divide the city into sections or otherwise prioritize replacement of the sidewalks identified as needing replacement or repair so all sidewalks

identified in the initial sidewalk survey as needing replacement or repair are replaced or repaired by _____ *(date)*.

- Take into consideration and weigh the following factors:
  - Sidewalk location and amount of pedestrian traffic
  - Proximity of sidewalk identified as needing replacement or repair to other sidewalks also needing replacement or repair
  - The nature and severity of the condition needing replacement or repair
  - The city's budget for replacement or repair of sidewalks
  - Whether, or to what extent, the cost of repair can be recovered from adjacent property owners
  - Availability of employees, equipment, and other resources for sidewalk replacement or repair
  - Public safety
  - History of prior accidents or complaints
  - Schedules of independent contractors and work necessary to prepare bids and bid specifications if work is to be performed by independent contractors

Sidewalk Maintenance Policy

City employees will be responsible for removing snow from sidewalks that abut city-owned buildings or parking lots. Adjacent property owners, including other public entities, are responsible for removing snow and ice from sidewalks that abut their property (see City Ordinance No. _____). The city may, as a public service and for reasons of public safety, remove snow and ice from sidewalks. The _____ (*Insert Street Superintendent / Director of Public Works / City Engineer or other applicable staff member*) will identify sidewalks from which the city will remove ice and snow.

Review and Modification of Policy

The City Council may modify or clarify this policy at any time. Where the city council has delegated responsibility or authority to any city employee or official for development or implementation of any portion of this policy, that employee or official shall have full authority to modify that portion of the policy at any time. The _____ (*Insert Street Superintendent / Director of Public Works / City Engineer or other applicable staff member*) will keep on file comments and complaints received regarding this policy. The policy will be reviewed periodically. Any review will consider comments and complaints since the last review and any other factors affecting the policy or its implementation.

Effective Date of Policy

This policy shall be effective as of_____ (*insert date*). Modifications of the policy shall be effective on the date said modifications are approved by city council resolution, or on the date city employee or official (with authority granted by the city council) has approved the policy modification or change.

Appendix B: Eau Claire, Wisconsin Sidewalk Ordinance (City of Eau Claire, 2017)

Chapter 13.04

CONSTRUCTION AND REPAIR*

Sections:

13.04.010 Installation of sidewalks--General. This chapter is adopted pursuant to the authority provided in Wis. Stats. 66.615(7). Subject to other provisions of this chapter, sidewalks shall be constructed as follows:

A. Within new subdivisions, as provided in Section 17.12.280 of this code. The provisions of s. 13.04.020, entitled "Deferral of sidewalk construction," and s. 13.04.025, entitled "Procedures for deferral of sidewalk construction," shall not apply to this subsection A. for the construction of sidewalks within new subdivisions.

B. Abutting any lot described on a certified survey map under Wis. Stats. s. 236.34, or any other unplatted lot, at the time when the main building on the lot is initially constructed or when it is entirely reconstructed or replaced. Prior to issuance of a building permit for such construction, reconstruction or replacement, the property owner shall execute and file with the city Administrator of Inspections and Zoning a written document certifying installation of a public sidewalk abutting such lot or execute a petition to the city for such installation and the levy of special assessments in connection therewith and waiving notice and hearing pursuant to Wis. Stats. s. 66.60 (18).

C. Along streets lying within one-half mile of a public or private elementary or secondary school;

D. Along any street or portion of street which is classified by the city council as a collector street or arterial street under the functional street classification system of the city;

E. Where the installation of a sidewalk will connect previously constructed and existing sidewalks within the immediate area;

F. When property owners who own over one-half of the frontage along a street file a petition with the city requesting that sidewalks be installed along such frontage; and

G. At such other locations where the city council determines that one or more of the following conditions exist:

1. Vehicular and pedestrian

conflicts present a potential danger to the health and safety of persons; or

2. The number of small children, senior citizens or other persons having special needs reside on a street and require a sidewalk to assure their safety; or

3. Parks, playgrounds or other locations exist which are attractive to large numbers of children and are not served by sidewalks thereby resulting in an immediate danger to the health and safety of such children. (Ord. 6285 §1, 2002; Ord. 4510 §1, 1984).

13.04.020 Deferral of sidewalk construction.

Sidewalk shall be constructed in all locations as outlined in section 13.04.010, except the city council retains the authority to review any sidewalk proposal and to designate procedures to defer the construction thereof whenever it is deemed necessary and desirable. A deferral shall not constitute a permanent waiver of sidewalk construction, and the city council may review and reconsider the need for construction at any time. Sidewalk construction may be deferred in the following situations:

A. Where the construction would be along a cemetery, outlying industrial property, or in any other area where little or no pedestrian use is reasonably anticipated;

B. Where the owner of the property adjacent to the street elects to provide an alternative pedestrian facility which is acceptable and approved;

C. When it is determined that the construction of sidewalk is not feasible or practical due to topographical or other physical constraints; or

D. When it is found that construction of sidewalk would not serve the public interest, safety or convenience. (Ord. 4981, 1989; Ord. 4510 §2, 1984).

13.04.025 Procedures for deferral of sidewalk construction.

All requests for deferral of sidewalk construction shall be submitted in writing to the department of public works. Applications for deferral of sidewalk construction shall be processed as follows:

A. The director of public works is authorized to approve the deferral of sidewalk construction under the following circumstances:

1. Where the location is on a cul-de-sac or dead-end street of 750 ft or less in length and no other sidewalk exists on the cul-de-sac or dead-end street segment;

2. Where development is substantially complete in the area and no other sidewalk exists on the street segment;

3. Where the location is a remote rural area and no sidewalk exists or is planned to be

constructed in the near future;

4. In locations where the city has programmed or scheduled street construction as part of the capital improvement program; or

5. Where topography, street grades or physical constraints make the construction impractical.

B. Decisions rendered by the director of public works may be appealed by the applicant to the city council for consideration and determination by the council.

C. All applications for deferral of sidewalk construction for reasons not included in subsection 13.04.025 A. shall be submitted to the city council for review, consideration, and determination.

D. Locations where construction of sidewalk is deferred shall be subject to the following conditions:

1. A concrete sidewalk section shall be constructed at the time the driveway is constructed in the location and at an elevation established by the department of public works which is calculated to accommodate a possible future sidewalk in the location.

2. The terrace and yard area shall be graded to meet a possible future sidewalk in the location and elevation established by the department of public works. This subsection shall not apply where sidewalk construction is not practical for topographic reasons. (Ord. 4981, 1989).

13.04.030 Design and construction of sidewalks.

A. Sidewalks shall be constructed in accordance with city specifications as established by the Department of Public Works. Subject to the provisions of subsection B, and unless as otherwise directed by the Director of Public Works, the width of all sidewalks in residential areas shall be 5 ft. The sidewalk width in all other areas shall be established by the Director of Public Works.

B. The design of sidewalks shall be flexible and shall be adapted to suit the particular needs of the area within which they are constructed. The materials used and designs employed in connection with sidewalk construction shall be consistent with topography and aesthetics. Trees shall not be removed in order to construct sidewalks unless their removal is reasonably necessary in order to accommodate such construction, as determined by the Director of Public Works. If a boulevard exists, as much space as possible shall be retained on it to provide for the storage of snow. (Ord. 4510 §1, 1984).

13.16.010 Obstructing--Littering--Vegetation control.

A. No person shall place, deposit or cast or cause to be placed, deposited or

cast upon any street, alley, gutter, sidewalk or public ground within the city any grass clippings, leaves, ashes, rubbish, paper, snow or ice or anything or substance whatever which may obstruct any such street, alley, gutter, sidewalk or public ground, or impede, hinder or endanger travel thereon, or which shall or may injure or disfigure the same, or tend to the injury or disfigurement thereof, or tend to render the same unclean or a nuisance; nor shall any person cause or suffer any motor vehicle or other vehicle, or any box, crate, bale, package, merchandise or other thing to stand or be in or upon any such street, alley, sidewalk or public ground longer than may be actually necessary, under a penalty of up to fifty dollars for each and every offense.

B. No person shall permit any vegetation growing on premises owned or controlled by him to obstruct or impede, hinder or endanger travel upon any street, sidewalk, or alley under like penalty. (Ord. 4246 §4, 1982; Ord. 3936 §4, 1978; Ord. 3639, 1976; prior code §5.01).

13.20.010 Cleaning of snow and ice required.

A. The owner of every lot or parcel of land shall keep the public sidewalk adjacent to said premises reasonably free and clear from snow and ice and shall clear the snow from such sidewalk within twenty-four hours following a snowfall. Any owner violating the pro-visions of this section shall be subject to a forfeiture of not less than five dollars nor more than fifty dollars for each offense. Upon the failure of an owner to clear any sidewalk as required under this section, the City shall cause the sidewalk to be so cleared and shall cause the cost thereof to be levied as a special tax chargeable to such lot or parcel of land to be collected like other taxes upon real estate, as prescribed in Wis. Stats. s. 66.615

B. "Sidewalk" as used in this chapter means any sidewalk, path, walk or way regularly used by pedestrians along any opened and established street and within the boundaries of such street. (Ord. 4262, 1982; Ord. 3599 (part), 1976; prior code §5.12).

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* For provisions of general municipality law authorizing city councils to require sidewalks and to provide rules for their grade, construction, maintenance and repair, see WSA 66.615; for provisions of general charter law regarding street improvement and repair, see WSA 62.16.292 (Eau Claire 6/2002)

Appendix C: Des Moines, Iowa Sidewalk Ordinance

City of Des Moines, Iowa Sidewalk Maintenance Ordinance Section 102-42 - Maintenance.

(a) The owner of any property abutting a public sidewalk shall maintain the sidewalk in a safe condition, in a State of good repair, and free from defects. The abutting property owner may be liable for damages caused by failure to maintain the sidewalk.

(b) In the sole discretion of the department director and if funds and personnel are available for the same, the city inspector may, but is not required to, conduct voluntary inspections of city sidewalks following receipt of a sidewalk complaint to assure that the owners of property abutting sidewalks are complying with the maintenance requirements imposed above.

(c) (1) If, through sidewalk complaint and voluntary inspection or otherwise, it comes to the attention of a city inspector that an owner of property abutting a sidewalk is not complying with the maintenance requirements imposed above, then the city inspector may cause to be served upon the property owner, by certified mail at the property owner's last known address as shown by the records of the county auditor, notice of the sidewalk defect and of the requirement to cure said defect and/or reconstruct the defective sidewalk or a portion thereof within 180 days from the date of said notice.

(2) In response to said notice, the property owner may submit a written request to the city inspector for an 180 day extension of time to cure the sidewalk defect and/or reconstruct the defective sidewalk, for a total period, as extended, of up to 360 days from the date of the notice to cure and/or reconstruct.

(3) Said notice, if given, shall also State the nature of any immediate or interim repairs or precautions required to be undertaken by the property owner following notice but prior to repair of the sidewalk defect, including but not limited to temporary asphalt wedges, barricading, and placement of protective devices.

(4) Said notice, if given, shall also State that if the property owner does not make the required immediate or interim repairs, and/or cure the sidewalk defect and/or reconstruct the sidewalk within 180 days from the date of the notice or within such extended time as approved by the city inspector, the city may pursue action against the property owner for civil infraction, and/or may give notice and take action pursuant to sections 102-83 and 102-84 of this Code, and/or may pursue any other legally available remedy. Failure of the abutting property owner to complete the maintenance within

180 days from the date of the notice or within such extended time as approved by the city inspector may be punishable as a municipal infraction by a civil penalty pursuant to section 1-15 of this Code.

(d) Curing of sidewalk defect and/or sidewalk reconstruction as ordered by this section shall be undertaken by property owners in accordance with division 2 of this article, except that the following code sections shall not apply: sections 102-71, 102-74, 102-81, 102-91, 102-92 and 102-93

(e) The department director may, in his or her sole discretion, establish policies and procedures relating to income-based subsidies, and to reimbursement of part or all of the cost to repair a sidewalk defect determined by the city inspector at time of inspection to have been caused by city activities and/or city trees, for property owners receiving notice of sidewalk defect. Any subsidies or reimbursements authorized in accordance with such policies shall be subject to funding availability, as determined by the department director in his or her sole discretion.

(f) In the sole discretion of the department director and if funds and personnel are available for the same, the public works department, at the request of the city inspector, may, but is not required to, place barricades or other devices or materials in such places as may serve to protect the public from sidewalks not in compliance with the maintenance requirements imposed above. If such protective devices are placed by the department, they shall not be removed until all sidewalk defects are corrected. Premature removal of the protective devices may be punishable as a municipal infraction by a civil penalty pursuant to section 1-15 of this Code, which penalty shall be available to the city as a remedy in addition to all other legally available remedies.

(g) The department director shall keep records of all sidewalk complaints received, all voluntary sidewalk inspections conducted, notices of defects sent, protective devices placed and sidewalk work done by the city for a period of three years from the date of the action and shall, to the extent required by open records law, make the same available to all persons who claim to have been damaged or injured as a result of the failure to maintain a sidewalk by an abutting property owner.

(h) This section shall not apply to multiuse recreational trails as defined pursuant to section 114-1 of this Code.

(i) Nothing set forth in this section shall be construed so as to prevent or preclude the city, or the department(s) and department director(s) responsible for enforcement of this article, from taking any emergency action or nuisance abatement action,

including but not limited to notice and assessment of costs, as deemed appropriate pursuant to chapter 42 of this Code in the event that sidewalk defects are determined by the department director to constitute a nuisance.

(C85, § 23-2.01; O.11,361; C91, § 23-2.01; O.13,314, 14,092, 14,164, 14,800, 15,107)

Sec. 102-43. Definitions—Maintenance of sidewalks.

As used in divisions 1 and 2 of this article, the following words have the following meanings:

Defect or defective condition means a public sidewalk has a defect or defective condition when it exhibits one or more of the following characteristics:

(1) Vertical separations equal to three-fourth inch or more;

(2) Horizontal separations equal to three-fourth inch or more;

(3) Holes or depressions equal to three-fourth inch or more;

(4) Spalling over 50 percent of a single square or panel of sidewalk with one or more depressions equal to one-half inch or more;

(5) A single square or panel of sidewalk cracked in such a manner that no part thereof has a piece greater than one ft^2, or is cracked in such a manner that it constitutes danger or potential danger to the public;

(6) A sidewalk with any part thereof missing to the full depth;

(7) A deviation on the staked and constructed grade equal to three-fourth inch or more;

(8) Covered in whole or in part with weeds or other plants, garbage, junk, rubbish, debris, solid waste, bird or animal droppings or any nuisances, obstructions or hazards which makes or tends to make pedestrian travel either dangerous or impractical.

City inspector means any city employee designated by the department director to undertake the city's inspection and notice actions as set forth in divisions 1 and 2 of this article.

Department director means the director of any city department charged with enforcement of any section of divisions 1 and 2 of this article, or his or her designee. Maintain or maintenance means the duty to remove and replace a public sidewalk, or a portion of a public sidewalk, all work to be performed in accordance with established city specifications in effect at the time the work is commenced, so as to render the sidewalk free from defect.

Property owner or owner means the record holder of legal title, and the contract purchaser, if there is one of record, and may be referred to as "person" in division 2 of this article.

Sidewalk means the paved portion of that area between the curb lines of the roadway and the adjacent property lines intended for the use of pedestrians.

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