Final Regulatory Impact Analysis

Public Rights-of-Way Accessibility Guidelines (PROWAG)

[ATBCB-2011-0004]

U.S. Access Board
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Executive Summary

This document is a Final Regulatory Impact Analysis (FRIA) and Final Regulatory Flexibility Analysis (FRFA) for the Public Rights-of-Way Accessibility Guidelines (PROWAG) issued by the U.S Access Board. PROWAG provides technical standards for ensuring that sidewalks, crosswalks, shared-use paths, pedestrian signals, on-street parking, and other pedestrian facilities are accessible under the Americans with Disabilities Act.

The FRIA identifies the need for the PROWAG rule, defines the selected alternative and the baseline, and presents information on the methodology used to calculate compliance costs and associated benefits. This includes data sources, key input values and assumptions, calculation methods, and information on potential limitations and sources of uncertainty. Much of this information has been refined based on prior stakeholder input and docket comments received.

This methodology is then applied to estimate the costs and benefits of major PROWAG provisions on a lifecycle basis, relative to a no-action baseline. The FRFA assesses the potential impact of these provisions on small entities, primarily small governmental units.

PROWAG guidelines are not legally enforceable until they are adopted by Department of Justice or Department of Transportation regulations, and by the four standard-setting agencies under the Architectural Barriers Act. Thus, in the strictest sense, there are no benefits or costs associated with this final rule in itself, only in any future rulemakings that are based on PROWAG. However, in the interests of promoting informed decision making, the FRIA is calculated *as if* PROWAG's provisions were legally binding.

The following table (Table 1) summarizes the quantified cost and benefit estimates. The FRIA also presents a discussion of potential compliance costs for pedestrian overpasses and underpasses; sidewalk dimensions and materials; handrails; public street toilets; and transit stops and shelters. However, these are not listed in the summary table because they are expected to have little to no overall cost impact relative to the baseline. Similarly, a number of other benefits were identified that could not be monetized using the available data.

As the relevant analysis time periods can vary by provision, the costs and benefits have been converted to annualized equivalents (using both a 7% discount rate and a 3% rate) to ease comparisons. As the figures indicate, estimated monetized benefits exceed estimated compliance costs by a considerable margin. However, some of the most important benefits of this rule, in the form of equal access to public facilities, personal freedom and independence, and the elimination of accessibility barriers to mobility, are not quantified due to the inherent difficulty in monetizing such impacts.

Table 1. Summary of Estimated Benefits and Costs (2021 dollars).:

PROWAG Provision	Annualized Cost / Benefit ($ millions, 7% discounting to 2021 base year)	Annualized Cost / Benefit ($ millions, 3% discounting to 2021 base year)	Time Period Analyzed (Years)
Detectable Warning	$1.0	$1.0	50
On-Street Parking	$11.4	$17.0	20
Passenger Loading Zones	$1.4	$1.4	20
Accessible Pedestrian Signals	$98.8	$103.6	25
Shared-Use Paths	$43.9	$60.0	15
Pedestrian Overpasses and Underpasses	$0.0	$0.0	30
Sidewalk Width	$0.0	$0.0	50
Roundabouts - Crossings	$12.6	$16.9	25
Roundabouts - Edge Detection	$2.4	$2.8	50
Curb Ramps	$22.0	$30.6	20
Stair Visual Contrast	$0.1	$0.1	50
Crosswalk Cross Slope	$3.0	$3.1	25
TOTAL COSTS	**$196.7**	**$236.5**	**-**

PROWAG Provision	Annualized Cost / Benefit ($ millions, 7% discounting to 2021 base year)	Annualized Cost / Benefit ($ millions, 3% discounting to 2021 base year)	Time Period Analyzed (Years)
Accessible Pedestrian Signals: Mobility Component	$68.9	$83.5	25
Roundabouts: Safety Component	$0.1	$0.1	25
On-Street Parking: Mobility Component	$928.0	$1,083.6	20
Multiple Provisions: New Trips Value	$14,479.3	$19,575.3	30
Multiple Provisions: Health Benefit	$0.03	$0.04	30
TOTAL BENEFITS	**$15,476.3**	**$20,742.5**	**-**

1 Introduction

This document is a Final Regulatory Impact Analysis (FRIA) for the Public Rights-of-Way Accessibility Guidelines (PROWAG) issued by the U.S Access Board. PROWAG provides technical standards for ensuring that sidewalks, crosswalks, shared-use paths, pedestrian signals, on-street parking, and other pedestrian facilities are accessible under the Americans with Disabilities Act.

In this FRIA, the major elements of PROWAG are discussed and analyzed individually, and the implementation costs of PROWAG are estimated relative to a no-action baseline. As described in more detail below and in the accompanying Final Rule, the PROWAG guidelines have been revised over time, drawing on multiple rounds of stakeholder consultation and public comment. This FRIA builds on analysis originally conducted as part of the Notice of Proposed Rulemaking in 2011 and incorporates information received via docket comments. In particular, information from stakeholder comments has been used to delineate the no-action baseline, as well as to refine the estimates of unit costs, asset lifespans, and the number of affected locations associated with PROWAG implementation.

2 Regulatory Analysis

Executive Orders 12866 and 13563 direct all Federal agencies to consider the costs and benefits of "significant regulatory actions." Federal agencies are directed to develop a formal Regulatory Impact Analysis consistent with Office of Management and Budget (OMB) Circular A-4 for all rules significant under Section (3)(f)(1) of Executive Order 12866. The Order also requires a determination as to whether a rule could adversely affect the economy in terms of productivity and employment, the environment, public health, safety, or State, local, or tribal governments. This requirement applies to rulemakings that rescind or modify existing rules as well as to those that establish new requirements. The goal of the analysis is to provide decision makers with a clear indication of the most efficient alternative. In keeping with these requirements, this FRIA:

- Identifies the target problem, including a statement of the need for the action and the associated market failures
- Identifies available alternative approaches for addressing the target problem
- Defines the baseline
- Defines the scope and parameters of the analysis
- Defines and evaluates the costs and benefits of the action relative to the baseline, quantifying these costs and benefits to the extent possible with available information
- Compares the costs and benefits and interprets those results
- Addresses the equity implications of the action.

2.1 Identification of the Problem and the Need for the Rule

Executive Order 12866 states that "Federal agencies should promulgate only such regulations as are required by law, are necessary to interpret the law, or are made necessary by compelling need, such as material failures of private markets to protect or improve the health and safety of the public, the environment, or the well-being of the American people ..." Executive Order 13563 states that, to the extent permitted by law, agencies must (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor its regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.

The Americans with Disabilities Act (ADA) and the Rehabilitation Act charge the Access Board with responsibility for the development of minimum guidelines aimed at ensuring the accessibility and usability of pedestrian facilities by persons with disabilities. See 29 U.S.C. 792(b)(3)(B), 49 U.S.C. 12204, 12149(b). The guidelines are also issued under the Architectural Barriers Act of 1968 (ABA), which requires buildings and facilities constructed or leased by the federal government to be accessible to persons with disabilities. These guidelines serve as the minimum requirements for enforceable standards issued by other agencies pursuant to their responsibilities under the ADA and ABA. 29 U.S.C. 792(b)(3)(A) & (B).

Accessibility requirements for federal facilities have existed since the passage of the ABA in 1968. However, guidelines issued under that law have historically focused on buildings and sites and have not specifically addressed accessibility issues unique to public rights-of-way. After enactment of the ADA in 1990, the Access Board began development of additional accessibility guidelines, including accessibility guidelines for pedestrian facilities in the public right-of-way. The Board’s first set of accessibility guidelines under the ADA was issued in 1991 but did not include requirements for pedestrian facilities in the public right-of-way. The Access Board conducted training programs and produced a series of videos, a design guide, and an accessibility checklist for pedestrian facilities in the public right-of-way. Additionally, they coordinated with various transportation industry, state, and local organizations.

In 1999, the Access Board established a federal advisory committee to recommend accessibility guidelines for pedestrian facilities in the public right-of-way. The Access Board developed draft accessibility guidelines for pedestrian facilities in the public right-of-way based on the advisory committee’s recommendations and made the draft guidelines available for public review and comment in 2002. The Access Board revised the draft guidelines in 2005 and made the revised draft guidelines available for public review to facilitate the gathering of data for a regulatory assessment of the potential costs and benefits of the guidelines. In 2011, proposed guidelines were published in a Notice of Proposed Rulemaking (NPRM), and the Access Board received approximately 600 stakeholder comments via the docket system. A supplemental NPRM was issued in 2013 to include specific guidelines for shared-use paths.

PROWAG is intended to ensure accessible public access to facilities for pedestrian circulation and use within the public right-of-way that are usable by pedestrians with disabilities. These guidelines specify accessibility features for several covered elements of the public right of way, providing consistent dimensions and other standards. Consistent and clear guidelines in turn reduce complexity and costs of compliance. PROWAG does not address existing facilities unless they are included within the scope of an alteration to an existing facility undertaken at the discretion of a covered entity.

Several market failures exist that prevent full accessibility of public rights-of-way from being achieved solely from the operation of an unregulated private market. Notably, sidewalks and other elements of public rights-of-way are considered public goods because they are largely nonrival in consumption, and it is not feasible, or generally desirable, to exclude users for non-payment. Such facilities are almost always provided by the public sector since there is no viable private market for them. There are also issues with coordination and limited information, as in the absence of published accessibility standards, such that each local agency would bear the cost of conducting or accessing research on how to design sidewalks and other facilities to achieve accessibility for different types of users.

2.2 Identification of Available Alternative Approaches

2.2.1 No Action

Regulatory analyses typically consider an alternative in which the agency would not take any action, and thus the status quo would be maintained. Under the no-action alternative, no new requirements would be instituted, and no costs would be incurred to implement new requirements. There would likewise be no corresponding benefits.

More specifically in the case of PROWAG, the no-action alternative would imply that technical standards for sidewalks and other components of the public right-of-way would remain as they are under current state and local design guidelines and construction practices. New and altered facilities would be accessible in some cases but not others, as detailed below for specific types of accessible features and elements. Travelers with disabilities would still encounter inequities in their ability to use the public right-of-way and would have associated difficulties in making trips and accessing jobs and services.

This was used as the baseline against which benefits and costs were calculated. As discussed below, this baseline is somewhat of a simplification of reality, as even in the absence of PROWAG, state and local governments would still be responsible for ADA compliance in their public rights-of-way. Some existing construction practices and design standards could change due to litigation. However, the “no action” baseline was chosen to be conservative.

2.2.2 Selected PROWAG option

Under this option, PROWAG would be adopted and would become the formal accessibility standard for sidewalks and other elements of the public right-of-way. This includes technical standards for curb ramps, detectable warning surfaces, pedestrian signals, on-street parking and passenger loading zones, shared use paths, and other facilities.

PROWAG would apply to new and altered facilities in the public right-of-way only. There is no requirement to retrofit existing facilities that are not undergoing alteration. PROWAG also does not create any underlying requirement for the federal government or for a state or local government to provide pedestrian facilities, only that any such facilities that are provided must meet accessibility standards. As an example, many suburban and rural communities do not provide sidewalks along their roads;

PROWAG does not require sidewalks to be installed but provides technical accessibility standards that would need to be followed if sidewalks were added later.

Executive Order 13563 expresses a preference for performance rather than design standards, and in some provisions PROWAG provides a range of options that can be used to achieve the same result (for example, for pedestrian crossings at roundabouts). However, in practice, performance-based standards can be difficult to implement in the context of sidewalk and roadway construction, which relies on standardized units. PROWAG strikes a balance by defining many of its provisions in the form of specific dimensions and specifications that can be used in procurement and construction.

2.2.3 Other Alternatives Considered

As explained in the preamble to the final rule, consideration of the content of accessibility guidelines for public rights-of-way has been underway for over three decades. In that time, many iterations of these requirements have been considered. The Board here notes three specific alternative approaches considered in this final phase of the rulemaking process:

- Use of Engineering Judgement to Determine Installation of Accessible Features—an approach where local and state DOTs would use engineering judgment to determine whether an accessible feature would be installed.
- Treatment of Added Facilities—an approach where added facilities were to comply with the applicable requirements for new construction.
- Crossing Treatments at Roundabouts—an approach where the crosswalk treatments at roundabouts applied to *all* roundabouts, rather than only multilane roundabouts.

Further discussion of these alternatives, including relevant analysis of the costs and benefits of these alternate approaches, can be found in Section 10.

3 Definition and Evaluation of the Benefits and Costs

3.1 Definition of Baseline

Benefits and costs are calculated for the selected PROWAG alternative relative to a no-action baseline. As described above, the no-action baseline represents a continuation of existing state and local design standards and construction practices. The details of the baseline vary significantly across PROWAG provisions, because in some areas existing practices align fairly closely with PROWAG, while in other cases there are larger differences.

An alternative analytical choice would be to assess that accessibility of public rights-of-way *should be considered part of the baseline*, since accessible facilities are already required by the Americans with Disabilities Act and the Architectural Barriers Act (ABA). In that case, PROWAG would be viewed as providing technical guidance on how to assess the degree of compliance. Incremental costs and benefits would be minimal, though PROWAG might still yield cost savings by providing a single, clear standard and thus reducing the costs and complexity of implementation and the costs of potential litigation. Although this could be a valid view of the baseline, this FRIA is instead calculated using a de facto baseline as reflected in existing practices. This approach is intended to provide more useful information on likely costs and benefits, and thus to support informed decision making.

Likewise, it is worth noting that PROWAG guidelines are not legally enforceable until they are adopted by Department of Justice or Department of Transportation regulations, and by the four standard-setting agencies under the ABA. Thus, in the strictest sense, there are no benefits or costs associated with the adoption of PROWAG in itself, only in any future DOJ/DOT rulemakings that are based on PROWAG. Again, however, in the interests of promoting informed decision making, the FRIA is calculated *as if* PROWAG's provisions were legally binding.

3.2 Key Variables, Data Sources, and Limitations

Unless otherwise noted, cost and benefit calculations in the sections below are expressed in 2021 dollars. Future values are discounted to present value terms, with a base year of 2021. The main analysis uses a 7% real discount rate, with a 3% rate also presented as a sensitivity analysis.

Unlike many other forms of transportation, there is no comprehensive national database of sidewalks or other pedestrian facilities. In the sections below, estimates of the current inventory of facilities and the expected levels of future growth have been drawn from available state and local data, published research, docket comments, and other sources. Future growth rates have been forecast using proxies such as growth in population or roadway mileage. Although the study team has used the best available information, estimating cost and benefit impacts on this scale has an inherent element of imprecision. Some of the cost estimates include specific low-high ranges to illustrate this uncertainty, but all estimates should be considered as best estimates rather than definitive.

A more specific limitation of this approach is that the sources of local data are not always representative of the nation as a whole. Large cities and university communities that have robust data collection programs and available Geographic Information System (GIS) files are also likely to have a greater provision of sidewalks and pedestrian facilities and to invest in accessibility features. Indeed, in some cases the data collection effort itself stems from a need to track these investments. As a result, it is possible that by relying on the available data sets, the study team has overestimated the prevalence of pedestrian facilities and thus the associated costs. At the same time, estimates of the baseline level of accessibility may be overstated, which would tend to reduce the costs of the rule. Thus, these data limitations work in opposite directions on the cost estimates, though their magnitude is not known.

The available data from states and localities could potentially omit or undercount relevant pedestrian facilities on federal lands, which are still within the scope of PROWAG. However, the study team verified that several of the databases used in developing cost estimates (including those for roundabouts and shared-use paths) did encompass federal facilities. Thus, this data limitation appears to be unlikely to have a significant influence on the final cost and benefit estimates.

The most important benefits of this rule, in the form of equal access to public facilities; personal freedom and independence; and the elimination of accessibility barriers to mobility, are difficult to quantity. There are few widely accepted methodologies for monetizing these impacts, and the impacts can vary significantly from person to person and in different contexts. The benefit discussion captures some elements of these impacts by translating them into concepts that can be more readily quantified, such as travel time savings. Nonetheless, the monetized benefit total as presented in this FRIA does not reflect the full spectrum of societal benefits.

A summary table (Table 2) of the data limitations' effect on estimates is included below.

Table 2. Data Limitations.

Limitation	Effect
Limited data on total inventory (e.g., sidewalks, parking) and baseline compliance rates.	The study team has estimated these elements using the best available information, but the resulting cost and benefit figures are inherently imprecise due to these data limitations.
Available data sources are not necessarily nationally representative.	Both number of facilities and the extent of current accessibility may be overstated. These factors work in opposite directions on the total cost estimates.
Most important benefit categories are difficult to quantify.	Total benefits as calculated are understated, but these impacts are noted qualitatively.

3.3 Terminology

PROWAG uses the terms "newly constructed" and "new construction" to refer exclusively to pedestrian facilities constructed on undeveloped land and considers pedestrian facilities added to existing right-of-way to be alterations. This distinction is made in PROWAG, which applies a somewhat less stringent standard to facilities added to existing right-of-way, because of physical constraints that might exist there that would not be present on undeveloped land. By contrast, in the FRIA's cost estimation methodology, the more relevant distinction is usually between existing facilities and those that will be added in the future, whether on developed or undeveloped land, since added facilities would typically be constructed using updated Federal, state and/or local design guidelines in the no-action baseline. An example would be an existing stop-controlled intersection that is converted to a roundabout. This would typically be constructed according to relevant design guidelines for new facilities – and might be colloquially described as a "new" roundabout – but for PROWAG purposes, it would be considered an alteration rather than a new facility. To avoid confusion, this FRIA generally uses the terms "added" or "additional" facilities rather than "new" or "newly constructed," unless the distinction is otherwise clear from context. In this FRIA, "added" or "additional" facilities may reference facilities that are added to an existing right-of-way or are part of an entirely new development. This terminology issue does not significantly affect the cost and benefit calculations but is noted here for clarity.

4 Costs

The following sections detail cost calculation methodologies and total costs for each of the major PROWAG elements. Total costs are the sum of the individual cost elements. Analysis time periods differ across the major PROWAG elements due to variations in expected implementation rates and the lifespan of the affected assets. As such, costs are presented for each major PROWAG element on an annualized basis, using a 7% discount rate.

4.1 Detectable Warning Surfaces

4.1.1 Background

Detectable Warnings Surfaces (DWS) are distinctive sections of raised material that are used at curb ramps and other locations to provide pedestrians with a tactile indication underfoot and contrast to the surrounding paving material. DWS alert pedestrians who are blind or have low vision to the transition between the pedestrian way and the vehicular way.

The PROWAG guidelines provide technical standards for DWS, including their size, the pattern and spacing of the truncated domes used in the design, and the level of visual contrast to the surrounding material. In general, DWS would be required for new and altered facilities at five types of locations: curb ramps and blended transitions; pedestrian refuge islands; at-grade rail crossings; transit boarding platforms; and commercial driveways. (DWS would also be required in some locations along shared-use paths; these impacts are discussed in a separate section on shared-use paths.) The guidelines include additional technical detail, such that these location types would require DWS only when meeting specified criteria. These details are discussed below.

4.1.2 Methodology Overview, Terminology and Key Assumptions

This cost summary builds on research conducted as part of a previously published report, "Cost Analysis of Public Rights-of-Way Accessibility Guidelines" (hereafter, Initial PROWAG Cost Report).[1] Material from that report was incorporated into the preliminary regulatory assessment that was included with the PROWAG Notice of Proposed Rulemaking (NPRM).

The Initial PROWAG Cost Report included a section on estimated unit costs for DWS materials at curb ramps. This document is intended to provide updated unit costs of DWS materials and installation, as well as provide information on unit costs with respect to the use of DWS in the other location types.

Implementation costs for DWS were defined relative to a no-action baseline in which the guidelines are not adopted and current practices continue with respect to DWS. These implementation costs were estimated using a three-stage process. First, unit costs for DWS were estimated based on materials and labor costs for the DWS itself. Second, the number of affected locations within the United States was estimated for each of the five location types, using a range of available data sources, as described in more detail below. Third, unit costs were combined with the number of affected locations to generate annual total costs for a single year and a total discounted value over a multi-year period.

4.1.3 Unit Costs: General

As noted above, unit costs for DWS were gathered using a combination of online price quotations, discussions with city public works departments, earlier Access Board research, and stakeholder comments. Because DWS products come in a variety of sizes and materials, costs were generally converted to an equivalent cost per square foot for consistent comparisons.

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[1] Volpe Center, Cost Analysis of Public Rights-of-Way Accessibility Guidelines (PROWAG) (Nov. 2010), available via regulations.gov, Docket ID: ATBCB-2011-0004-0002.

In the Initial PROWAG Cost Report, DWS costs were estimated as $30 per square foot for stainless steel or cast iron, $15 to $25 for polymer/composite material, $6 to $10 per square foot for concrete pavers, and $16 per square foot for brick pavers.

NPRM comments received on this topic were generally consistent with these estimates, though some cited slightly higher cost ranges and others noted that some materials were not suitable for their climate or other local conditions. The American Association of State and Highway Transportation Officials (AASHTO)'s comments cited a typical cost of $20 to $40 per square foot, with glue-down materials at the lower end of that range[2]. Among others, the City of Seattle[3] and Washington State DOT[4] both estimated costs of $300 per unit, which is the equivalent of $37.50 per square foot.[5]

These costs are for materials only. As noted in the 2010 PROWAG Cost Report, installation labor costs will vary substantially according to location, material, and type of DWS product project type. As a point of reference, two manufacturers of composite DWS estimate that 0.5 person-hours of labor are required for the installation of a 4' by 2' panel (or 0.0625 person-hours/square foot).[6,7,8]

Specific labor costs per hour were not available from docket comments, but as a benchmark, the average wage for cement masons and concrete finishers in the highway construction industry is roughly $24 per hour.[9] Similar average wages prevail for construction laborers in the highway construction industry.[10] With an allowance for non-wage benefits and other costs of compensation, a reasonable estimate is in the range of $40 per person-hour. This would imply installation labor costs of $2.50 per square foot ($40 * 0.0625) for these product types. Labor costs could be higher for other DWS materials and/or for more complex installation situations.

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[2] Comments from American Association of State Highway and Transportation Officials, available via regulations.gov, Docket ID: ATBCB-2011-0004-0378.
[3] Comments from City of Seattle, available via regulations.gov, Docket ID: ATBCB-2011-0004-0117.
[4] Comments from Washington State DOT, available via regulations.gov, Docket ID: ATBCB-2011-0004-0072.
[5] Based on 8 square feet per DWS (e.g., 2'x4'). There are several other docket comments that generally support the $20-$40 estimate, including those from Los Angeles County, $40/sq. ft. including installation, Docket ID: ATBCB-2011-0004-0261; Oakland County, Michigan, $25/sq. ft., Docket ID: ATBCB-2011-0004-0309; Centerville, Ohio, $18.75/sq. ft., Docket ID: ATBCB-2011-0004-0582; Florida DOT, $20-50/sq. ft., Docket ID: ATBCB-2011-0004-0285 ; Minnesota DOT, $32.16/sq. ft., Docket ID: ATBCB-2011-0004-0325; Missouri DOT, $15-22/sq. ft., Docket ID: ATBCB-2011-0004-0596-; North Dakota DOT, $43.25/sq. ft., Docket ID: ATBCB-2011-0004-0216; Pennsylvania, $25-45/sq. ft., Docket ID: ATBCB-2011-0004-0294-; Texas DOT, $31.25-37.50/sq. ft., Docket ID: ATBCB-2011-0004-0100; and the New Mexico Governor's Commission on Disability, $42/sq. ft. for cast iron, Docket ID: ATBCB-2011-0004-0195-. All comments available via regulations.gov.

[6] TrafficWORKS, DWT Tough-EZ Tile, Accessed July 2016. http://www.trafficwks.com/details/ada-mats/dwt-tough-ez-tile
[7] QEP Corporation, ADA Approved Detectable Warnings System Advantages, accessed July 2016. http://www.qepcorp.com/advantages.php
[8] Reconfirmed in December 2021. http://www.qepcorp.com/advantages.php and https://www.trafficwks.com/details/ada-mats/dwt-tough-ez-tile
[9] BLS OES data (May 2020), https://www.bls.gov/oes/current/oes472051.htm
[10] BLS OES data (May 2020), https://www.bls.gov/oes/current/oes472061.htm

A small number of commenters also provided costs that were inclusive of installation labor. Des Moines, Iowa quoted $27 a square foot[11] and Illinois DOT quoted $26 per square foot[12] including materials and labor. The City of Thornton, CO provided an estimated cost of $600 for materials and labor for a 2'-by-4' cast-in-place DWS.[13] This equates to $75 per square foot and is significantly higher than other estimates, likely representing the upper end of the range.

The study team conducted an additional round of online price quotes in 2021 to gauge the extent to which unit costs for DWS materials have changed since the 2010 report. Searching within one product line, a composite 3'x4' DWS available via a major retailer has risen from $215 in 2010[14] to $253 in 2021[15], an increase of approximately 1.5% per year. The current cost is equivalent to just over $21 per square foot. Other online price quotes found composite materials at $25 per square foot[16] and cast iron at a range of $24 to $43 per square foot.[17,18] These are individual retail asking prices that do not reflect any preferential pricing for bulk purchases or other possible discounts.

Looking at construction cost bid data, many state databases do not list the cost for DWS as a separate line-item, possibly because they are handled primarily by local agencies and/or are included as a component of the larger cost category of "curb ramps." However, detailed information was located for two states. The Caltrans Contract Cost Database shows a weighted average cost of approximately $40 per square foot for construction projects during the period 2019-2021.[19] New Hampshire DOT data for 2020 includes an average cost of $499.45 per square yard for cast iron DWS[20], which is the equivalent of $55.49 per square foot. Thus, more recent price quotes for DWS correspond fairly closely to the $20-$40 range noted in the AASHTO comment from 2011, though slightly higher as might be expected due to general construction cost increases over the intervening years.

As these cost estimates illustrate, composite materials appear to be at the lower end of the range and cast iron materials at the higher end. Although both types can be compliant with the PROWAG guidelines, the

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[11] Comments from City of Des Moines, Iowa, available via regulations.gov, Docket ID: ATBCB-2011-0004-0183.
[12] Comments from Illinois DOT, available via regulations.gov, Docket ID: ATBCB-2011-0004-0069.
[13] Comments from City of Thornton, CO, available via regulations.gov, Docket ID: ATBCB-2011-0004-0240.
[14] Volpe Center, Cost Analysis of Public Rights-of-Way Accessibility Guidelines (PROWAG) (Nov. 2010), available via regulations.gov, Docket ID: ATBCB-2011-0004-0002.
[15] Home Depot, DWT Tough-EZ Tile, accessed December 2021. https://www.homedepot.com/p/DWT-Tough-EZ-Tile-3-ft-x-4-ft-Yellow-Detectable-Warning-Tile-TEZ3648YW/100660259
[16] $309 for 3'x'4' according to ADA Sign Shop, Surface Applied Truncated Domes for Installation on Concrete, accessed December 2021. https://www.adasigndepot.com/collections/truncated-domes-dry-set
[17] $95.80 for 2'x2' according to DWP, Cast Iron WET SET Replaceable Detectable Warning TufTile, accessed December 2021. https://dwpnow.com/products/cast-iron-wet-set-replaceable-detectable-warning-tuttile?variant=40409996492964
[18] $169.95 for 2'x2' according to Mainline Materials, Cast Iron Detectable Warning Mat Cast in Place, accessed December 2021. https://www.mainlinematerials.com/products/cast-iron-detectable-warning-mats-24-x-24?variant=39305907405000&currency=USD&utm_medium=product_sync&utm_source=google&utm_content=sag_organic&utm_campaign=sag_organic&gclid=EAIaIQobChMI2NjokuXe8wIViuKzCh0kogjGEAQYBCABEgIjzvD_BwE
[19] Caltrans, Contract Cost Data, retrieved on 12/2/2021. Includes all 12 Caltrans districts, awarded bids only. https://sv08data.dot.ca.gov/contractcost/results.php?item=detectable+warning&min=&max=&minU=&maxU=&unit=none&Year=y2021%2Cy2020%2Cy2019&sortby=qty&desc=&convert=&ob=1
[20] NHDOT, Weighted Average Unit Prices, 2020, retrieved on 12/2/2021. https://www.nh.gov/dot/org/projectdevelopment/highwaydesign/documents/WeightedAveragesImperial.pdf

choice of DWS material tends to vary by jurisdiction. Metal panels, for example, are often used in areas with severe winters due to the wear and tear associated with snow clearance and de-icing chemicals. In its comments, the City of Cambridge, MA, noted that it had moved to cast iron material due to installation and maintenance issues[21] with other commenters more specifically noting issues with snow and ice removal in areas with severe winter weather. Conversely, Washington State DOT noted that composite DWS are their primary choice, and that other materials are not typically used.[22] There were few, if any, comments noting the use of concrete and brick pavers.

Overall, a reasonable midrange estimate of unit costs for DWS in 2021 dollars would be $20 to $50 per square foot for materials, or $25 to $75 per square foot including materials and labor, keeping in mind that there are significant variations in DWS material choice and labor costs across locations. In the calculations below, the $25 value will be used as the low scenario and $75 for the high scenario.

For a curb ramp installation using eight square feet (2’ by 4’) of DWS materials or a single composite panel of 2’ by 4’, this implies costs of $200 (low) to $600 (high) for materials and labor. A typical 4-way intersection with sidewalks and crosswalks on all four sides would generally require a total of 8 DWS, i.e., one for each of the 2 curb ramps on each of the 4 corners. Total costs per intersection, including materials and labor, would thus range from $1,600 to $4,800. Costs would vary for mid-block crossings, T-junctions, blended transitions, and other layouts.

For pedestrian refuge islands and commercial driveways, a typical configuration would involve 2 DWS – one on each side – with a total cost of $400 to $1200. Again, this could vary depending on the layout of the site.

At rail crossings, a typical DWS application would involve 4 sidewalk-width installations, one at each approach toward the railroad on each side of the street. Assuming that each installation could be covered by a 2’-by’4’ DWS, that would mean a total of 32 square feet of DWS per railroad crossing location, for a total of $800 to $2,400 in costs, including materials and labor.

Transit boarding platforms would require additional lengths of DWS. Platform lengths vary but would tend to range from about 40 feet (the length of a standard transit bus) up to perhaps 120 feet, for a platform that could accommodate two larger, articulated buses at the same time. Using an illustrative value of 60 feet at a depth of 2 feet, a total of 120 square feet of DWS would be required, with total costs of roughly $3,000 to $9,000 including materials and installation labor.

Looking beyond installation materials and labor, relatively little information is available on possible maintenance costs for DWS and other components of their overall lifecycle costs. Prior docket comments received from state and local DOTs on DWS costs focused on installation costs and did not provide details on any incremental recurring costs.[23] In general, however, the presence of DWS does not appear to entail additional sidewalk or roadway maintenance costs. Some research has been pursued on the extent to which DWS may be damaged by snow removal operations, with one study finding that DWS are robust

[21] Comments from City of Cambridge, MA, available via regulations.gov, Docket ID: ATBCB-2011-0004-0078.
[22] Comments from Washington State DOT, available via regulations.gov, Docket ID: ATBCB-2011-0004-0072.
[23] Regulations.gov, Docket ID: ATBCB-2011-0004. DWS costs were in Question 8 in the NPRM.

but that there were some differences across designs.[24] Other studies have found that DWS are able to survive impacts and cold temperatures[25] but experience some degradation due to sunlight over time[26]. Overall, it appears reasonable to assume that there are no significant recurring costs for DWS, though more research in this area would be useful.

4.1.4 Number of Affected Locations and Total Costs: Curb Ramps and Blended Transitions

As detailed in the Initial PROWAG Cost Report, all State and local DOTs that receive Federal financial assistance must comply with the USDOT Section 504 regulations, which include a requirement for DWS at curb ramps. The USDOT Section 504 regulations cover all sidewalk construction projects, including state or locally funded projects. (See 49 CFR 27.19).

When the study team prepared the Initial PROWAG Cost Report, the review of the State DOT and the District of Columbia DOT websites found that all install DWS at curb ramps and use the technical provisions for DWS in the 2004 ADAAG, as modified by USDOT. Limited interviews with local government officials also confirmed that they install DWS at curb ramps. Comments in the NPRM docket from local governments (including Charlotte, NC; Seattle, WA; Cambridge, MA) describe the use of DWS as standard practice for sidewalk projects. As such, the incremental costs of these proposed guidelines will be minimal with respect to curb ramps and blended transitions, as discussed in the Initial PROWAG Cost Report. One potential exception is for locations where two curb ramps will be required, rather than a single, diagonal curb ramp that would have been used in the absence of the rule. This situation is discussed in the cost summary for curb ramps.

4.1.5 Number of Affected Locations and Total Costs: Pedestrian Refuge Islands

Many pedestrian refuge islands are built at curb height and thus have curb ramps at the interface with street level. In these cases, the same logic and findings from the section above would apply – that is, implementation costs would be minimal because state and local DOTs already use DWS in their standard designs for all new and rebuilt curb ramps, including curb ramps at pedestrian refuge islands. However, some island designs use a "cut-through" approach in which the portion of the island that is designed for pedestrian use is at street level rather than curb level, so no curb ramp would be present. PROWAG requires a DWS on each end of a cut-through pedestrian refuge island wherever the width is at least 6 feet, as this allows 2 feet of space between the two DWS. The rationale for the DWS is the same as for a curb ramp, in that pedestrians using a cut-through island need a tactile and visual indication of the transition between the pedestrian-only space and the space shared with motorized traffic.

The Manual on Uniform Traffic Control Devices (MUTCD) calls for the use of DWS at pedestrian islands (Section 3I.06).[27] MUTCD guidance is widely followed by state and local DOTs, though this particular statement uses nonbinding language. State-level standard diagrams and accessibility design guidelines for sidewalks do not always explicitly address the specifics of cut-through refuge island design, as distinct from more common situations such as curb ramps and driveways, though many do. The

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[24] New Hampshire DOT, Durability of Truncated Dome Systems (April 2003). http://docs.trb.org/00942591.pdf
[25] Suderman and Peters, Development of the Detectable Warning Surface Tiles Standard Specification for the City of Winnipeg (2015). http://conf.tac-atc.ca/english/annualconference/tac2015/s7/suderman.pdf
[26] Na et al., Transportation Research Record (2018). https://journals.sagepub.com/doi/10.1177/0361198118796380
[27] FHWA, Manual on Uniform Traffic Control Devices (MUTCD) Part 3, (2009). https://mutcd.fhwa.dot.gov/htm/2009/part3/part3i.htm

study team reviewed the state sidewalk design diagrams from all available states and conducted an online search for additional state-level sidewalk design manuals. This review found that wherever cut-through pedestrian refuge islands are mentioned in state design standards, DWS are required whenever the island is at least 6 feet in width.[28] (Arizona, Delaware, and Maryland also require DWS even on narrower islands, which is not consistent with PROWAG, but would not involve significant cost implications, since their current practice is more costly than what PROWAG requires.)

This review indicates that the use of DWS at new or altered pedestrian refuge islands of at least 6 feet in width is a widespread component of current state and local practice for sidewalk design and is supported by national MUTCD guidance. In this way, it appears similar to the near-universal use of DWS at curb ramps – similar accessibility considerations apply at both types of locations, namely the need to provide an indication of the transition between the pedestrian space and the area shared with motorized traffic. When further considering the lack of any counterexamples in state guidance, the use of DWS at cut-through pedestrian refuge islands at least 6 feet in width should most likely be considered part of the no-action baseline, although data limitations prevent a fully definitive conclusion regarding all 50 states. Overall, little to no incremental compliance costs are anticipated from this PROWAG provision.

4.1.6 Number of Affected Locations and Total Costs: At-Grade Railroad Crossings

At-grade rail or railroad crossings are the intersection of a line of rail and a road or highway. The draft final rule requires DWS where pedestrian routes (including sidewalks and shared-use paths) cross an at-grade rail crossing that is not located within a road or highway (thereby excluding rail vehicles that travel within the highway right-of-way, as with certain city rail systems). Typically, at-grade rail crossings provide safety control features, such as lights and gates, to prevent vehicles and pedestrians from crossing when a train is arriving.

The MUTCD does not require DWS for pedestrian at-grade railroad crossings, though it does have nonbinding language (Section 8D.04) encouraging the use of DWS when railroad tracks cross “pathways” (i.e., shared use paths) and notes that similar considerations apply to sidewalks.[29] Sixteen states include DWS in their standard road plans for rail crossings. These states are: Alabama, Connecticut, Florida, Iowa, Louisiana, Michigan, Minnesota, Mississippi, New Jersey, New York, Oregon, Pennsylvania, South Dakota, Vermont, Washington, and Wisconsin.[30] Among the remaining states, the study team’s review of state-level design diagrams did not uncover an example of a state that describes DWS as <u>not</u> required at a railroad crossing, but many states’ diagrams do not specifically cover railroad crossings.

[28] A keyword search for “cut through”, “refuge”, and “island” was performed on a file containing state DOT design diagrams, as compiled by the Access Board, and an internet search was conducted for additional state-level documentation. This research confirmed that DWS are required for cut-through pedestrian refuge islands wider than 6 feet in: Alabama, Arizona, California, Connecticut, Delaware, Florida, Idaho, Illinois, Maryland, Massachusetts, Michigan, Mississippi, New Jersey, New York, North Carolina, North Dakota, Oregon, Pennsylvania, South Carolina, Texas, Utah, Virginia, Washington, and Wisconsin. The remaining states either did not have standard design diagrams available to the study team, or did not explicitly address cut-through pedestrian refuge islands in their diagrams. It is possible that this guidance is contained elsewhere and/or that the state relies on the MUTCD standard. The study team did not identify any cases in which state-level guidance called for <u>not</u> placing DWS at cut-through pedestrian refuge islands of 6 feet or greater width.
[29] FHWA, Manual on Uniform Traffic Control Devices (MUTCD) Part 8, (2009). https://mutcd.fhwa.dot.gov/htm/2009/part8/part8d.htm
[30] U.S. Access Board communication based on review of state plans.

Overall, the extent to which DWS are installed at new or altered rail crossings in these remaining states is unknown and may be limited. This analysis therefore conservatively assumes that no new and altered rail crossings are treated with DWS other than those within states that include DWS in their standard plans. For these states, costs are calculated as described below. For the 16 states that already specify the use of DWS in these settings, their rail crossings are counted as already having DWS for all new or altered locations in the baseline, such that no incremental costs would be incurred in those states.

The Federal Railroad Administration (FRA) maintains a database of rail grade crossing locations[31], and encourages safety initiatives such as safety control features, or removing crossings where possible (either by blocking roads or through grade separation). A review of the FRA database indicates that the number of at-grade crossings has exhibited a downward trend in the recent years, likely due to these efforts. As such, and given that the U.S. rail network is mature, this assessment assumes for simplicity that the annual net change in at-grade rail crossings in the United States is effectively zero. In other words, the rate at which at-grade crossings are added is assumed to be roughly equal to the rate at which existing at-grade rail crossings are removed due to at-grade crossing elimination projects.

The assessment further assumes that pedestrian circulation paths at rail crossings are altered (triggering the requirements in the draft final rule) every 50 years on average. This corresponds to the approximate lifecycle for the most common type of pedestrian facilities that traverse railroad crossings, which are concrete sidewalks. Actual lifecycles and replacement schedules will vary by region, pavement type, and conditions. For shared-use paths, a variety of materials are used, but a typical path with asphalt paving has a lifespan in the range of 20 years. However, shared-use path crossings represent such a small share of overall at-grade rail crossings[32] that 50 years still represents a reasonable overall average, particularly since some shared use paths also use concrete, brick, or other similarly long-lived materials.

Not enough information was available via the FRA database or other sources on specific sidewalk configurations. For calculation purposes, it is assumed that each location where a sidewalk crosses an at-grade railroad crossing would require four DWS installations – one on each side of the rail crossing and on both sides of the street. Each DWS would be at least 2 feet deep and 4 feet wide.

Many at-grade railroad crossings are located in areas with no pedestrian facilities, so that the DWS requirements in the draft final rule would not be applicable. In order to estimate the number of rail crossings that actually have sidewalks, the study team used GIS software to combine FRA data on grade crossing locations with limited available local data on sidewalk locations, thereby identifying the grade crossings that do and don't have sidewalks present. This analysis was conducted using an automated script that aligned the location data, and then the results were manually checked for accuracy. The full analysis was originally conducted using data from the 2015 version of the database. The results were more recently revised using the September 2021 database to provide updated counts of crossings per state, but the other components of the analysis were not repeated.

[31] Federal Railroad Administration, Office of Safety Analysis, Highway-Rail Crossing Inventory, accessed December 2015 and September 2021, available online at https://safetydata.fra.dot.gov/officeofsafety/publicsite/DownloadCrossingInventoryData.aspx

[32] For example, FRA Grade Crossing data for 2021 that 98% of crossings are of type "highway", with less than 2% classified as "pathway pedestrian."

The key limitation of this approach is that only a small and potentially non-representative set of localities make their sidewalk GIS data available. That is, the presence of a publicly available GIS file providing sidewalk location data may be correlated with one of the variables of interest, particularly the extent of sidewalk coverage. It is difficult to avoid this limitation since sidewalk data can only be analyzed when they are available. A further limitation is that the sidewalk data layers did not necessarily include other types of pedestrian facilities, such as shared-use paths, though these are a small share of rail crossings. The study team believes that, on balance, these data limitations tend to result in an overestimate of sidewalk presence (and therefore DWS costs) rather than an underestimate, because the localities that have attempted to gather sidewalk data tend to be in urban areas with extensive sidewalk networks.

Results from the GIS matching analysis were used to identify the variables from the FRA dataset and other nationally available GIS datasets that would most accurately identify rail grade crossings with and without sidewalks. The following predictor variables were used to identify crossings that were likely to be <u>without</u> sidewalks:

- Crossing on rural and urban interstates and freeways
- Crossing in development type ‘Open Space’ and has a block group population density less than 500
- Crossing in development type ‘Open Space’ and on a rural or urban local road
- Crossing in development type ‘Industrial’
- Crossing in development type ‘Commercial’ and on an urban local road
- Crossing with ‘no warning signs or signals’, or with ‘other signs or signals’
- Crossing in a block group with population density less than 100
- Crossings that are not type ‘pedestrian crossing’ (since those by definition would not involve crossings of pedestrian facilities)

Estimates from this algorithm were compared against those from the manual check of GIS locations for the subset of localities for which complete data were available. In that comparison, the algorithm predicted that 50% of the total crossings in the test area would have sidewalks, versus an estimate of 54% that came from the manual check. This is considered an acceptable estimate given the limitations of the available GIS data layers. More detail on the estimation method and data files are provided in Appendix A.

In order to generate a national estimate, this predictive algorithm was then used to generate estimates for each state, using information from the FRA database and other available GIS datasets. For states that already include DWS in their standard plans for at-grade rail crossings, the calculated total was reset to zero to reflect this. Conversely, in states that do not include DWS in their plans, all at-grade crossing locations with sidewalks are assumed to be covered by the final rule. Under these parameters, a total of 32,501 rail crossings are estimated to be covered under the final rule. The state-by-state breakdown is shown below.

With an assumed 50-year sidewalk lifecycle for an at-grade rail crossing, an estimated 1/50th (2%) of rail crossings will be rebuilt or upgraded annually. This means that, under the draft final rule, an estimated 650 crossing locations will require DWS installation annually (=32,501 * 0.02). This may slightly overstate the true total, given the general downward trend in at-grade crossings.

Table 3 provides the results of the crossing estimation algorithm for each state as well as the number of crossings covered by the final rule.

As noted above, the standard rail crossing DWS application would involve 4 sidewalk-width installations, one at each approach toward the railroad on each side of the street. Assuming that each installation could be covered by a 2'-by'4' DWS, that would mean a total of 32 square feet of DWS per railroad crossing location. Applying the range of unit costs described above, this results in a total of $800 to $2,400 in costs, including materials and labor. With these low and high figures applied to the estimated 650 affected crossings per year, this yields an implementation cost range of $520,000 to $1,560,000 per year. The annualized cost over a 50-year period with 7% discounting and a 2021 base year is $0.5 million (low cost) to $1.5 million (high cost). The midpoint value, using a simple average of the low and high scenarios, is just under $1.0 million per year.

Table 3. State Railroad Crossings and Estimated Affected Locations

State	DWS in Standard Plan	# of At-Grade RR Crossings	Estimated % Crossings with Sidewalks	Estimated # of At-Grade RR Crossings with Sidewalks	Estimated # of At-Grade RR Crossings Affected by Draft Final Rule
Alabama	Yes	2732	44.0%	1202.1	0.0
Alaska	No	161	28.0%	45.1	45.1
Arizona	No	699	35.0%	244.7	244.7
Arkansas	No	2485	26.9%	668.5	668.5
California	No	5705	47.2%	2692.8	2692.8
Colorado	No	1766	23.8%	420.3	420.3
Connecticut	Yes	358	62.2%	222.7	0.0
Delaware	No	267	53.8%	143.6	143.6
District of Columbia	No	1	83.3%	0.8	0.8
Florida	Yes	3681	51.6%	1899.4	0.0
Georgia	No	5042	36.3%	1830.2	1830.2
Hawaii	No	8	75.0%	6.0	6.0
Idaho	No	1195	13.8%	164.9	164.9
Illinois	No	7795	38.4%	2993.3	2993.3
Indiana	No	5511	43.9%	2419.3	2419.3
Iowa	Yes	4202	23.9%	1004.3	0.0
Kansas	No	5076	12.8%	649.7	649.7
Kentucky	No	2188	35.1%	768.0	768.0
Louisiana	Yes	2771	44.0%	1219.2	1219.2
Maine	No	778	37.3%	290.2	290.2
Maryland	No	661	46.9%	310.0	310.0
Massachusetts	No	746	62.9%	469.2	469.2
Michigan	Yes	4684	36.5%	1709.7	1709.7
Minnesota	Yes	4222	19.0%	802.2	802.2
Mississippi	No	2137	34.4%	735.1	735.1
Missouri	No	3289	21.1%	694.0	694.0
Montana	No	1387	14.1%	195.6	195.6
Nebraska	No	2858	8.5%	242.9	242.9

State	DWS in Standard Plan	# of At-Grade RR Crossings	Estimated % Crossings with Sidewalks	Estimated # of At-Grade RR Crossings with Sidewalks	Estimated # of At-Grade RR Crossings Affected by Draft Final Rule
Nevada	No	322	21.5%	69.2	69.2
New Hampshire	No	342	50.6%	173.1	173.1
New Jersey	Yes	1461	50.9%	743.6	0.0
New Mexico	No	737	25.2%	185.7	185.7
New York	Yes	2677	43.2%	1156.5	0.0
North Carolina	No	3824	45.6%	1743.7	1743.7
North Dakota	No	3293	4.4%	144.9	144.9
Ohio	No	5670	44.2%	2506.1	2506.1
Oklahoma	No	3642	17.2%	626.4	626.4
Oregon	Yes	1863	30.6%	570.1	0.0
Pennsylvania	Yes	3623	48.2%	1746.3	0.0
Puerto Rico	No	0	0.0%	0.0	0.0
Rhode Island	No	59	62.8%	37.1	37.1
South Carolina	No	2636	40.0%	1054.4	1054.4
South Dakota	Yes	1881	9.2%	173.1	0.0
Tennessee	No	2747	42.0%	1153.7	1153.7
Texas	No	9201	39.3%	3616.0	3616.0
Utah	No	792	31.7%	251.1	251.1
Vermont	Yes	380	35.6%	135.3	0.0
Virginia	No	1840	41.4%	761.8	761.8
Washington	Yes	2245	28.8%	646.6	0.0
West Virginia	No	1341	33.7%	451.9	451.9
Wisconsin	Yes	3995	31.2%	1246.4	0.0
Wyoming	No	394	2.7%	10.6	10.6
	TOTAL	**127,370**		**43,247**	**32,501**

4.1.7 Number of Affected Locations and Total Costs: Transit Boarding Platforms

Rail and ferry boarding areas are already covered by other accessibility guidelines, so compliance costs for this provision would stem from other transit modes that have boarding platforms that are higher than standard curb height. This primarily affects bus rapid transit (BRT), which is a form of enhanced transit bus service. Definitions of BRT vary, but these services generally have features designed to improve travel times and service quality, such as dedicated rights-of-way, limited stops, and expedited fare payment and boarding. For this analysis, BRT was defined as in the National Transit Database (NTD)[33], and it was assumed that other modes of transit would not be affected.

The number of potential locations where DWS would be required at transit boarding platforms that are higher than standard curb height was assessed by referencing the published rider guides, photographs of stations, and similar information available online for each existing and planned BRT system in the United States. Although the draft final rule would not apply to existing stations, the analysis also looked for

[33] Federal Transit Administration, National Transit Database (2013 update), accessed December 2015. http://www.ntdprogram.gov/ntdprogram/data.htm

instances where boarding locations were higher than standard curb height with and without DWS as an indicator of the degree to which DWS are already a standard part of such designs. Industry standards and design guidelines were also referenced as described in more detail below.

In previous decades, transit buses had interior floors that were roughly 30 to 35 inches above street level and required passengers to enter via a set of steps.[34] To improve the passenger experience, many BRT systems around the world were built with elevated boarding platforms that match the buses' interior floor height, allowing for level boarding.[35] This tends to speed up the boarding process and generally makes the system more accessible for persons with limited mobility.

In the United States, there are no BRT systems that use these kinds of 30"-35" high boarding platforms. This may be due to cost issues and/or the fact that most BRT systems in the U.S. were built after the advent of "low floor" style buses, whose interior floors are only about 15 inches above street level. With standard curb heights often being in the range of 6 inches, these low floor buses are often entered by passengers taking a step up from their curbside boarding area.[36] Many of these buses have doorways that can be lowered slightly further via an adjustable suspension, creating something that approaches near-level boarding from a standard curb, as well as folding ramps that can be deployed for users of wheeled mobility devices.

According to a review of worldwide BRT systems conducted by the Institute for Transportation and Development Policy[37], as well as an APTA publication on BRT design[38], there are four BRT systems in the United States that have boarding platforms that are higher than standard curb height at some or all of their boarding locations:

- Cleveland: Health Line
- Eugene, Oregon: Emerald Express (Lane Transit District)
- Las Vegas: Strip & Downtown Express
- San Bernardino, California: sbX

Based on that review, all four of these BRT systems provide detectable warnings at boarding areas that are elevated above curb level.

In order to provide a more comprehensive review and account for additional BRT systems that may have started service after the publication of the above-noted references, the team also reviewed online rider guides and photographs from all other BRT systems in the US. This included all systems that are listed as BRT in the National Transit Database, as summarized in the APTA Factbook for 2021, plus an additional 20 systems that did not meet the NTD reporting definition but were listed in the Wikipedia entry on BRT. (This includes some systems that are still in the design or construction phases and not yet in service.) Results of this review are summarized in the table in Appendix B.

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[34] American Public Transit Association, Technical Specifications: Standard Bus Procurement Guidelines, 1999.
[35] Institute for Transportation and Development Policy, BRT Scorecard, https://www.itdp.org/brt-standard-scores/
[36] American Public Transit Association, Recommended Practice: Bus Rapid Transit Stations and Stops, October 2010.
[37] Institute for Transportation and Development Policy, BRT Scorecard, https://www.itdp.org/brt-standard-scores/
[38] American Public Transit Association, Technical Specifications: Standard Bus Procurement Guidelines, 1999.

There are limitations to this review, since precise boarding platform heights are seldom mentioned in materials oriented to the general public, and standard curb height varies by jurisdiction. These details can be difficult to discern from photos, so the study team looked for any visual indicator that the boarding platform was above curb height (e.g., ramps sloping up from sidewalk level, or platforms nearly even with bus door sills). An additional limitation is that bus stop design and the presence of DWS could vary even within the same system, and future practices could differ from current designs.

With these limitations in mind, the review found that there are no systems with platforms that are higher than curb height yet with no DWS. On the contrary, many systems provide DWS even when boarding is at normal curb heights. APTA also recommends the use of detectable warnings in its design principles.[39]

Overall, given the historical evolution of bus services in the U.S. and the move toward low-floor vehicles, the number of added or rebuilt boarding platforms that are above standard curb height would be expected to be fairly small. Where such platforms do exist, it is current agency practice to provide DWS and DWS are part of industrywide standards. As such, no costs are expected from this component of PROWAG.

4.1.8 Number of Affected Locations and Total Costs: Commercial Driveways

Under the PROWAG guidelines, DWS would be required where pedestrian routes cross commercial driveways that have stop or yield control or a traffic signal. In these cases, the presence of traffic control devices indicates a level of activity that is more characteristic of a city street, and DWS are needed to provide pedestrians with awareness of the presence of vehicular traffic crossing the sidewalk. Although these commercial driveway locations are not public streets, their higher traffic volumes and traffic control devices make them highly similar in design and function. Thus, it is likely that state and local transportation departments would install DWS at these locations, just as they do at other intersections (see above). However, this is more difficult to verify because this specific scenario is not necessarily described in agency standard design documents. Based on a review of state DOT documentation, states that address this type of commercial driveway setting already require DWS at these locations, recognizing that they are “street-like” in their layout.[40,41,42] As such, little to no incremental costs are anticipated.

4.1.9 Cost Summary

Estimated compliance costs for DWS are summarized in

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[39] American Public Transit Association, Recommended Practice: Bus Rapid Transit Stations and Stops, October 2010.

[40] Vermont Agency of Transportation, Use of detectable warning surface at driveways and on shared use paths, (May 2014). https://vtrans.vermont.gov/sites/aot/files/highway/documents/ltf/DWS%20at%20Drives%20May2014.pdf

[41] New Jersey DOT, Guidance for Americans with Disabilities Act (ADA) Project Design, (May 2014). https://www.nj.gov/transportation/business/procurement/ProfServ/documents/ADACurbRampDesignChecklistItems_2.PDF

[42] Florida DOT, ADA Q&A, (February 2018). https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/roadway/roadway/ada/ada-qa.pdf?sfvrsn=b0d693a_0

Table 4 below. Using the midpoint of the range for the only element with non-zero costs, annualized costs are $1.0 million per year at both the 7% and 3% discount rates.

Table 4. DWS Compliance Cost Summary

Location Type	Annual Cost (millions)
Curb Ramps	$0
Pedestrian Refuge Islands	$0
At-Grade Railroad Crossings	$0.5 to $1.5
Transit Boarding Platforms	$0
Commercial Driveways	$0

4.2 On-Street Parking

The Access Board's PROWAG final rule includes provisions related to accessible on-street parking spaces. These provisions are intended to ensure that persons with disabilities are able to access destinations that are served by on-street parking and are able to safely exit and re-enter their vehicles. The final rule specifies that new or altered on-street parking must meet minimum thresholds for the number of accessible spaces per block perimeter or other location (R211). These requirements do not apply to on-street parking that is designated exclusively as residential parking, nor to spaces that are designated exclusively for commercial or law enforcement vehicles.

Where required, the parallel on-street parking spaces must be 13 feet wide and 24 feet long. Exceptions exist for alterations, allowing parallel on-street parking spaces to have the same dimensions as adjacent spaces where providing parallel on-street parking spaces with the dimensions specified in R310.2.1 would result in an available right-of-way width less than or equal to 9 feet (2.7 m), measured from the curb line to the right-of-way line. In these situations, the parallel parking space must be located nearest the end of the block face or at a midblock crossing and have a curb ramp or blended transition serving the crosswalk. Separate provisions on access aisles apply to angled and perpendicular parking spaces. Accessible parking spaces must be marked with the International Symbol of Accessibility, and any associated meters or pay stations must meet accessibility guidelines regarding clear space and reach ranges.

4.2.1 Methodology Overview, Terminology, and Key Assumptions

This analysis estimates the number of new and altered on-street parking spaces that would be affected annually by the accessibility requirements promulgated in the Access Board's final rule and assesses the incremental costs relative to a baseline in which PROWAG is not enacted.

In line with the wording in PROWAG, this analysis is limited to new and altered on-street parking that is not exclusively for residential use or reserved for law enforcement or commercial vehicles (such as trucks and taxi/livery vehicles). This would generally include on-street parking as is typically found along the curbside in retail, office, and mixed-use areas, whether paid or unpaid.

Perpendicular and angle on-street spaces are covered by the draft final rule, but the costs are not analyzed in detail here because they are assumed to be minimal. On-street parking with a perpendicular or angled layout generally allows the additional width of the accessible space to be provided within the paved roadway area, with only some additional pavement markings rather than changes to the curb and sidewalk.

The final rule includes an alternative provision for situations in which on-street parallel parking spaces that are metered or marked are not situated along a block perimeter (i.e., along a street without intervening cross-streets). Not enough data on parking inventory for these types of locations were available to produce a separate estimate for these situations. Instead, these parking spaces are included in the overall estimates and totals as if they were located on block perimeters.

The study team prepared the estimates below of the number of affected parking spaces, followed by development of unit costs for the parking provisions, with four distinct scenarios presented. The methodology for the estimates of affected on-street parking spaces was based primarily on a review of existing literature. The literature in this area emphasizes that relatively little attention has been paid to the size of the U.S. parking infrastructure,[43,44] so the focus was on the most comprehensive and credible estimates that were available in this literature. Additional calculations were performed based on GIS analysis. Alterations were forecast using the existing inventory of relevant parking spaces and an estimated pavement lifecycle.

No data were available on the spatial orientation of on-street parking spaces. The analysis used an assumption that 90% of marked or metered on-street non-residential parking spaces are parallel to the curb, rather than angled or perpendicular. This assumption is believed to be reasonable but is necessarily an approximation. This approximation may overstate the share of parallel on-street parking spaces but is intended to avoid underestimating parallel spaces affected by this rule. A further simplifying assumption is that published estimates of "metered" parking refer to on-street metered spaces, even though off-street municipal parking lots that use meters or pay stations may be included in these estimates.

Likewise, while there are published estimates of existing parking inventories, there are no published estimates of future parking growth at the national level. For this analysis, future growth in on-street metered and marked parking spaces was forecast using population growth as a proxy, with reference to published parking studies. Population growth is an imperfect proxy for reasons that are discussed below. However, the limited available research on historical growth in parking supply (also discussed in more detail below) shows that it has grown at roughly the same rate as population for the region studied. As a practical matter, population is a variable for which highly credible estimates are available at the national level.

The share of affected on-street parking spaces that are adjacent to an available right-of-way of more than 14 feet was examined using the limited available GIS data on sidewalk width (under and assumption that post installation right-of-way width would remain at least nine feet). However, these sources had several key limitations that are explained in more detail below. As a result, the team calculated this split using an assumption that at least nine-foot (or greater) right-of-way would be available for 20 percent of alterations and 40 percent of new on-street parallel parking spaces that are marked or metered. These figures are approximations and are significantly greater than those indicated by the limited GIS analysis. However, they more closely reflect the prevalence of urban design standards (discussed below) that call for wider sidewalks in commercial districts. These higher estimates, rather than the results of the GIS analysis, were used due to the limitations of that data and to avoid potential under-estimation.

This analysis covers only direct compliance costs and does not include any potential indirect effects, such as the impact of providing wider accessible spaces on pedestrian flows. For example, there may be cases where the additional width of the space causes a slight decrease in useable pedestrian space, with associated effects on pedestrian journey quality or comfort. These impacts are assumed to be minor, and the associated disutility is not estimated here. Future maintenance costs are also not analyzed, as there is

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[43] Chester, M., A. Horvath, and S. Madanat. (2010). "Parking Infrastructure: energy, emissions, and automobile life-cycle environmental accounting," Environmental Research Letters, Vol. 5, No. 3.
[44] de Cerreno, A. (2004). "Dynamics of On-Street Parking in Large Central Cities," Transportation Research Record, Vol. 1898: pp. 130-137. Several of the cities in this study could not estimate the number of on-street parking spaces in their downtown areas, and the study highlights other key data gaps with regard to parking.

little to no difference in overall lifecycle costs for accessible parking spaces versus equivalent areas of non-accessible parking spaces and sidewalks.

As a conservative assumption, the cost analysis is calculated against a baseline in which there are zero existing on-street parking spaces not designated exclusively as residential parking that meet the PROWAG standards. This is clearly an imperfect assumption, as some cities already dedicate a number of on-street spaces to holders of disability permits/placards. However, many do not, electing instead to provide dedicated spaces in off-street facilities or to allocate spaces on residential streets on a request basis. Many states also exempt permit holders from posted time limits and meter payments. Practices vary significantly and very little data are available on the number of existing on-street accessible spaces and the extent to which they meet the PROWAG requirements.

4.2.2 Estimated Parking Spaces Affected

The academic literature on parking emphasizes that there are no comprehensive national inventories of parking spaces, and that there is considerable variation and uncertainty among the estimates that do exist.[45] One starting point is a real estate industry publication which estimated that the total number of parking meters in the U.S. is 5 million.[46] (As many cities have moved away from traditional meters to other types of payment stations, this figure should be interpreted as the number of metered on-street parking *spaces*, rather than the number of *meters* per se.) While this estimate did not include a breakdown, it is reasonable to assume that very few of the 5 million metered spaces are designated exclusively as residential parking; metered parking is commonly found in mixed-use areas but seldom in areas that are exclusively residential.

San Francisco became one of the first cities to conduct a comprehensive inventory of all parking within its boundaries, including on- and off-street parking. The study identified just over 320,000 on-street spaces in the city, of which 24,000 were metered, plus an additional 1,000 meters under the jurisdiction of the Port of San Francisco, for a total of 25,000 on-street metered spaces.[47] Much of the remaining on-street parking is in residential permit districts and would not be affected by the final rule, though the study did not provide a detailed breakdown.

Using published estimates of metered, on-street parking inventory in cities, combined with population estimates from the most recent prior decennial Census, shows variation in the density of metered parking relative to population. Comparing San Francisco's 25,000 metered, on-street spaces to its population of 873,000 yields a ratio of roughly 29 metered spaces per 1,000 population. Similar ratios were derived for other cities who have posted their total meter counts online, including Washington, D.C. (26 metered spaces per 1,000 population) and Cambridge, Massachusetts (29 per 1,000). Somewhat lower ratios were found for New York City (10 per 1,000) and Chicago (13 per 1,000) as might be expected for these very large, densely populated cities.[48] Conversely, some lower-density cities also have relatively few metered

[45] Chester et al. (2010), "Parking Infrastructure."
[46] CCIM Institute (2004). "What Drives Parking Investments?" CIRE Magazine, March-April 2004.
[47] San Francisco County Transportation Authority, On-Street Parking Management and Pricing Study, September 2009. Archived online at: https://docplayer.net/7658470-Final-report-on-street-parking-management-and-pricing-study-san-francisco-county-transportation-authority.html
[48] See Appendix I for detail.

parking spaces per capita because most parking is free of charge and/or there is widespread availability of off-street parking. For example, Phoenix has roughly 1.4 metered spaces per 1,000 population, and Houston has about 4 metered spaces per 1,000 population. Smaller communities often have no metered spaces at all, though on-street spaces may be marked with enforced time limits.[49] An update of this analysis, conducted in 2021 and comparing against 2020 Census data, found that the ratios of metered parking to population had remained fairly stable (see Table 5) though there were more cities in which population growth outstripped growth in metered parking rather than vice versa.

A midrange estimate, considering the per-capita figures above, would be a ratio of roughly 20 metered spaces per 1,000 residents. Applying this ratio to the current U.S. urban (non-rural) population of 249 million[50] yields a total of 4.98 million metered parking spaces (= 249,000,000 * 20/1,000), which very closely matches the estimate of 5 million meters as noted above.

In addition to the estimated 5 million metered on-street parking spaces, there are many designated curbside parking spaces that do not have meters. These spaces are often designated with signs or markings that set time limits or usage restrictions. For this element, the analysis draws from Chester et al. (2010), who estimated that 20 percent of the roughly 220 million non-residential parking spaces—or 44 million (=220,000,000*0.2)——are met by free, on-street spaces.[51] These unmetered on-street spaces, combined with the 5 million metered on-street spaces, sum to a total estimated 49 million on-street parking spaces that are not designated exclusively as residential parking.

The share of on-street spaces that are parallel to the curb, rather than angled or perpendicular, is unknown and no estimates were discovered in the literature search. As such, an estimate of 90% parallel spaces was used based on professional judgment. As shown in Table 5 below, these assumptions combine to produce an overall estimated of 44.1 million on-street, non-residential parking spaces that are parallel to the curb.

Table 5. National Estimate of Existing Stock of Non-Residential On-Street Parallel Parking Spaces, Metered or Signed/Marked

Parking Category	Estimate
On-Street: Metered, Non-Residential	5.0 million
On-Street: Un-metered, but Signed or Marked, Non-Residential	44.0 million
Total	49.0 million
Parallel Parking as Share of Total (Not Angle, Not Perpendicular)	90%
Total Parking Inventory Used in Calculations	44.1 million

[49] Figures cited in this paragraph come from available published estimates of metered, on-street parking inventory in cities as shown in appendix table "On-street Metered Parking Estimates in 2016," combined with Census population estimates for 2010. The table was then updated with information from a review in 2021, combined with 2020 Census data.
[50] 2010 Census data for urban areas, including urbanized areas and urban clusters. https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/ua-facts.html
[51] Chester et al. (2010), "Parking Infrastructure," pp.3-4. This is an intermediate calculations of the authors' scenario 2 and builds on an earlier estimate from Litman, T. (2009). "Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications, Second Edition," Victoria Transportation Institute.

Two types of parking spaces are affected by the draft final rule: new on-street non-residential/commercial parking spaces that are metered or marked, and alterations of existing on-street non-residential/commercial parking spaces that are metered or marked.

4.2.3 Newly Constructed Parking Spaces

Newly constructed parking spaces include two different scenarios:

- Existing roadways on which other types of curbside uses (such as loading zones or through-travel lanes) are converted to parking spaces, and
- On-street parking spaces on entirely new roads, such as may be found in new developments with retail businesses or employment centers.

Since the latter scenario involves new construction that may be subject to fewer site-specific constraints, it is more likely to follow modern design standards that call for wider sidewalks. Due to a lack of data on this point, this analysis does not specifically distinguish between these two types of newly constructed spaces. However, because of the prevalence of entirely new construction, it is assumed that new parking spaces are more likely than alterations to meet the PROWAG condition related to having nine feet of post-installation adjacent right-of-way (as discussed below).

Relatively little data or findings from the literature are available to support an estimate of the growth rate in on-street parking provision. However, Chester et al. (2015), in a study of Los Angeles County, show roughly 0.6% annual growth in on-street parking during the period from 1990 to 2010, which is roughly equal to the average annual population growth rate for Los Angeles County during that time period.[52] The study team readily acknowledges that the apparent correspondence between population growth and on-street parking growth in Los Angeles County may not be representative of the broader United States, and that this relationship could change in future decades. Within the set of new on-street parking spaces, the share that are *non-residential*/*commercial* may be somewhat limited, since suburban developments such as shopping malls and office parks tend to emphasize off-street parking in lots and garages rather than on-street parking.

However, the overall relationship is generally plausible, in that population is a proxy for automobile travel demand, and most automobile travel requires parking (on both ends of the trip). The observed growth in on-street parking also indicates that there is at least some supply response to additional parking demand even in intensively developed areas such as Los Angeles County. Other proxies for parking space growth could include the change in road supply, since on-street parking by definition requires road space, or vehicle-miles traveled (VMT), which is another measure of travel demand.

The actual change in on-street parking supply for any given location is affected by many factors, particularly local planning and zoning decisions and development patterns, which in turn may be influenced by patterns of vehicle ownership, the availability of transit and other alternatives, and policy goals.[53] These factors do not lend themselves to national estimation due to data limitations and large

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[52] Chester, M., et al. (2015). "Parking Infrastructure: A Constraint on or Opportunity for Urban Development? A Study of Los Angeles County Parking Supply and Growth," Journal of the American Planning Association, Vol. 81, No. 4.

[53] de Cerreno, "Dynamics of On-Street Parking."

regional variations. Looking at proxy measures, the Census Bureau's forecast of annual U.S. population growth in the U.S. for the 20-year period from 2022 to 2047 is 0.524%[54] and the average annual growth rate for urban road supply over the past decade has been 0.7%.[55] The most recent forecast of VMT growth for light-duty vehicles estimates annual growth of 0.6% over the next 20 years.[56] Overall, population growth may be the best available proxy for changes in on-street parking given the link to underlying parking demand, but all three measures are in fairly close agreement.

Applying the Census population growth rate to the estimated current stock of 44.1 million parallel spaces that are on-street and non-residential/commercial (see Table 5 above) yields a total of approximately 231,026 new spaces per year. Of these, approximately 4%, or 9,241 (= 231,026 * 0.04), would be required to be accessible parking spaces according to the provisions in the final rule. As noted above, this figure is used in calculations directly rather than including any assumed offset for existing accessible on-street spaces, since the number of such spaces is unknown and believed to be limited.

4.2.4 Altered Parking Spaces

For the purpose of this analysis, re-striping of existing parking areas or other maintenance projects would not constitute alterations. Here, the analysis assumes that alterations occur roughly at the same rate that on-street parking areas are reconstructed—either due to roadway pavement reconstruction or reconstruction of the adjacent sidewalk. Chester et al. (2010) use an estimated 10-year lifespan for a typical asphalt on-street parking lane.[57] However, a more typical asphalt pavement lifespan is 20-30 years.[58] Concrete sidewalk has a longer expected lifespan, which can be up to 80 years when following best maintenance practices, but more typically in the range of 50 years.[59]

This analysis assumes that the relevant lifespan for alterations follows the following pattern:

- Where the adjacent sidewalk has available right-of-way for nine feet or more post-installation, this involves alterations to the sidewalk area and thus the relevant lifespan is that of the sidewalk (50 years);
- Where the adjacent sidewalk would have less than nine feet of available right-of-way, the relevant lifespan is that of the paved parking lane (25 years).

When combined with the assumption that 20% of altered parking spaces would have the nine feet of available post-installation right-of-way, this yields an overall weighted average replacement cycle of

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[54] US Census (2017), 2017 National Projections, data retrieved December 2021.
[55] Bureau of Transportation Statistics, National Transportation Statistics, Table 1-5. Growth rate calculated for urban road mileage from 2010 to 2019 in three functional classes: other principal arterials, minor arterials, and major collectors. This excludes highways and other limited-access roads that do not have on-street parking, as well as small local roads that are primarily residential.
[56] Federal Highway Administration, Forecasts of VMT, Spring 2021. https://www.fhwa.dot.gov/policyinformation/tables/vmt/vmt_forecast_sum.cfm
[57] Chester, "Parking Infrastructure."
[58] Elkins, G et al. (2013). "Reformulated Pavement Remaining Service Life Framework," Office of Infrastructure Research and Development, Federal Highway Administration, FHWA-HRT-13-038. https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/13038/13038.pdf
[59] Federal Highway Administration. (2013). "A Guide for Maintaining Pedestrian Facilities for Enhanced Safety: 6 Construction Techniques to Lessen Maintenance for Sidewalks and Paths," Office of Safety, Federal Highway Administration, https://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa13037/chap6.cfm

3.6% of existing spaces altered per year.[60] Applying this replacement cycle to the above estimate of 44.1 million spaces yields a total of 1,587,600 (= 44,100,000 * 0.036) spaces per year that are altered. Of these, approximately 4%, or 63,504 (= 1,587,600 * 0.04), would be required to be accessible parking spaces according to the formula in the draft final rule. This should be regarded as an upper bound, because many municipalities already provide accessible parking to some extent, and the requisite number of accessible spaces can be met elsewhere on the block face. A national estimate of accessible spaces constructed or altered, per year is included in Table 6.

Table 6. National Estimate of Accessible Spaces Constructed or Altered, Per Year

Parking Category	Estimate
New Construction	9,243
Alterations	63,504
TOTAL	72,747

4.2.5 Accessible Parking Spaces With and Without Increased Width

As noted above, the requirements in the draft final rule vary depending on whether the adjacent right-of-way has more or less than nine feet of remaining right-of-way width after accommodating the widened accessible space. The available right-of-way may contain a combination of sidewalk, tree boxes, grassy strips, and other elements. However, for the purpose of this analysis, where available data contains only sidewalk width, we use a sidewalk width as a proxy for the width of the right-of-way. There is no comprehensive data source on either right-of-way or sidewalk width, though a few cities provide this information via GIS datasets. In addition, one commenter, the City of Cambridge, Massachusetts, specifically noted that some of its commercial districts do have sidewalks greater than 14 feet wide.[61]

Based on an initial review of publicly available GIS files, only three localities had sidewalk data that included comprehensive information on width: Denver, Colorado; Bellingham, Washington; and Jefferson City, Missouri. This group is fairly diverse with respect to city size and region but is ultimately a very small sample. In these cities, the share of sidewalks that are greater than 14 feet in width ranged from 0.3 percent in Bellingham to 2 percent in Jefferson City.

The relevant figure is likely to be higher than that 0.3% to 2% range, for two reasons. First, these citywide averages include many residential streets with narrower sidewalks, thus obscuring the prevalence of wider sidewalks in the commercial districts and downtown areas where on-street metered or marked parking is generally located. Second, no GIS information on sidewalk width was available for some of the largest cities that have large inventories of on-street parking, such as Chicago, San Francisco, Washington, DC, and New York. Sidewalks that are greater than 14 feet in width are not universal even in these large cities but are more commonly found there due to the need to accommodate high pedestrian volumes in their business districts.

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[60] The 20% of existing spaces for which it is assumed that the nine feet of ROW are available have a 50-year replacement cycle based on the adjacent sidewalk, while the remaining 80% have a 25-year cycle based on the asphalt pavement of the parking lane. This overall average is calculated as [20% * (1/50) + 80% * (1/25)].
[61] Comments from City of Cambridge, Massachusetts. Docket ID: ATBCB-2011-0004-0078. Available via regulations.gov.

Many cities have implemented design guidelines that specify minimum or recommended sidewalk widths for new projects. For example, the City of Chicago's design guidelines call for a minimum sidewalk width that ranges from 5 feet for some local streets up to 14 feet for designated "mobility streets" in the downtown area.[62] In San Francisco, the city's street plan calls for minimum sidewalk widths of 12 feet in commercial districts, with a recommended width of 15 feet.[63] The District of Columbia's design guidelines for the downtown area call for a minimum 16 feet of sidewalk width, plus a 6-foot tree box area.[64] Boston's minimums range from 7 feet on neighborhood main streets to 10 feet for the downtown area, with a recommended width of 16.5 feet to 20.5 feet.[65] In New York City, by contrast, although the official minimum for commercial areas is 8 feet of sidewalk width,[66] many sidewalks in Manhattan's midtown and downtown areas and major avenues are in the range of 15 to 20 feet wide, based on aerial photographs. New York City also noted in its docket comments that requiring widened accessible spaces could impede pedestrian flow on its very busy sidewalks.[67]

Note, however, that these guidelines relate primarily to new projects and do not necessarily reflect actual conditions in each city, where some existing sidewalks are below the stated minimums and there is often little room for expansion due to building lines and other right-of-way constraints. Even for new projects where space permits, sidewalks of less than 13 or 14 feet in width (approximately nine feet in width post-installation) would be permitted by many of these design guidelines, especially outside of the downtown core.

For new developments that include newly constructed on-street parking, such as new mixed-use or "lifestyle" centers that include retail space, there are differences in parking configuration and sidewalk width. The study team used satellite imagery to estimate the available sidewalk right-of-way width for a sample of five mixed-use centers built around the U.S. over the past 20 years. While not a comprehensive assessment, this review found that these newer developments generally had sidewalk rights-of-way in the range of 10 to 20 feet on streets that had on-street parallel parking. Two of the five developments had sidewalk right-of-way widths that generally exceeded the nine-foot (post-installation) threshold for the provision of widened accessible spaces.[68]

Overall, while GIS data and city design guidelines provide some insight, they do not present a comprehensive picture of sidewalk width in areas adjacent to on-street parking. Based on the available

[62] City of Chicago, Street and Site Design Standards, April 2007. http://www.cityofchicago.org/dam/city/depts/cdot/StreetandSitePlanDesignStandards407.pdf
[63] City of San Francisco, Guide to the San Francisco Better Streets Plan, December 2010, http://www.sf-planning.org/ftp/betterstreets/docs/Guide_to_BSP.pdf
[64] Government of the District of Columbia, Public Realm Design Manual, 2011, http://ddot.dc.gov/sites/default/files/dc/sites/ddot/publication/attachments/ddot_public_realm_design_manual_2011_0.pdf
[65] Boston Transportation Department, Boston Complete Streets Guidelines, 2013. http://bostoncompletestreets.org/pdf/2013/Sidewalks_Chart.pdf
[66] New York City DOT, Street Design Manual, January 2016. http://www.nyc.gov/html/dot/downloads/pdf/nycdot-streetdesignmanual-interior-02-geometry.pdf
[67] Comments from City of New York, New York. Docket ID: ATBCB-2011-0004-0274. Available via regulations.gov.
[68] Based on a review using Google Maps satellite imagery and distance-measurement tool for streets with non-residential parallel parking is shown in Appendix table "Estimated sidewalk ROW width." All figures approximate and based on building line to back of curb.

information, an overall estimate is that approximately 20% of existing sidewalks that are adjacent to relevant on-street, non-residential/commercial parallel parking spaces have a width sufficient to remain at least nine foot in width post-installation. The estimate is 40% for new construction settings, which tend to have fewer right-of-way constraints and would reflect revised design guidelines and industry practices. Applying those proportions to the estimates of new and altered on-street parallel parking spaces that are metered or marked yields the totals as shown below. For alterations, these calculations also reflect the two different lifespan assumptions discussed above (i.e., 25-year asphalt pavement lifespan and 50-year concrete sidewalk lifespan). Estimated yearly totals of new construction and alterations are below in Table 7.

Table 7. Estimated Yearly Totals

Parking Category	Total Accessible Parking Spaces	With Widened Accessible Space (9'+ Post-Installation Sidewalk)	No Increased Width, Pole and Sign Only (Less than 9' Post-Installation Sidewalk)
New Construction	9,243	3,697	5,546
Alterations	63,504	7,056	56,448
TOTAL	72,747	10,753	61,994

4.2.6 Estimate of Additional Cost

The study team coordinated with the Access Board to develop a list of expected additional cost components necessary for installation of accessible on-street parallel parking spaces, beyond those needed for a non-accessible on-street parallel parking space. This resulted in separate cost estimates for four different installation scenarios:

- Scenario A: New Construction, sidewalk ROW greater than 14 feet
- Scenario B: Sidewalk and roadway improvement, sidewalk ROW greater than nine feet post-installation, and will be reduced in width to accommodate a widened accessible space
- Scenario C: Sidewalk and roadway improvement, sidewalk ROW greater than nine feet post-installation, sidewalk is reconfigured to jog around a widened accessible space
- Scenario D: New construction or improvement, sidewalk ROW less than or equal to nine feet post-installation

The additional costs were estimated using the "2022 Public Works Costbook" (BNi), [69] a review of curb ramp costs,[70] and publicly available pricing of individual components (noted where appropriate below). Cost information was also provided via interviews with the cities of Bellingham, WA[71] and San Diego, CA.[72] However, in both cases, the cost estimates included additional elements that are not requirements of PROWAG guidelines (e.g., curb painting) and did not have an itemized breakdown that would allow them

[69] BNi, "2022 Public Works: Costbook," BNi Publications. 2022.
[70] Pedestrian Safety Guide and Countermeasure Selection Systems: Curb Ramps. Pedsafe. http://pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=3
[71] Access Board interview with City of Bellingham, WA Public Works Department September 2020
[72] Access Board interview with City of San Diego, CA Office of ADA Compliance and Accessibility, September 2020

to be directly applicable. These cost estimates were therefore not used in calculation, though they provide useful benchmarks.

All scenarios involve costs for accessible parking signage. In addition, the scenarios vary to the extent to which the provision of widened accessible spaces entails additional costs for curbs, curb ramps, pavement, grading, and base material for construction. See tables below for a detailed cost breakdown for each scenario. The unit costs are then combined with estimates of the number of affected locations, which were developed in 2016 and have been recently updated.

4.2.6.1 Scenario A: New construction, ROW greater than nine feet post-installation

The following table shows estimated per unit and total incremental costs for each cost component when entirely new sidewalk and roadway are constructed. There are a few aspects of the cost components to note. Unless otherwise stated, costs are from the 2022 BNi Costbook and are in 2021 dollars.[73] Curb ramp costs are from a Pedsafe review of available curb ramp costs, and do not include detectable warning panels,[74] as detectable warnings are generally not needed at these locations and have a separate PROW cost estimate.

Estimates in this scenario do not include costs for grade and base material, as there is no incremental difference between accessible and non-accessible parking for these items in a new construction setting.

Based on a review of several payment kiosk vendors, there does not appear to be any price differential or other distinction made between ADA-compliant and non-compliant payment kiosks for on-street parking. Furthermore, there does not appear to be any additional installation cost associated with an accessible payment kiosk. (As a practical matter, a significant portion of States and municipalities exempt ADA placard holders from on-street parking fees, but this is not universal.)

The curb and gutter cost estimates include a low, mid-range, and high value available in the BNi Costbook. In the absence of detailed realized costs for this component in the context of on-street parking installation, the mid-range value was chosen as the value used in most of the subsequent calculations.

The curb ramp mid-range value is the median per-unit price reported of 31 observations. Notably, curb ramp costs vary significantly, with low and high values nearly an order of magnitude lower and higher than this median.

The cost of the accessible parking sign and pole are included. The "low" scenario reflects a case where no additional pole is needed because of the presence of other parking signs, such as those with information on parking hours or street cleaning times. The "high" scenario includes both the pole and the accessible parking sign. A mid-range value would fall between these two scenarios, but no data were available on the availability of existing poles. To be conservative, the value used in calculations is the one corresponding to the high scenario, even though existing poles are likely to be available in many urban areas with extensive parking regulations and signage.

[73] BNi, "Costbook,"
[74] Pedsafe, "Curb Ramps."

Table 8 below presents low, mid-range, and high values for Scenario A.

Table 8. Unit Cost of Accessible On-Street Parking for Scenario A

Cost Component	Num-ber	Units	Cost per Unit (low)	Cost per Unit (mid)	Cost per Unit (high)	Total Cost (low)	Total Cost (mid)	Total Cost (high)
Curb and Gutter[75]	3.2	linear foot (LF)	$10	$11	$13	$31	$37	$42
Curb Ramp[76]	1	each	$104	$865	$4,207	$104	$865	$4,207
Sign/Post/Installation[77,78]	1	each	$15	$96	$96	$15	$96	$96
Total	-	-	-	-	-	*$150*	*$997*	*$4,345*

4.2.6.2 Scenario B: Improvement, ROW greater than nine feet post-installation, reduced width

The following table shows estimated per unit and total incremental costs for each cost component when both the existing sidewalk and roadway are being improved and the existing sidewalk is wider than nine feet post-installation. In this scenario the wide existing sidewalk will be reduced in width to accommodate the additional width for an accessible parking space at street pavement level. This affects costs for grading and base material, but other cost components shared with Scenario A remain the same. Incremental costs are derived from the 2022 BNi Costbook and are in 2021 dollars.[79]

Grading cost vary by equipment used, and a midpoint was chosen as the most likely value given the uncertainty over individual municipal or contractor resources. Pavement and base material costs available in the BNi Costbook did not vary, and as such the low, mid-range, and high values are the same across each cost component.

[75] BNi, "Costbook,": Curb Formwork (03 - 11133) Curved 6" high, Cost per unit decreases depending on uses. Plus Sidewalks (32 - 13131) 6" assume 6" width.
[76] Pedsafe, “Curb Ramps.”: Estimated Cost table, row 2 (price each without detectable warning). Low and high values are minimum and maximum values reported in source. Recommended value is the median reported value. Adjusted from 2013 to 2021 dollars with GDP deflator.
[77] Road Traffic Signs, https://www.roadtrafficsigns.com/fos/ada-state-signs/handicapped-parking-only-sign/sku-k-1437 (accessed October 20, 2022): Sign available retail price, sign only (assumes existing post).
[78] BNi, "Costbook,": Signage (10 - 14530) Handicap parking, 12"x18" (includes post and labor)
[79] BNi, "2022 Public Works: Costbook," BNi Publications. 2022.

Table 9 presents low, mid-range, and high values for Scenario B.

Table 9. Unit Cost of Accessible On-Street Parking for Scenario B

Cost Component	**Number**	**Units**	**Cost per Unit (low)**	**Cost per Unit (mid)**	**Cost per Unit (high)**	**Total Cost (low)**	**Total Cost (mid)**	**Total Cost (high)**
Curb and Gutter[80]	3.2	LF	$10	$11	$13	$31	$37	$42
Curb Ramp[81]	1	each	$104	$865	$4,207	$104	$865	$4,207
Pavement for increased width[82]	15	sq yd	$21	$21	$21	$308	$308	$308
Grading for increased width 6”[83]	2.5	cubic yd	$9	$11	$13	$22	$28	$33
Base material for increased width 6”[84]	15	sq yd	$34	$34	$34	$514	$514	$514
Sign/Post/Installation[85, 86]	1	each	$15	$96	$96	$15	$96	$96
Total	-	-	-	-	-	*$993*	*$1,846*	*$5,200*

4.2.6.3 Scenario C: Improvement, wide ROW, adjacent unimproved ROW

The following table shows estimated per unit and total incremental costs for each cost component when both the existing sidewalk and roadway are being improved and there exists unimproved ROW available to reconstruct the sidewalk so that it jogs around the additional width of the accessible space with no reduction in overall sidewalk width. This would necessitate grading and base material for sidewalk realignment in the unimproved ROW. Cost components shared with scenarios A and B remain the same, and additional incremental costs are derived from the 2022 BNi Costbook and are in 2021 dollars.[87]

Grading costs for the new sidewalk jog around the widened accessible space was assumed to be at the same rate as the parking space grading, and as such the mid-range value is the midpoint between high and low costs, which are dependent on the grading equipment used.

80 BNi, "Costbook,": Curb Formwork (03 - 11133) Curved 6" high, Cost per unit decreases depending on uses. Plus Sidewalks (32 - 13131) 6" assume 6" width.
81 Pedsafe, “Curb Ramps.”: Estimated Cost table, row 2 (price each without detectable warning). Low and high values are minimum and maximum values reported in source. Recommended value is the median reported value. Adjusted from 2013 to 2021 dollars with GDP deflator.
82 BNi, "Costbook,": Asphalt Surfaces (32 - 12160) 3" thick
83 BNi, "Costbook,": Rough Grading (31 - 22130) Unit cost depends on equipment used.
84 BNi, "Costbook,": Asphalt Surfaces (32 - 12160) Binder course 6" thick.
85 Road Traffic Signs, https://www.roadtrafficsigns.com/parking-sign/reserved-parking-ada-symbol-sign/sku-x-r7- (accessed June 10, 2020): Sign available retail price, sign only (assumes existing post).
86 BNi, "Costbook,": Signage (10 - 14530) Handicap parking, 12"x18" (includes post and labor)
87 BNi, "2022 Public Works: Costbook," BNi Publications. 2022.

Table 10. Unit Cost of Accessible On-Street Parking for Scenario C

Cost Component	Number	Units	Cost per Unit (low)	Cost per Unit (mid)	Cost per Unit (high)	Total Cost (low)	Total Cost (mid)	Total Cost (high)
Curb and Gutter[88]	3.2	LF	$10	$11	$13	$31	$37	$42
Curb Ramp[89]	1	each	$104	$865	$4,207	$104	$865	$4,207
Pavement for increased width[90]	15	sq yd	$21	$21	$21	$308	$308	$308
Grading for increased width 6”[91]	2.5	cubic yd	$9	$11	$13	$22	$28	$33
Base material for increased width 6” [92]	15	sq yd	$34	$34	$34	$514	$514	$514
Base material for re-aligned sidewalk 6”[93]	11	sq yd	$8	$8	$8	$86	$86	$86
Grading of area where new sidewalk jogs around increased width[94]	1.8	cubic yd	$9	$11	$13	$16	$20	$24
Sign/Post/Installation[95,96]	1	each	$15	$96	$96	$15	$96	$96
Total	-	-	-	-	-	*$1,095*	*$1,952*	*$5,310*

4.2.6.4 Scenario D: Narrow ROW (less than 9’ post-installation)

Table 11 shows estimated per unit and total incremental costs for each cost component in cases where the available ROW is less than nine feet post-installation. This covers both new construction and alterations. Again, the lower value is the cost of accessible parking signage only, while the high values include the post and labor; to be conservative, the mid-range estimate is simply the same as the high estimate. These are the only incremental costs in this scenario. Additional cost information collected by an Access Board interview with Bellingham, WA, indicated the cost of restriping and signage combined was $500. It was not possible to separate the incremental cost of ADA signage from the costs of restriping and other signage, which would be required even in the absence of accessible parking.

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88 BNi, "Costbook,": Curb Formwork (03 - 11133) Curved 6" high, Cost per unit decreases depending on uses. Plus Sidewalks (32 - 13131) 6" assume 6" width.
89 Pedsafe, “Curb Ramps.”: Estimated Cost table, row 2 (price each without detectable warning), low and high values are minimum and maximum values reported in source. Recommended value is the median reported value.
90 BNi, "Costbook,": Asphalt Surfaces (32 - 12160) 3" thick
91 BNi, "Costbook,": Rough Grading (31 - 22130) Unit cost depends on equipment used.
92 BNi, "Costbook,": Asphalt Surfaces (32 - 12160) Binder course 6" thick.
93 BNi, "Costbook,": Base Course (31 - 23131) 6".
94 BNi, "Costbook,": Rough Grading (31 - 22130) Unit cost depends on equipment used.
95 Road Traffic Signs, https://www.roadtrafficsigns.com/parking-sign/reserved-parking-ada-symbol-sign/sku-x-r7- (accessed June 10, 2020): Sign available retail price, sign only (assumes existing post).
96 BNi, "Costbook,": Signage (10 - 14530) Handicap parking, 12"x18" (includes post and labor)

Table 11. Unit Cost of Accessible On-Street Parking for Scenario D

Cost Component	Num-ber	Units	Cost per Unit (low)	Cost per Unit (mid)	Cost per Unit (high)	Total Cost (low)	Total Cost (mid)	Total Cost (high)
Sign/Post/Installation[97,98]	1	each	$15	$96	$96	$15	$96	$96
Total	-	-	-	-	-	*$15*	*$96*	*$96*

4.2.7 Estimated Annual Cost

As described above, the research team estimated the annual number of newly constructed and altered on-street parking spaces that would be affected by the accessibility requirements of the Access Board's draft final rule. This estimate was based on a review of available literature and Geographic Information System (GIS) analysis of on-street parking.

Through this approach, the existing stock of on-street metered or marked non-residential parking spaces was estimated. From this estimate, a turnover model was used using estimated pavement lifespans, such that a share of this existing total would be subject to alteration each year, triggering the PROWAG requirements.

For new construction, future growth in on-street parking was estimated based on published reports on historical changes in parking supply and was tied to U.S. Census projections of population growth.

For both new construction and alterations, a simplifying assumption is used that 4% of spaces must be accessible. The 4% figure is used for parking spaces that are not on a block perimeter, but it is also a reasonable approximation of the requirements for block perimeters, which use a lookup table with whole number values.

This analysis indicated 10,753 accessible on-street parking spaces with nine-foot or wider ROW post-installation and 61,994 accessible on-street parking spaces with less than nine-foot ROW post-installation are replaced or added each year. The wider ROW installations were further divided into new construction (Scenario A) and alterations. Alterations were then divided into Scenario B and Scenario C. Due to a lack of data on adjacent unimproved ROW, the following analysis assumes half of new improvements have characteristics of Scenario B, and half are in Scenario C. Scenario C's costs are approximately 10% greater than Scenario B, so this assumption has a relatively minor impact on the total annual estimated cost. Scenario D covers the remaining parking spaces, those for which less than nine feet of ROW are available post-installation; this is the largest group.

For alterations, there are also an assumed number of scenario D improvements that would be prompted by improvements to the adjacent roadway, but without any improvements to the pedestrian right-of-way. Here, the analysis assumes requirements would be met with Scenario D improvements, which do not require large changes to the pedestrian right-of-way. In the first year after the rule is in effect, an

[97] Road Traffic Signs, https://www.roadtrafficsigns.com/parking-sign/reserved-parking-ada-symbol-sign/sku-x-r7- (accessed June 10, 2020): Sign available retail price, sign only (assumes existing post).
[98] BNi, "Costbook,": Signage (10 - 14530) Handicap parking, 12"x18" (includes post and labor)

estimated additional 7,056 spaces would require scenario D improvements. This annual number would decrease over time, as an increasing number of improvements are completed per scenarios B and C.

Combining the estimated per-space costs by the number of new and altered spaces by scenario leads to an overall estimated cost per in the initial year of $23.0 million (in undiscounted 2021 dollars) using the mid-range values. The following table (Table 12) provides initial year annual costs by scenario. For presentation purposes, unit costs have been rounded to the nearest dollar and locations to the nearest integer; thus, intermediate calculations may not agree.

Table 12. Summary of Estimated Costs

Scenario	Unit Cost: Low	Unit Cost: Mid	Unit Cost: High	Annual Occurrence	Total Cost: Low	Total Cost: Mid.	Total Cost: High
A: New construction, wide ROW	$150	$997	$4,345	3,697	$554,323	$3,687,493	$16,064,370
B: Alteration, wide ROW, reduced width	$993	$1,846	$5,200	3,528	$3,504,234	$6,513,670	$18,344,259
C: Alteration, wide ROW, adjacent unimproved ROW	$1,095	$1,952	$5,310	3,528	$3,864,563	$6,888,033	$18,732,657
D: Narrow ROW	$15	$96	$96	61,994	$927,430	$5,951,424	$5,951,424
Total				*72,747*	$8,850,549	$23,040,620	59,092,710

Over a 20-year analysis period, the discounted annualized cost is $11.4 million at a 7% discount rate or $17.0 million at a 3% discount rate.

4.3 Passenger Loading Zones

4.3.1 Background

The Access Board's PROWAG final rule includes provisions related to accessible passenger loading zones. As with accessible parking, these provisions are intended to ensure that persons with disabilities are able to access destinations and are able to safely exit and enter vehicles. Passenger loading zones are typically provided at hotels, convention centers, airports, and similar locations, and are particularly important for situations involving pickup and drop-off by taxi or shuttle.

In general, the final rule specifies that whenever passenger loading zones are constructed or altered, at least one accessible passenger loading zone must be provided for every 100 continuous feet of passenger loading zone, or fraction thereof (R212). Accessible passenger loading zones must meet dimensional requirements and include an access aisle that allows for ramps or other mobility devices to be used (R311).

4.3.2 Methodology Overview, Terminology, and Key Assumptions

This analysis estimates the number of newly constructed and altered passenger loading zones that would be affected annually by the accessibility requirements of the Access Board's final rule and assesses the incremental costs relative to a baseline in which PROWAG is not enacted. The study team prepared the estimates below of the number of affected passenger loading zones, followed by development of unit costs for the loading zone provisions.

This analysis covers only direct compliance costs and does not include any potential indirect effects, such as the impact of the passenger loading zone access aisles on pedestrian flows. For example, there may be cases where the access aisle causes a change in sidewalk layout or useable pedestrian space, with associated effects on pedestrian journey quality or comfort. These impacts are assumed to be minor, and the associated disutility is not estimated here.

Future maintenance costs are also not analyzed, as there is little to no difference in overall lifecycle costs for accessible passenger loading spaces and their access aisles versus equivalent areas of non-accessible loading zones (or similar alternative uses for the space, such as parking areas or sidewalks).

The cost analysis is calculated against a baseline in which PROWAG is not in effect, and passenger loading zones are constructed and altered according to existing state and local practices and standards. As discussed in more detail below, most current practices are modeled on the 2010 ADA standards and/or state and local codes that are largely identical to the guidelines in PROWAG.

Note that "loading zones" can have many different definitions in city codes and planning guides. The PROWAG provisions apply only to permanently designated passenger loading zones in the public right-of-way. Thus, the PROWAG provisions would not apply to:

- Loading zones that are designated for the loading and unloading of goods rather than passengers;
- Passenger loading zones that are not permanently designated, such as in the case of curbside space that is designated for passenger loading only during certain times of day [99];
- Passenger loading zones on sites, outside of the public right-of-way, including those on private property in hotel driveways and similar locations;
- Transit boarding areas, which are covered by other accessibility guidelines.

4.3.3 Estimated Passenger Loading Zones Affected

The study team was unable to locate any national estimates of total passenger loading zones. Non-parking curbside uses have tended to receive little attention in the transportation research literature, though there has been an increase in recent years as cities consider approaches to addressing the needs of users of ride hailing services and other new transportation providers.

Some cities have made computerized inventories of their curbside space available. One analysis of curbside allocation in the downtown areas of three major cities for which comprehensive data were available found that the extent of passenger pickup/dropoff spaces varied widely. In Washington, D.C., the ratio of metered (or time-limited) curbside parking to curbside pickup/dropoff spaces was approximately 24:1, while it was roughly 6:1 in Chicago and 1.8:1 in Seattle.[100] These figures are not

[99] For example, "Neighborhood Loading Zones" in New York City. https://www1.nyc.gov/html/dot/html/motorist/nlz.shtml
[100] Miller, Dawn. "Comparing Loading Zones," Coord blog, May 26, 2020. https://www.coord.com/blog/comparing-loading-zones

strictly comparable because each city has different definitions and requirements about the use of such zones, such as the types of vehicles permitted, the maximum period of use, and whether payment is required. The author of the report also highlights that there can be significant changes to allowable curb usage by time of day or day of week.

Counts of curbside pickup/dropoff spaces also do not directly correspond with the definition of "passenger loading zone" in PROWAG, since in many cases these spaces are not permanently designated– i.e., they may allow parking or other uses at other times of day or serve as through lanes of traffic during rush hour periods. In order to assess the extent of this difference, the study team conducted an informal visual check via Google Street View of each of the three downtown areas and reviewed online information from each city about parking regulations. This review found that almost all passenger loading zones (sometimes referred to as pickup/dropoff spaces) allow for other uses during at least some times of day, and thus are not permanently designated for passenger loading. Relevant regulations can be found in Table 13.

Table 13. Review of Curbside Loading Regulations for Selected Large Cities

City	Relevant Curbside Regulations
Seattle[101]	Passenger Load Zone: All vehicles may stop for up to 3 minutes to pick up and drop off passengers during posted hours (commonly 7 AM to 6 PM)
Chicago[102]	15-Minute Standing Zone: Non-commercial vehicles may stop for up to 15 minutes for pickup and dropoff of passengers or goods.
Washington, DC[103]	Pick-Up/Drop-off (PUDO) Zone: For pickup and dropoff of goods and people. School Pickup/Dropoff Zone: 15-minute limit, applicable during school hours. No parking at other times.

As summarized in the Accessible On-Street Parking section (Section 4.2.2), there are approximately 44.1 million on-street parallel parking spaces that are commercial or non-residential, with meters and/or posted time limits. The ratio of parking spaces to passenger loading zones varies significantly by location but could be estimated at very roughly 10:1, using a simple unweighted average of the three cities in the study cited above as well as the information from the GIS analysis. Applying this ratio would yield a total of 4.4 million passenger loading zones. Information from city parking guides in these cities indicates that very few would meet the PROWAG definition of passenger loading zone, as they are not permanently designated for passenger loading. Assuming that no more than 5% of the total would thus meet the PROWAG definition, this produces an estimate of 220,000 passenger loading zones in the U.S. as an upper bound.

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[101]https://www.seattle.gov/documents/Departments/SDOT/ParkingProgram/CanIParkHere_Flyer_COVID19_ADA%20July%2013.pdf
[102] https://www.chicago.gov/city/en/depts/bacp/sbc/loading_zones.html
[103] https://www.parkdc.com/pages/signs

As an additional point of reference, the study team conducted a review of curbside loading data for three cities for which comprehensive data were available through GIS. The number of passenger loading zones that would be covered by PROWAG was estimated by excluding loading zones that do not allow passenger pickup and dropoff, as well as those that are restricted by time of day. The results of this analysis are presented in the table below (Table 14), which generally shows a wide range when comparing passenger loading zones to metered parking spaces or other metrics such as population.

Table 14. GIS Analysis of Parking and Loading Zones for 3 Midsized Cities

	Estimated Passenger Loading Zones	Estimated Metered Parking Spaces	Estimated Ratio of Parking: Passenger Loading Zones	Estimated Passenger Loading Zones Per 1,000 Population
Madison, WI	126	323	2.6:1	0.47
Columbus, OH	117	5,803	50:1	0.13
Raleigh, NC	21	205	10:1	0.04

Note: Parking space total for Raleigh includes spaces that do not require payment but are time-limited.

The weighted average across these three cities is 0.16 passenger loading zones per 1,000 city population. If this proportion were applied across the U.S. urban population of 249 million, this yields a total of just over 40,000 passenger loading zones. Thus, the true figure may fall between this estimate of 40,000 and the upper-bound estimate above derived from larger cities, which is 220,000.

Because the required access aisle would typically involve alteration of the adjacent sidewalk, the 50-year concrete pavement lifecycle that is typical for sidewalks could be used for a further assumption that 2% (1/50th) of locations are altered in any given year. This is around 800 (lower estimate) to 4,400 (higher estimate) locations per year. Many passenger loading zone locations have physical constraints that would prevent a 5’-wide access aisle from being provided while still maintaining the accessibility of the sidewalk, so the actual number affected in a given year would be lower. A small number of passenger loading zones would be newly constructed each year, for example as part of new commercial developments on previously undeveloped land. This number is difficult to estimate.

4.3.4 Estimated Unit Costs

Construction costs for an accessible passenger loading zone (relative to a non-accessible loading zone) are very similar to the costs estimated in the Accessible On-Street Parking section (Section 4.2.7). These costs relate primarily to the additional curb, gutter, base and grading work that is required to create the 5’ access aisle, plus the costs for a curb ramp connecting the access aisle to the sidewalk. Unlike on-street parking, no sign is required by PROWAG, though some cities would likely indicate the status of the loading zone with signage of some kind. For alterations of existing passenger loading zones, costs would thus be in the range of $1,723 to $1,856, based on the mid-range costs estimated in the Accessible On-Street Parking section, less costs for the pole and sign. The former figure relates to locations where the sidewalk would be narrowed (Scenario B), while the latter figure related to locations where additional unimproved right-of-way is available, such that the sidewalk would jog around the access aisle (Scenario C). Using a simple average of these two cost figures, the cost per alteration location is $1,790.

For new construction, costs would also likely be similar to new construction of on-street parking. This is estimated to require approximately $901 for curb and gutter work and the curb ramp, using the mid-range cost estimate from the Accessible On-Street parking section (Scenario A), less the costs for the pole and sign.

4.3.5 Baseline: Current Practices

The 2010 ADA Standards for Accessible Design (sections 209 and 503) contain enforceable standards for the provision of passenger loading zones in new construction and alterations that are highly similar to those in PROWAG. [104] These standards apply to "sites, facilities, buildings, and elements," and not to passenger loading zones in the public right-of-way. Thus, local practices may vary as to whether and how accessible passenger loading zones are provided as part of street design. Only a few of the PROWAG docket comments that were received mentioned passenger loading zones, and these largely described situations that would not be classified as passenger loading zones under the current PROWAG language (e.g., when allowable uses change by time of day).[105]

The study team conducted internet-based research on a convenience sample of 14 states to assess current practices relative to passenger loading zones. In this review, the state's current guidelines or standards were considered to be essentially consistent with the PROWAG standards if they listed a requirement for accessible passenger loading zones (one per 100 feet of loading space) and were consistent on the key dimensional requirements (width of 8 feet, length of 20 feet, access aisle 5 feet in width).

Most states had a clear requirement for accessible passenger loading zones that were identical to PROWAG (or the earlier 2010 ADA standards), often with the same example diagram. However, this review also found that guidelines for loading zones may be located in a number of different types of documents, including state DOT design guidelines, parking codes, and building codes. This makes it less clear as to whether and how the published guidelines would actually apply to specific projects in the public right-of-way.

In at least one state, Wyoming, the relevant code makes note of ADA standards and requires loading zones to be "accessible," but does not appear to list the specific dimensional requirements. For several other states that were searched, no information was readily available online (Arizona, Utah, Vermont) so it is unclear what the baseline would be in these states. It is possible that no requirements currently exist in these states, or alternatively that guidelines for loading zones are handled at the local level.[106] A summary is provided below in Table 15.

[104] https://www.ada.gov/regs2010/2010ADAStandards/2010ADAStandards_prt.pdf
[105] City of Seattle docket comments available via regulations.gov, Docket ID: ATBCB-2011-0004-0117
[106] At least one municipality in Arizona, the city of Chandler, has specific requirements for accessible passenger loading zones. https://www.chandleraz.gov/sites/default/files/documents/imported/UDM_TDM4.pdf

Table 15. Passenger Loading Zone Guidelines by State

State	Passenger Loading Zone Guidelines Generally Consistent with PROWAG?	Source
Arizona	No Information	
California	Yes	California Parking Code Regulations[107]
Georgia	Yes	Georgia Accessibility Code[108]
Illinois	Yes	Illinois DOT, Accessible Public Right-of-Way Field Guide[109]
Indiana	Yes	Indiana DOT, Indiana Design Manual[110]
Iowa	Yes	Iowa Statewide Urban Design and Specifications, Design Manual[111]
Massachusetts	Yes	Massachusetts Architectural Access Board Regulations[112]
Pennsylvania	Yes	Pennsylvania Department of Labor and Industry, Universal Accessibility Standards[113]
Tennessee	Yes	Tennessee DOT[114]
Texas	Yes	Architectural Barriers Texas Accessibility Standards[115]
Utah	No Information	
Vermont	No Information	
Washington	Yes	Washington State DOT, Terminal Design Manual[116]
Wyoming	Unclear – requires "accessible" loading zone but no dimensional details	Wyoming Building Code[117]

[107] https://www.dgs.ca.gov/-/media/Divisions/CCDA/Item-7a-Parking-Code-Regulations-accessible.docx?la=en&hash=253BCA2683D7C15A3748DAF4E7BB26BAAFBA9C76
[108] http://web.gsfic.ga.gov/ADA/GA%20Accessibility%20Code%20Comparison_rev%2004-11%20(2).htm
[109] https://idot.illinois.gov/Assets/uploads/files/About-IDOT/Laws-&-Rules/Accessible%20Public%20ROW%20Field%20Guide%20January%202016.pdf
[110] https://www.in.gov/dot/div/contracts/standards/dm-Archived/10English/Part5/ECh51/DECh51.pdf
[111] https://intrans.iastate.edu/app/uploads/sites/15/2018/12/Chapter_08-2018.pdf
[112] https://www.mass.gov/doc/521-cmr-2300-parking-and-passenger-loading-zones/download#
[113] https://www.dli.pa.gov/laws-regs/regulations/Pages/Universal-Accessibility-Standards.aspx
[114] https://jcmpo.org/Data/TDOT_TransitionPlanPresentation_2016-07-14.pdf. Although the presentation is not detailed, it notes the adoption of 2010 ADA standards and mentions accessible loading zones.
[115] https://www.tdlr.texas.gov/ab/2012abtas5.htm#503
[116] https://www.wsdot.wa.gov/publications/manuals/fulltext/M3082/300.pdf
[117] https://up.codes/viewer/wyoming/ibc-2021/chapter/11/accessibility#11

4.3.6 Estimate of Additional Cost

Relative to a baseline in which no alterations of passenger loading zones were designed to be accessible, the costs of the PROWAG provisions could be estimated using the estimate of 800 to 4,400 alterations per year at a cost of $1,761 per location, or a total of between $1.4 million to $7.8 million annually. A small additional cost would be incurred for passenger loading zones that are added, but this could not be estimated with any precision. Evidence from a review of state-level design standards and guidelines suggests that many states already use accessibility standards for passenger loading zones that are similar or identical to PROWAG, although information was not available for every state, and practices may vary by locality. In the case where (nearly) all states and localities already follow guidelines that are consistent with PROWAG, then the incremental costs would logically be (nearly) zero. Actual costs would likely fall between these two extremes of $0 and $7.8 million per year. For purposes of generating a single point estimate, the low value of $1.4 million was used. This should still be a conservative estimate of cost when considering the large share of states whose standards are already consistent with PROWAG. The estimated annualized cost is $1.4 million per year using both the 7% and 3% discount rates.

4.4 Accessible Pedestrian Signals

4.4.1 Background

An accessible pedestrian signal (APS) and pedestrian pushbutton is an integrated device that communicates information about the "Walk" and "Don't Walk" intervals at signalized intersections in non-visual formats (i.e., audible tones and vibrotactile surfaces) to pedestrians who are blind or have low vision. The pedestrian pushbutton has a locator tone for detecting the device and a tactile arrow to indicate which pedestrian street crossing is served by the device. The use of APS is intended to provide pedestrians who are blind or have low vision with similar pedestrian crossing information to that available in visual format, thereby improving personal mobility and safety.

The Manual on Uniform Traffic Control Devices (MUTCD) contains standards, guidance and support for accessible pedestrian signals and pedestrian pushbuttons; it recommends but does not require providing APS (MUTCD, 4E.09, 4E.10, 4E.11, 4E.12, 4E.13).[118] PROWAG guidelines will require accessible pedestrian signals and pedestrian pushbuttons to be provided at pedestrian street crossings when new pedestrian signal heads are installed or in an alteration project where existing pedestrian signals are altered(R206). Accessible pedestrian signals and pedestrian pushbuttons must comply with the corresponding technical requirements in Chapter 3 (R307 and R308) and the technical requirements for operable parts in Chapter R4 (R403).

4.4.2 Methodology Overview, Terminology, and Key Assumptions

Conceptually, compliance costs can be thought of as the total lifecycle cost of pedestrian signal installations with the APS provision in place, less the cost of such projects under current baseline conditions in the absence of this provision, in present value terms over the course of the equipment lifecycle or other reasonable time period. This, in turn, is based on the difference in upfront equipment and installation costs for APS versus those for conventional (visual-only) signals, plus any incremental ongoing operations and maintenance costs for APS compared to conventional signals.

[118] Federal Highway Administration (2009). "Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways."

"Intersection" and "traffic signal" are used here with essentially the same meanings as in the MUTCD (MUTCD, 1A.13). For clarity in the discussion, this analysis also uses the term "signalized intersection," which is not defined in MUTCD, but refers to intersections that have traffic signals where "traffic is alternately directed to stop and permitted to proceed" (MUTCD, 1A.13). Colloquially, these are the locations with the familiar red-yellow-green traffic signals, or the newer type of pedestrian hybrid beacon signals.

PROWAG also requires APS at crossing locations that are not signalized intersections and do not have a defined "Walk" phase, such as crosswalks with rectangular rapid flashing beacons. In those cases, the APS would still have a locator tone but would provide information on the status of the beacon rather than information on a Walk phase.[119] Implementation costs for these types of locations will be covered by a separate cost analysis and are not included in this discussion.

Signalized intersections come in a variety of configurations. They can include conventional 4-way intersections as well as 3-way "Y" or "T" junctions, intersections with multiple intersecting roads, signalized traffic circles, or signalized midblock crossings. No data were available on the distribution of signalized intersections by type, so for simplicity, this analysis is based on an assumed typical signalized intersection that is a 4-way crossing. It is further assumed that there are pedestrian crossings on all four legs of each intersection, even though in practice some intersections have crosswalks only on certain legs.

Many, but not all, signalized intersections have pedestrian indication – i.e., pedestrian signals with Walk/Don't Walk displays. Thus, for further clarity, the term "signalized intersections with pedestrian indication" is used to denote the subset of signalized intersections that have pedestrian crossing signals. No comprehensive data are available on the number of signalized intersections in the U.S. or the share that have pedestrian indication. In the Initial PROWAG Cost Report[120], it was assumed that 70 percent of signalized intersections had pedestrian indication at that time, and that the share would rise to 90 percent by 2040. This was an estimate based on professional judgment and the observation that signalized intersections are concentrated in metropolitan areas, where pedestrian facilities are more likely to be present. A comment was received that these estimates seemed high, but no specific alternative figures were suggested. The study team was unavailable to find comprehensive data sources on this question[121]. As such, these estimates have been carried over to the current analysis. (If the comment is correct that the estimates are high, the result will be to somewhat overstate the true costs, but this is preferable to understating the costs.) These estimates also reflect the potential for greater presence of pedestrian indication over time due to urbanization and the emphasis on "complete streets" designs that include facilities for non-motorized travel.

Starting with the Transportation Equity Act for the 21st Century (TEA-21) of 1998, Federal law has directed that audible traffic signals be included in transportation plans and projects where appropriate. As a result of this and other initiatives, a limited number of APS have already been installed, and some state

[119] Rectangular rapid flashing beacons draw drivers' attention to a pedestrian crossing, but do not have a "walk" phase.

[120] Volpe Center, Cost Analysis of Public Rights-of-Way Accessibility Guidelines (PROWAG) (Nov. 2010), available via regulations.gov, Docket ID: ATBCB-2011-0004-0002.

[121] Comments from the American Association of State Highway and Transportation Officials (AASHTO). Docket ID: ATBCB-2011-0004. Available via regulations.gov.

and local transportation departments have programs and policies providing for APS to be installed at added and/or existing signalized intersections.

Question 9 in the NPRM sought information on how many state and local transportation departments currently provide accessible pedestrian signals and pedestrian pushbuttons when pedestrian signals are added or replaced at signalized intersections. Several state and local DOTs (including California, Minnesota, New York City, and Charlotte) noted in their responses that they have already begun installing APS at some signalized intersections[122]. Even as adoption has grown, the overall share of signalized intersections with pedestrian indication that have APS appears to be fairly small, although no comprehensive data are available on this metric. In a set of 8 cities for which detailed data were available, APS is currently used at approximately 12%-17% of signalized intersection locations.[123] Because this is a non-random sample with a number of larger cities, it may represent an overestimate of current APS prevalence.

In calculating costs and benefits, the study team estimated that 10% of existing signalized intersections with pedestrian indication have APS. Similarly, it was assumed that, in the absence of the proposed rule, 10% of pedestrian signals that are added in the future would have APS, while the remaining 90% would be non-APS. For replacement of existing signals at the end of their lifespan, it was assumed that non-APS would be replaced with non-APS, while APS would be replaced with APS. This is likely a conservative set of assumptions in that the adoption rate for APS appears to be growing over time rather than remaining constant.

APS installations would result from three main types of roadway projects: 1) replacement of existing pedestrian signals at the end of their useful life; 2) the addition of pedestrian signals at signalized intersections that do not currently have pedestrian indication; and 3) entirely new signalized intersections with pedestrian indication, as for example may be built with new developments, which could include a mix of “new” and “altered” facilities depending on whether the construction is on undeveloped land.

This analysis uses a lifecycle model of the current stock of pedestrian signals and assumes that, with PROWAG in place, existing, non-APS signals will be replaced with APS equipment as they are retired from service after a 25-year service life. It is further assumed that both types of added signalized intersections with pedestrian indication will have APS installed.[124]

In almost all APS products on the market today, the audio and vibrotactile functions are integrated into the pushbutton, which is coordinated with the pedestrian signal head. The term “APS equipment” is used

[122] Comments from California Department of Transportation. Docket ID: ATBCB-2011-0004-0314. Available via regulations.gov.; Comments from City of Boston, Massachusetts. Docket ID: ATBCB-2011-0004-0321. Available via regulations.gov.; Comments from City of Charlotte, North Carolina. Docket ID: ATBCB-2011-0004-0298. Available via regulations.gov.; Comments from City of New York, New York. Docket ID: ATBCB-2011-0004-0429. Available via regulations.gov.; Comments from City of Seattle, Washington. Docket ID: ATBCB-2011-0004. Available via regulations.gov.; Comments from City of Thornton, Colorado. Docket ID: ATBCB-2011-0004-0240. Available via regulations.gov.

[123] Volpe Center analysis of public GIS data from Austin, TX; Charlotte, NC; Dallas, TX; New York, NY; Portland, OR; San Francisco, CA; Seattle, WA; and Sioux Falls, SD. The unweighted average across these cities was 17%, while the population-weighted average was 12%.

[124] The 25-year APS equipment lifespan is based on interviews with vendors and local transportation officials conducted during the 2010 analysis.

in this analysis to refer to the equipment that provides the required audio and vibrotactile APS features. The terms "conventional" or "non-APS" equipment to refer to pedestrian signals that do not meet the APS standard in PROWAG. A typical 4-way intersection with crosswalks on all legs would have 8 APS "units" – sometimes referred to as 8 "stations" – where APS equipment would be installed, with one to serve each of the potential pedestrian crossing movements. The installation of APS equipment may, in some locations, also require new or relocated poles onto which the accessible pushbuttons are mounted; these are referred to here as "pushbutton poles" or "poles."

Some NPRM docket comments noted that the traffic signal controller, which is the electromechanical or computerized device that governs the overall operation of the traffic signal, may also need to be upgraded, as some legacy models cannot support APS. However, when considering new construction or alterations, it is likely that the signal controller would be upgraded even in the no-action baseline, and thus would not represent an incremental cost of APS installation.

4.4.3 Estimated Locations Affected and Compliance Costs

The requirement in the proposed guidelines for APS and pedestrian pushbuttons will have impacts on state and local transportation departments that do not currently provide APS equipment when pedestrian signals are added or replaced at signalized intersections with pedestrian indication.

4.4.3.1 Number of Signalized Intersections with Pedestrian Indication

Using the same methodology from the Initial PROWAG Cost Report[125] but with updated Census data, the study team estimated that there were approximately 337,342 signalized intersections in the United States as of 2022. This is based on an industry rule-of-thumb of one signalized intersection per 1,000 population[126] and estimated population for 2022.[127] Of the overall total, an estimated 236,139 (70%) were assumed to have pedestrian indication; as noted above, this is based on professional judgment due to a lack of data and is subject to some uncertainty. With the assumption that 90% of these are non-APS and 10% are APS, this implies a total of 212,525 signalized intersections with pedestrian indication that do not already have APS.

Using a population growth rate derived from the Census forecast of population for 2022 and 2047, and the same 1:1000 ratio, the study team created a forecast of total signalized intersections for 2047 of 384,415, of which an estimated 345,973 (90%) would have pedestrian indication. Estimates for the intermediate years between 2023 and 2047 were interpolated using a calculated compound annual growth rate. (Note

[125] Volpe Center, Cost Analysis of Public Rights-of-Way Accessibility Guidelines (PROWAG) (Nov. 2010), available via regulations.gov, Docket ID: ATBCB-2011-0004-0002.

[126] See FHWA online information sheet, http://mutcd.fhwa.dot.gov/knowledge/faqs/faq_part4.htm, which in turn is based on a 2004 publication from the Institute of Transportation Engineers. Actual ratios vary according to the level of urbanization and other factors. For example, according to their respective city websites as of 2015, there is roughly 1 signalized intersection per 705 residents of New York City, 1 per 632 in Cambridge, Mass., and 1 per 614 in Seattle. Ratios are higher in suburban areas, e.g., 1:923 in Naperville, Ill., 1:1055 in Loudon County, Va., and 1:1976 in Gwinnett County, Ga. Ratios are higher in many areas, and some rural counties have no signalized intersections at all. Overall, although these figures constitute a very limited sample, they suggest that the 1:1000 figure is reasonable as a nationwide estimate.

[127] US Census, 2017 National Projections, data retrieved December 2021.

that all figures presented in this section are presented without rounding in order to make the discussion easier to follow but should not be interpreted as precise point estimates.)

From interviews with vendors and local transportation officials that were conducted as part of the previous analysis, the study team estimated that the average lifecycle or replacement rate for existing pedestrian signals is roughly 25 years. A few comments were received noting that not all signals will last to the 25-year mark and that some APS equipment has had reliability issues. However, this still appears to be an appropriate average that can be used to estimate the rate at which *existing* signals will be replaced with APS. AASHTO's comment described a 25-year lifecycle assumption as optimistic, with a recommended range of 5 to 25 years depending on "environmental conditions."[128]

Based on this lifecycle estimate, it can be estimated that approximately 1/25th (or 4%) of the existing stock of signalized intersections with pedestrian indication with non-APS will have their existing pedestrian signal equipment replaced each year. This equates to 8,501 per year (=212,525 * 0.04) during the period 2023 to 2047.

In addition to these replacements, APS would also be added at signalized intersections with pedestrian indication. Added APS installations per year were estimated based on the forecast above of signalized intersections with pedestrian indication. The forecasted number of APS installations for equipment replacement and added signalized intersections is displayed in Table 16.

Table 16. Forecast APS Installations by Type, 2023 and 2047

	2023	**2047**
Equipment Replacement at Existing Signalized Intersections with Pedestrian Indication	8,501	8,501
Added Signalized Intersections with Pedestrian Indication	3,272	4,721
Annual Total	**11,773**	**13,222**

4.4.3.2 Unit Cost of APS Equipment

In the 2011 draft regulatory analysis, costs for APS equipment were estimated at $600 per unit, relative to non-APS costs of $250 per unit, for an incremental cost of $350. This estimate was based on price quotations received from three vendors in 2010, comparing the accessible and non-accessible versions of similar pedestrian signal equipment.[129]

Question 10 in the 2011 preamble requested additional information from state and local transportation departments that currently provide APS on the additional costs of APS. Question 11 sought information

[128] Comments from the American Association of State Highway and Transportation Officials (AASHTO). Docket ID: ATBCB-2011-0004. Available via regulations.gov.
[129] Volpe Center Initial PROWAG Cost Analysis, 2010. Price quotes were from telephone/email interviews and pricing sheets from Campbell, Polara, and Prisma.

on the assumptions used to estimate the total annual costs for requiring APS when pedestrian signals are newly installed or replaced at signalized intersections.

Data from these docket comments received were combined with information from the Pedestrian and Bicycle Information Center and a pedestrian signal manufacturer[130] to develop updated unit cost estimates for APS and associated equipment that may be needed for their installation. Additional information on the cost of non-APS units was also collected in order to estimate the incremental costs of APS.

Cost estimates were obtained from a number of sources, as listed below. These estimates exhibit a large range between the lowest and highest values, for a number of reasons:

- There are price differences across the various APS products available in the market, as well as local differences in procurement practices that can affect final costs.
- Estimates come from different points in time and were generally not adjusted for inflation in the original sources.
- A few of the estimates reflect the incremental cost of APS relative to non-APS, whereas most of the estimates simply reflect total APS costs with no offset.
- Many of the estimates are drawn from experience with retrofitting existing intersections with APS based on local needs, and thus reflect the (generally higher) costs for retrofits relative to new construction.

Note also that some estimates are presented on a per-unit basis, while others are on a per-intersection basis. For the most common 4-way intersection layout described above, eight APS units would be needed, so as an example, an estimate of $1,000 per APS unit would be the rough equivalent of an estimate of $8,000 per intersection.

Estimates from publications and news media:

- Pedestrian and Bicycle Information Center[131]: $550 to $990 per APS unit, with an average of $800 and median of $810.
- BidExpress subscription data service: $171 to $1,331 per unit, based on bid data from construction projects in Michigan, New Mexico and Massachusetts, as compiled by the Pedestrian and Bicycle Information Center for projects 2006 to 2011.
- New York City study[132]: $985 per unit, including materials and installation.
- Newton, MA[133]: $6,000 to $8,000 per intersection.

[130] Polara Enterprises, LLC (2016). "Excellence in Accessible Pedestrian Signals and Push Buttons". Available via Polara Enterprises' website: http://www.polara.com/traffic.php

[131] Pedestrian and Bicycle Information Center (2013). "Costs for Pedestrian and Bicyclist Infrastructure Improvements." Retrieved from https://www.pedbikeinfo.org/cms/downloads/Countermeasure%20Costs_Report_Nov2013.pdf

[132] New York City Department of Transportation (November, 2015). "Accessible Pedestrian Signals Program Status Report." Available via New York City Department of Transportation's website: http://www.nyc.gov/html/dot/downloads/pdf/2015-aps-program-status-report.pdf

[133] Cohen, J. "Council OKs $100K to Move Accessible Pedestrian Signal Program Forward," *Wicked Local,* 12-4-2018. https://www.wickedlocal.com/story/newton-tab/2018/12/04/council-oks-100k-to-move/7950766007/

Estimates from docket comments:

- Delaware DOT: $798 per unit, plus mounting brackets.[134]
- Boston: $7,000 per intersection.[135]
- Washington DOT: $10,000 per existing intersection.[136]
- Florida DOT: $10,000 per intersection.
- Minnesota DOT: $15,000 per intersection for hardware.[137]
- Charlotte: $5,000 per intersection.[138]
- Denver: $7,000 to $12,000 per intersection.[139]
- Milwaukee: $15,000 per intersection.[140]
- New York City: $571 per unit for materials and $500 per unit for installation.[141]
- Seattle: $900 incremental cost per unit. Total cost of $10,000 to $25,000 per intersection.[142]
- Thornton, CO: $335 per signal head plus 0.75 hours of labor; $415 per vibrotactile pushbutton and sign plus 0.25 hours of labor. Total of roughly $6400 per intersection.[143]

The estimate from PBIC 2013 is notable because it draws on four different sources, whereas the others generally come only from a single agency. The $800 average value reported would be just over $950 when converted to 2021 dollars. Overall, allowing for the possibility of some higher-cost equipment types or locations, a reasonable overall value is $1,000 per APS unit, or $8,000 per intersection. At this estimated cost level, almost all of the available data points are within 50% on either side of this value. APS costs may come down over time as economies of scale take greater hold in the market or technological innovations reduce production costs, but these factors could not be forecast or estimated.

The *incremental* costs of APS equipment were calculated as the difference between APS equipment and conventional, non-APS equipment. The team re-interviewed an APS manufacturer, who provided an estimated cost of about $310 per unit for non-APS equipment[144] as of 2015. PBIC separately estimated the average cost of a conventional pedestrian signal head at $550, again based on available data from state DOTs, as of 2013.[145] On balance, the study team believes that the PBIC value is more representative of

[134] Comments from Delaware Department of Transportation. Docket ID: ATBCB-2011-0004-0165. Available via regulations.gov.
[135] Comments from City of Boston, Massachusetts. Docket ID: ATBCB-2011-0004-0321. Available via regulations.gov.
[136] Comments from Washington State Department of Transportation. Docket ID: ATBCB-2011-0004-0072. Available via regulations.gov.
[137] Comments from Minnesota Department of Transportation. Docket ID: ATBCB-2011-0004-0325. Available via regulations.gov.
[138] Comments from City of Charlotte, North Carolina. Docket ID: ATBCB-2011-0004-0298. Available via regulations.gov.
[139] Comments from City of Denver, Colorado. Docket ID: ATBCB-2011-0004-0289. Available via regulations.gov.
[140] Comments from City of Milwaukee, Wisconsin. Docket ID: ATBCB-2011-0004-0406. Available via regulations.gov.
[141] Comments from City of New York, New York. Docket ID: ATBCB-2011-0004-0429. Available via regulations.gov.
[142] Comments from City of Seattle, Washington. Docket ID: ATBCB-2011-0004. Available via regulations.gov.
[143] Comments from City of Thornton, Colorado. Docket ID: ATBCB-2011-0004-0240. Available via regulations.gov.
[144] Prisma Tibro. Telephone interview with Ellen Lannemyr, December 15, 2015, and 2015 product price list, "Price List Prisma Tibro 20151216."
[145] Bushell, M. et al. 2013. *Costs for Pedestrian and Bicyclist Infrastructure Improvements*. https://www.pedbikeinfo.org/cms/downloads/Countermeasure%20Costs_Report_Nov2013.pdf

the costs experienced by state and local agencies. Adjusted for inflation, this would be just over $650 in 2021 dollars.

PBIC further estimated that the average cost of a non-APS pedestrian pushbutton is $350. Pushbutton costs would be part of the baseline to the extent that they are needed for non-APS installations. This is a common approach where the walk signal is actuated by pedestrians using the pushbutton. However, some localities have not used pushbuttons for non-APS signals in locations where the pedestrian walk phase comes up every signal cycle and does not require pedestrian actuation. If pushbutton costs were included in the no-action baseline, this would increase the total costs of the baseline and thus reduce the cost difference between APS and non-APS. To be conservative, pushbutton costs were not included in the non-APS baseline. (With additional information on pushbutton practices by city, a more refined estimate would be possible.)

Putting the unit cost figures together, the incremental cost of purchasing APS equipment relative to a non-APS equipment, is calculated as $1,000 per APS unit, less the $550 cost of non-APS equipment. These calculations are shown in the first three rows of Table 2 below.

These figures are for signal equipment only and do not include any additional installation labor for APS relative to non-APS. Several docket comments provided estimates for APS installation labor costs as distinct from equipment costs, though these comments did not always clarify whether, and to what extent, the labor costs of installing APS equipment differ from those of installing conventional, non-APS equipment. Relatively little published data are available on this topic. The most detailed and well-documented estimate came from comments provided by the city of Thornton, Colorado, which estimated that APS equipment installation required 0.75 person-hours per signal head and 0.25 person-hours for the pushbutton[146]. The labor associated with the signal head would be required even for non-APS equipment, and the labor associated with the pushbutton could be required, depending on whether the location uses pushbutton actuation. To be conservative, the study team included the 0.25 person-hours associated with APS pushbutton installation as an incremental cost for APS equipment. Some additional labor could be required for calibrating the audible tones or for other elements not present on non-APS equipment.

Local labor costs can vary significantly. The comments from Thornton, CO cited a local rate of $28 per hour at that time. Based on more recent national data from the Bureau of Labor Statistics for highway construction labor, an updated value of $40 per hour appears reasonable.[147] At this labor rate, incremental labor costs are $10 per APS unit (=(0.25 * $40). For a typical 4-way signalized intersection with pedestrian indication, 8 units would be required, for total incremental labor costs of $80.

At some locations, APS equipment installation also requires added or relocated pushbutton poles, which can include associated costs for wiring and/or conduit. An upgrade to the traffic signal controller is also required in cases where an existing, older controller can provide pedestrian indication but cannot support

[146] Comments from City of Thornton, Colorado. Docket ID: ATBCB-2011-0004-0240. Available via regulations.gov.

[147] Bureau of Labor Statistics, OES data (May 2020) for construction laborers in the highway construction industry. Average wage is $23.60. The study team increased this to an assumed $40 to account for non-wage fringe benefits and other costs of compensation. https://www.bls.gov/oes/current/oes472061.htm

APS operation. Only a limited number of comments received on APS included information on these potential additional costs. Comments from the City of Boston and the City of New York suggested additional costs for APS installation of $2,500 to $5,000 per pole,[148] and $5,000 for the signal controller upgrade[149]. It is possible that these generally high-cost locations in the urban northeast do not reflect national averages, as other sources list significantly lower costs. For example, FHWA estimated a cost of $800 to $1,200 (in 2013 dollars, equivalent to around $950 to $,1400 in 2021 dollars) for a pedestrian pushbutton installation that includes the pedestal/post.[150] Allowing for variations by region and the possibility of some high-cost installations, an overall average of $2,500 per pole appears to be a reasonable estimate.

The docket comments from Boston and New York did not provide a more detailed cost breakdown or comparison to non-APS equipment. However, for calculation purposes, these pole and signal controller costs are considered in the calculations as incremental costs of APS, as the implication of the comments was that they are costs that would not be otherwise incurred to provide pedestrian indication.

The City of Boston noted that existing signal controllers are routinely updated for a variety of reasons, such as improving traffic flow, and not necessarily retained for their full functional lifespan. For localities using a similar approach, this implies that the rate of replacement would be more frequent than the 25-year signal lifespan implies. On the other hand, in these cases, the cost of the signal upgrade would, by definition, be incurred in the baseline rather than representing an incremental cost of APS.[151]

Fewer cost estimates were provided by these sources for pushbutton pole installation and upgraded signal controllers, as they are not needed in many cases for APS. As a result, there was less variation in estimates for these items.

A summary of these equipment and labor costs is provided in Table 17.

Table 17. APS Equipment Costs

Equipment	Estimated Cost (per unit)
APS Equipment	$1,000
Non-APS Equipment	$550
Incremental Cost of APS Equipment	$450
APS Equipment: Incremental Installation Labor	$80
Pushbutton Pole for APS Equipment, where needed	$2,500

[148] Boston's comments cited a cost of $20,000 per intersection, which would imply $2,500 per pole, if 8 poles are needed (one serving each of the two pedestrian crossing directions on each of the 4 corners of the intersection). New York's comments estimated a cost of $5,000 per pole but noted that 4 might needed per intersection, for a cost of $20,000.
[149] Comments from City of Boston, Massachusetts. Docket ID: ATBCB-2011-0004-0321. Available via regulations.gov.; Comments from City of New York, New York. Docket ID: ATBCB-2011-0004-0429. Available via regulations.gov.
[150] Federal Highway Administration, *Pedestrian Safety Guide and Countermeasure Selection System*, 2013. http://www.pedbikesafe.org/pedsafe/countermeasures_detail.cfm?CM_NUM=52
[151] The study team conducted a range of sensitivity tests reflecting this situation, lowering the replacement cycle to 15-20 years instead of 25, and including signal controller upgrades in the baseline costs.

Signal Controller Upgrade to support use of APS Equipment, where needed	$5,000

To translate these values into costs per affected intersection that is constructed or altered, the study team again uses the illustrative 8-unit intersection (i.e., a signalized intersection with pedestrian indication and pedestrian crossings on all four legs). For calculation purposes, intersections are classified as either "low cost" or "high cost." This is a necessary simplification, since each intersection will be different in the range of equipment needs and the complexity of the APS installation.

- The Low Cost scenario assumes that 8 APS equipment units will be required.
- The High Cost scenario assumes that, in addition, 4 additional pushbutton poles and an upgraded traffic signal controller will be required.

Combining these assumptions with the unit costs in Table 17 yields total cost per intersection in the low cost and high cost settings. Table 18 shows the results of these calculations.

Table 18. Estimated Cost per Intersection

Installation Scenario for 4-Way Signalized Intersection with Pedestrian Indication (8 APS Units)	Cost Estimate
Low Cost 8 APS equipment units and labor	$3,680
High Cost 8 APS equipment units and labor, plus 4 pushbutton poles and upgraded traffic signal controller	$18,680

4.4.4 Operations and Maintenance Costs

At least one commenter noted the potential for higher costs with APS due to reliability and malfunction issues with the then-current generation of equipment (as of 2011) [152], and another noted that APS can be susceptible to vandalism by those who object to the locator tones[153]. While these may be valid concerns, they appear to be near-term issues that will ameliorate over time.

For the purposes of the lifecycle cost estimate, current research suggests that the recurring costs associated with APS, including electricity consumption and maintenance, are similar to those of non-accessible signals. The routine maintenance process for APS is more complex than for non-APS because it involves checking the operation of the audible and vibrotactile features. However, none of the public comments on the NPRM noted higher routine maintenance costs, as distinct from the reliability and vandalism issues associated with early generation equipment. NCHRP report 117A *Accessible Pedestrian Signals: A Guide to Best Practices*[154] documents the experiences of deploying APS from 12 state and

[152] Comments from City of Boston, Massachusetts. Docket ID: ATBCB-2011-0004-0321. Available via regulations.gov.
[153] Comments from Rick Perez. Docket ID: ATBCB-2011-0004-0574. Available via regulations.gov.
[154] Harkey, David L., Daniel Carter, Billie L. Bentzen, and Janet M. Barlow (2009). "Accessible Pedestrian Signals: A Guide to Best Practices." NCHRP Report 117A.

local DOTs, with all of these agencies reporting that maintenance concerns were minimal, though some did note the need to periodically adjust volume levels. Therefore, although APS' additional features could entail slightly higher costs, the available evidence is that these are not significant. This analysis uses an approximation of no incremental costs for operations and maintenance, compared to a baseline of non-APS.

4.4.5 Total Costs

Total annual costs on a nationwide basis are the product of the number of APS installed and the average cost of those installations. Average costs, in turn, depend on equipment and labor costs as experienced by the agency involved, as well as the relative prevalence of simple versus complex installation conditions (as illustrated by the Low Cost and High Cost scenarios above). In docket comments, AASHTO provided an overall estimate of $5,000 to $10,000 per intersection, and several state and local DOTs (Minnesota DOT, Washington State DOT, City of Milwaukee, City of Denver) all provided estimates that were in the general range of $7,000 to $15,000 per intersection. As noted above, it was not always clear whether these estimates reflected the total costs of APS or the incremental costs compared to non-APS. However, by comparing the estimates offered for per-unit costs against those for per-intersection costs, it is possible to make broad inferences about the overall prevalence of lower and high cost locations. That is, high cost locations appear to make up no more than about one-third of the total, since otherwise the average per-intersection cost offered by these sources would be higher than the ranges that were listed.

For the purpose of generating a national total, it was therefore estimated that 67% of APS installations would be in low-cost settings and 33% in high-cost. When this assumption is combined with the estimates above of unit costs and the number of affected signalized intersections, total costs equal $102 million in the first year (2023) and rise to $114 million (in real terms) in 2047. When converted to an annualized equivalent, this is $98.8 million per year (using a 7% discount rate) or $103.3 million (3% discount rate). A full set of year-by-year cost estimates are listed in Appendix C. Again, these costs are best estimates based on the available information, and costs in future years could be lower than forecast as a result of technology-driven cost reductions and/or economies of scale.

4.5 Shared-Use Paths

A shared use path (SUP) is a multi-use path designed primarily for use by bicyclists and pedestrians for transportation purposes and may also be used for recreation. Shared use paths are physically separated from motor vehicle traffic by an open space or barrier and are either within the highway right-of-way or within an independent right-of-way. PROWAG guidelines provide the technical requirements to ensure that shared use paths located in the public right-of-way are readily accessible to and usable by pedestrians with disabilities. The guidelines provide standards for shared use paths, including their grade, cross slope, width, surface material, detectable warning surfaces, vertical clearance, and curb ramps. The standards would apply to new construction and alterations. The following analysis discusses these requirements in more depth and estimates the increased costs associated with each technical requirement and the miles of shared use paths that would be affected annually by the accessibility requirements proposed by the Access Board's final rule. This analysis focuses solely on the costs—the benefits will be discussed separately.

4.5.1 Methodology Overview, Terminology and Key Assumptions

This cost summary updates research conducted as part of a previously published report, "Cost Analysis of Public Rights-of-Way Accessibility Guidelines" (hereafter, Initial PROWAG Cost Report).[155] Material from that report was incorporated into the preliminary regulatory assessment that was included with the PROWAG Notice of Proposed Rulemaking (NPRM). This document is intended to provide updated cost impacts of the accessibility requirements for shared use paths.

The cost impacts for shared use paths were defined relative to a no-action baseline in which the guidelines are not adopted, and current practices continue. These costs were estimated using a three-stage process. First, the number of affected locations within the United States was estimated using a range of available data sources, as described in more detail below. Second, unit costs for each of the shared use path requirements were estimated based on materials and labor costs. Third, unit costs were combined with the number of affected locations to generate a total discounted value over a multi-year period.

4.5.2 Number of Affected Locations

There is neither an official USDOT database nor a comprehensive inventory of SUPs in the United States available through commercial GIS software. The best available information comes from a database of trails maintained by the Rails-to-Trails Conservancy (hereafter referred to as the "RTC database").[156] The RTC database includes trail-level data covering the 50 states and the District of Columbia (including some coverage of Federal lands) derived from GIS and GPS data. While the RTC database provides information on allowed trail activities (i.e., walking, biking, or skiing), other trail databases that are more focused on recreational trails do not report the trail activities in a machine-readable format. Without data on the range of allowed trail activities, it is not possible to distinguish backcountry hiking trails from SUPs. Several municipalities, counties, and states have reported on or provided GIS layers of SUPs; however, the data are neither consistent nor comprehensive. The definition of SUPs varied by source and often lacked key details. In addition, data were available only for 10 out of 50 states and 50 cities or counties out of more than 3,000. The Alliance for Biking and Walking, an advocacy organization, has reported on the miles of multi-use paths across the nation's 51 largest cities, but the last report with information on multi-use paths was published in 2016.[157]

As of February 2022, the RTC database contained information on over 5,000 trails covering approximately 40,000 miles. Despite the name of the organization, the database is not limited to rail-to-trail conversions and includes a wide range of trail types. Many of the trails in the database do not meet the definition of an SUP, such as those that are designed principally for cross-country skiing, all-terrain vehicles, or snowmobiling. Accordingly, the database was filtered to include only those trails for which both walking and biking (as distinct from mountain biking) were listed as available trail uses. This is the closest available analogue to the SUP definition in the rule and yields a total of 4,807 SUPs covering 34,256 miles.

[155] Volpe Center, *Cost Analysis of Public Rights-of-Way Accessibility Guidelines (PROWAG)* (November 2010), available via regulations.gov, Docket ID: ATBCB-2011-0004-0002.
[156] The RTC database is available at www.traillink.com.
[157] Alliance for Biking & Walking, *Bicycling & Walking in the United States 2016 Benchmarking Report* (2016), https://bikeleague.org/sites/default/files/2016BenchmarkingReport_web.pdf

Data from the RTC database was also extracted in 2012. As of 2012, the database provided information on 2,089 existing SUPs covering 19,733 miles and 148 proposed trails covering 3,396 miles.[158] While each of the proposed trails were in a different stage of planning, most had already acquired right-of-way, so the study team assumed that these proposed paths were constructed over a five-year period to be consistent with typical regional planning cycles and project construction timelines. As of 2022, the RTC database no longer distinguished between existing trails and current projects, but it is confirmed that the RTC still includes both.

The majority of SUPs in the RTC database do not cross state lines, but there are a small number of multi-state trails. As of 2012, there were 14 multi-state SUP trails covering 508 miles, and as of 2022, there were 35 multi-state SUP trails covering 588 miles. These trails were apportioned to individual states according to the estimated trail length as measured in Google Maps.

Based on the described approach, the study team determined the number of miles of existing and planned SUPs by state, which is presented in Table 19.

Table 19. Estimated Existing and Planned SUP Trails by State

State	Existing Miles (2012)	Planned Miles (2012)	Existing + Planned Miles (2022)
Alabama	118.8	-	193.3
Alaska	36.9	-	57.6
Arizona	264.9	6.0	555.3
Arkansas	50.9	-	226.8
California	1,501.1	1,165.1	2,108.3
Colorado	576.4	1.9	1,124.7
Connecticut	127.6	-	251.3
District of Columbia	37.7	18.8	48.1
Delaware	99.4	-	132.3
Florida	903.8	54.6	1,563.5
Georgia	309.5	39.9	559.4
Hawaii	24.8	-	43.1
Idaho	326.6	27.0	466.1
Illinois	1,200.9	81.4	1,677.8
Indiana	343.5	91.8	700.2
Iowa	709.8	40.0	1,393.7
Kansas	337.9	-	544.6
Kentucky	38.9	164.0	152.8
Louisiana	55.1	25.9	145.8
Maine	97.4	1.3	251.5
Maryland	523.8	68.5	579.2
Massachusetts	195.2	67.0	391.3
Michigan	1,176.1	37.5	2,535.2
Minnesota	1,198.1	47.9	2,596.5
Mississippi	60.5	44.5	153.9
Missouri	418.7	71.6	719.1
Montana	94.8	-	295.1

[158] All proposed paths with a listed mileage were considered, as many of them did not have listed activities.

State	Existing Miles (2012)	Planned Miles (2012)	Existing + Planned Miles (2022)
Nebraska	434.3	321.0	467.6
Nevada	149.1	58.0	297.3
New Hampshire	131.6	5.0	299.1
New Jersey	275.2	-	395.9
New Mexico	80.3	-	257.9
New York	1,040.6	27.4	1,279.1
North Carolina	214.5	-	522.4
North Dakota	44.0	-	62.3
Ohio	1,101.6	399.3	1,850.7
Oklahoma	144.7	-	211.3
Oregon	308.7	14.3	542.1
Pennsylvania	1,086.8	-	1,978.5
Rhode Island	54.3	-	84.3
South Carolina	52.4	20.0	187.4
South Dakota	37.1	-	266.7
Tennessee	148.3	16.0	269.6
Texas	404.1	156.1	1,077.4
Utah	210.2	8.0	407.6
Vermont	95.5	46.7	187.5
Virginia	500.7	28.8	713.8
Washington	781.7	91.4	1,066.1
West Virginia	173.6	7.0	395.8
Wisconsin	1,391.0	38.5	1,824.9
Wyoming	32.2	-	144.7
US Total	**19,721.2**	**3,292.1**	**34,255.9**

There are several factors that may bias these figures. First, these figures may overstate the actual total since they include some backcountry trails that may not have a transportation function as envisioned in the SUP definition. Second, and conversely, it may underestimate the true total to the extent that the database is not comprehensive.

To validate these estimates, the study team reviewed State DOT and the District of Columbia DOT websites. Data on existing miles of SUPs were available for 10 states. Table 20 presents the state estimates, the estimates based on the RTC database for comparison, and the state definition of an SUP.[159] State definitions are largely consistent with the Access Board's definition but the requirements for certain features can vary. Notably, Florida specifies that SUPs are paved with asphalt, while the PROWAG rule is less prescriptive. The ratio of SUP miles based on the RTC database to SUP miles based on state data ranged from 37% in Wyoming to 185% in New Jersey. The unweighted average of this ratio across all 10 states is 110%. When weighting by SUP miles, the average is 116%. While the accuracy of estimates based on the RTC database likely varies by state, the review of State DOT data suggests that in aggregate,

[159] Not all data sources provide clear definitions of SUPs, so supplemental sources used for clarification are noted in a footnote.

a national estimate derived from the RTC database is likely reasonable. It is more likely that the RTC database overstates total mileage relative to the state data, so cost estimates will be conservative.

Table 20. Existing Trails Estimated with State Data

State	Estimated miles of SUPs based on RTC database as of 2022	Estimated miles of SUPs based on state data	Definition of a SUP in state documentation
Florida	1,563.5 (822.5 that are paved with asphalt)	934.9 as of June 2022[160]	"A shared path is an asphalt-paved way, within the highway right of way, at least ten feet wide, separated from the shoulder or back of curb by an open space at least five feet wide or by a barrier, not signed as closed to bicycle use, designation as a shared path not required. It is restricted from motor vehicle usage."
Iowa	1,393.7	1,990 as of December 2018[161]	"The phrase 'multi-use trail' refers to a paved or smooth gravel pathway for walking and bicycling that is separated from motor vehicle traffic yet still functions as a transportation facility."
Massachusetts	391.3	843.5 as of the end of 2020[162]	"Shared use paths—also called trails, multi-use paths, greenways, or bike paths—are off-road infrastructure that is physically separated from motorized vehicle traffic and designed for use by people of all ages and abilities. Shared use paths tend to be ADA-compliant and are typically paved, but can also use stabilized aggregate, crushed stone, or unimproved natural surfaces."[163]
Michigan	2,535.2	2,100 as of 2016[164]	"The multi-use trails indicated on this map are accessible for walking, running and bicycling at a minimum."
Montana	295.1	179.5 as of the summer of 2015[165]	Shared use paths include "all multiuse trails or other paths within state-maintained federal-aid highway rights-of-way that are separated from motorized vehicular traffic by open spaces, pavement, markings, or barriers and that are usable for transportation purposes by pedestrians, runners, bicyclists, skaters, equestrians, and other nonmotorized users."

[160] Florida Department of Transportation Office of Transportation Data and Analytics, *FDOT Roadway Characteristics Inventory Data* (June 2022), https://services1.arcgis.com/O1JpcwDW8sjYuddV/arcgis/rest/services/Shared_Path_TDA/FeatureServer

[161] Iowa Department of Transportation, *Iowa Bicycle and Pedestrian Long Range Plan* (December 2018), https://iowadot.gov/iowainmotion/files/Bike-and-Pedestrian-Plan.pdf

[162] Massachusetts Department of Transportation, *Bicycle Facility Inventory* (April 2021), https://massdot.maps.arcgis.com/apps/webappviewer/index.html?id=76fc33869d534c6ba0b16803d25ee990

[163] MassTrails, *Shared Use Path Planning Primer* (August 2018), https://www.mass.gov/guides/shared-use-path-planning-and-design-guide

[164] Michigan Trails and Greenways Alliance, *Michigan Multi-use Trail Directory & Map* (2016), https://www.michigantrails.org/wp-content/uploads/2016/08/16-Michigan-Trail-Directory-Map-Final-Web.pdf

[165] Montana Department of Transportation, *Shared Use Paths Inventory and Detailed Maintenance Plan* (November 2015), https://leg.mt.gov/content/Committees/Interim/2015-2016/Revenue-and-Transportation/Meetings/Nov-2015/shared-use-trail-report-draft.pdf

New Jersey	395.9	214 as of November 2016[166]	"Shared use paths are travel ways that are physically separated from motorized vehicular traffic and provide travel accommodation for bicyclists, pedestrians, inline and roller skaters, skateboarders, and kick scooter users. A shared use path may operate within a roadway right-of-way or within an independent right of way."
New York	1,279.1	2,068 as of 2020[167]	Shared use paths are "separated from roadways and vehicle traffic" and generally include "a minimum tread width of six feet, a relatively flat, graded surface and/or improved tread, [and] can be used for non-motorized transportation and recreation"
Ohio	1,850.7	1,367 as of 2020[168]	"Multi-use trails, also known as shared use paths, greenways or bike trails, are hard-surfaced trails designed for bicyclists, walkers, runners and other pedestrians."[169]
Rhode Island	84.3	75 as of 2020[170]	Shared use paths are "dedicated infrastructure completely separate from motor vehicle traffic that is shared by pedestrians, joggers, cyclists, and other non-vehicular uses (such as rollerbladers and skateboarders)."
Wyoming	144.7	394 as of 2016[171]	"Shared use paths accommodate both pedestrians and bicyclists."

[166] New Jersey Department of Transportation, *Bicycle & Pedestrian Master Plan* (November 2016), https://www.state.nj.us/transportation/commuter/bike/pdf/bikepedmasterplan2016.pdf

[167] New York State Office of Parks, Recreation and Historic Preservation, *Final Statewide Greenway Trails Plan & Final Generic Environmental Impact Statement* (April 2021), https://parks.ny.gov/documents/inside-our-agency/FinalStatewideGreenwayTrailsPlan2020.pdf

[168] Ohio Department of Transportation, *Statewide Bike and Pedestrian Plan* (2020), https://transportation.ohio.gov/static/Programs/WalkBikeOhio/WBO_DraftPlan_v3_reduced.pdf

[169] Ohio Department of Natural Resources, *The Ohio Trails Vision* (2019), https://ohiodnr.gov/static/documents/parks/trails/Ohio_Trails_Vision-2019-SM.pdf

[170] Rhode Island Statewide Planning Program, *Statewide Bicycle Mobility Plan* (December 2020), http://www.planning.ri.gov/documents/LRTP/Bicycle-Mobility-Plan.pdf

[171] Wyoming Department of Transportation, *Wyoming Bicycle & Pedestrian Transportation Plan* (2016), https://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Highway_Safety/Pedestrian%20Bicycle/WY%20Bicycle%20and%20Pedestrian%20Transportation%20Plan_2016.pdf

4.5.3 Growth in Shared Use Paths

An estimate of SUPs added annually in the US was derived from the RTC database. The miles of SUPs in 2012 could be directly calculated from the existing trails in the database as of 2012. The miles of SUPs in 2017 could be estimated from the existing and proposed trails in the database as of 2012, assuming that the proposed miles would be completed in five years. Because the SUP mileage as listed in the database for 2022 includes both existing and proposed trails, it would be reasonable to assume that this is representative of total trails open in 2027, that is, with the expectation that the proposed miles would also be completed in five years. Table 21 shows these figures.

Table 21. Estimated Trail Miles by Year

Year	2012	2017	2027
Estimated Existing Trail Miles	19,721	23,013	34,256

Estimates for the intermediate years between 2012, 2017, and 2027 were interpolated using a calculated compound annual growth rate, as shown in Table 22.[172] For the years between 2012 and 2017, the total trail miles are estimated to grow 3.1% annually from the 2012 total of 19,721 miles to the 2017 total of 23,013 miles. For the years between 2017 and 2027, the total trail miles are estimated to grow 4.1% annually from the 2017 total to the 2027 total of 34,256 miles.

Table 22. Estimated Trail Mile Growth Rates

Time Period	2012-2017	2017-2027
Annual Growth Rate in Trail Miles	3.1%	4.1%

As one point of comparison, the Alliance for Biking and Walking estimated in its 2010 and 2012 reports[173] the miles of multi-use paths across the nation's 51 largest cities. The average annual growth between 2010 and 2012 in the total miles of SUPs across this sample of cities was 15%. The annual growth in the mean and median miles of SUPs per city in this sample was 9% and 4%, respectively. While these growth rates are significantly higher than those estimated with the RTC data, it is likely that the large cities in this sample have constructed trails at a faster pace than smaller cities and rural areas.

[172] The compound annual growth rate is calculated as follows, $(trail\ miles_{final}/trail\ miles_{begin})^{1/time\ in\ years} - 1$. The exact calculation for the time period between 2012 and 2017 is as follows: $(23{,}013\ miles\ in\ 2017/19{,}721\ miles\ in\ 2012)^{1/5\ years} - 1 = 3.1\%$

[173] *Bicycling and Walking in the United States: 2012 Benchmarking Report*, p. 99, Alliance for Biking and Walking, Washington, DC.
Bicycling and Walking in the United States: 2010 Benchmarking Report, p. 90, Alliance for Biking and Walking, Washington, DC.

Dedicated infrastructure for active transportation is often unavailable in rural areas, so these estimates are not necessarily representative of the country as a whole.[174]

A forecast of SUP miles between 2028 and 2037 was derived from the estimated miles in 2027 as a baseline and assuming that annual growth would slow from the 4.1% pace to 1% by the end of this analysis period. Growth in trail miles is assumed to eventually moderate to a 1% pace, thus roughly aligning with US population growth in a typical year to approximate the expected growth in overall travel demand.[175]

In summary, trail miles by year are estimated using the following methods.

Table 23 below shows these figures broken out by year.

- For 2012, trail miles are estimated from existing trails in the RTC database
- For 2013-2016, trail miles are estimated assuming 3.1% growth based on proposed trails in the RTC database
- For 2017, trail miles are estimated from existing and proposed trails in the RTC database
- For 2018-2026, trail miles are estimated assuming 4.1% growth based on trails added to the RTC database between 2012 and 2022
- For 2027, trail miles are estimated from existing and proposed trails in the RTC database
- For 2028-2037, trail miles are estimated assuming that long term growth would fall to 1%

[174] Goodman, D. (2017, Autumn). Getting Around Town. *Public Roads.* https://highways.dot.gov/public-roads/autumn-2017/getting-around-town
[175] U.S. Census Bureau; Population Estimates, Table 1. Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2019 (PEPANNRES)

Table 23. Estimated Trail Miles by Year and Annual Growth

Year	Estimated Miles of SUPs	Annual Growth Rate
2012	19,721	-
2013	20,340	3.1%
2014	20,977	3.1%
2015	21,635	3.1%
2016	22,314	3.1%
2017	23,013	3.1%
2018	23,947	4.1%
2019	24,919	4.1%
2020	25,930	4.1%
2021	26,982	4.1%
2022	28,077	4.1%
2023	29,217	4.1%
2024	30,402	4.1%
2025	31,636	4.1%
2026	32,920	4.1%
2027	34,256	4.1%
2028	35,541	3.8%
2029	36,766	3.4%
2030	37,921	3.1%
2031	38,996	2.8%
2032	39,982	2.5%
2033	40,871	2.2%
2034	41,655	1.9%
2035	42,326	1.6%
2036	42,879	1.3%
2037	43,307	1.0%

4.5.3.1 Alterations

The study team assumed that the average lifecycle or replacement rate for existing SUPs is approximately 15 years based on the expected design life of the trail surface materials. According to Alta Planning + Design's report on multi-use trail surfacing options, the expected design life can range from 2 to 25 years.[176] A plurality of the SUP miles in the RTC database (36%) are fully paved with asphalt, which has a reported design life of 7-15 years. The next most common surface material is concrete, which has a reported design life of 25 years. At least 17% of SUP miles are either fully paved with concrete or a mix of concrete and asphalt. The remaining half of all SUP miles rely in some part on surface materials that have design lives shorter than asphalt, such as crushed stone, gravel, and dirt. According to Alta Planning

[176] Alta Planning + Design, *What's Under Foot? Multi-use Trail Surfacing Options* (December 2003), https://www.railstotrails.org/resourcehandler.ashx?name=whats-under-foot&id=4587&fileName=AltaTrailSurface.pdf

+ Design's report, crusher fines or gravel have a design life of two to five years depending on maintenance.[177] Given this distribution of surface materials, it would be reasonable to assume that, on average, an SUP would need to be reconstructed roughly every 15 years.

Based on this lifecycle estimate, it can be estimated that approximately 1/15th (or 7%) of the existing miles of SUPs will require reconstruction each year. Table 24 shows these figures broken out by year.

Table 24. Estimated Miles of SUP Reconstructions by Year

Year	Estimated Miles of SUPs	Estimated Miles of Trail Reconstructions (1/15th of Estimated Miles of SUPs)
2023	29,217	1,948
2024	30,402	2,027
2025	31,636	2,109
2026	32,920	2,195
2027	34,256	2,284
2028	35,541	2,369
2029	36,766	2,451
2030	37,921	2,528
2031	38,996	2,600
2032	39,982	2,665
2033	40,871	2,725
2034	41,655	2,777
2035	42,326	2,822
2036	42,879	2,859
2037	43,307	2,887

4.5.4 Unit Costs and Total Costs

The following sections detail the various cost factors involved in the cost estimate. Four of the required SUP elements in PROWAG are not expected to impact costs substantively: cross-slope, width, vertical clearance, and curb ramps. Three features may increase costs: grade, trail surface material and detectable warning surfaces.

4.5.4.1 Features with Minimal or No Cost Impacts

The PROWAG requirements for cross-slope, vertical clearance, and curb ramps are no more stringent than most design standards in current practice. According to the NPRM comments received, most SUP planners follow the standards in the American Association of State Highway Transportation Officials'

[177] Hudson, G. (2003, December). What's Under Foot? Multi-use Trail Surfacing Options. https://www.americantrails.org/resources/whats-under-foot-multi-use-trail-surfacing-options

Guide for the Development of Bicycle Facilities (hereafter referred to as the "AASHTO Guide.")[178] The rule is unlikely to have substantive cost impacts associated with these features.

- The rule requires a maximum cross-slope of 2.1%. The AASHTO Guide recommends a 1% maximum cross-slope for SUPs and sidewalks and 2% for bike paths.
- While there is no minimum width requirement in the rule, the pedestrian access route must extend the full width provided for pedestrian circulation on the path. FHWA[179] recommends 10 feet but allows for 8 feet for low-usage feeder paths. Based on a review of state design manuals for pedestrian and bicycle facilities, most states have adopted a 10-foot minimum standard or reference the AASHTO Guide, which recommends at least 10 feet for a 2-directional SUP. Existing SUPs, if widened or otherwise altered, would need to ensure compliance across the new width.
- The rule requires that objects not overhang or protrude into the SUP at or below eight feet from the surface. The AASHTO Guide recommends vertical clearance to obstructions of 10 feet with an allowance of 8 feet in constrained areas and that fixed objects should not protrude within the vertical or horizontal clearance of the path.
- For SUPs, the width of curb ramp runs and blended transitions are required to extend the full width of the path, which aligns with the AASHTO Guide.

4.5.4.2 Features with Potential Cost Impacts

The PROWAG requirements for grade, trail surface material, and detectable warning surfaces are no more stringent than the AASHTO Guide. However, evidence suggests that a portion of existing SUPs may not align with current standards.

4.5.4.2.1 Grade

The rule requires a maximum grade of 1:20 (5.0%), or the grade of the adjacent roadway when within the street right of way, which coincides with the AASHTO Guide. Exceptions to this maximum would be permitted where physical constraints prevent compliance.

Approximately 59% of SUP trail miles in the RTC database as of 2022 are rail-trails, which typically have a grade of less than 1:100 due to their origins as railways. Therefore, only 41% of SUPs could possibly experience issues with grade, assuming trails added in future years follow this distribution as well. It is likely (although not verifiable) that most non-rail-trails will also fall below the 1:20 (5.0%) maximum, as they are often constructed using existing right-of-way that is below that grade. Additionally, due to safety considerations already in place for cyclists and pedestrians, trails with steep slopes are unlikely to be constructed.

While the RTC database does not provide information on grade, the National Recreation Trails (NRT) database by American Trails at www.nrtdatabase.org reports on both the average and maximum grade of trails. The NRT database provides information on the over 1,200 trails nationwide that have been

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[178] AASHTO Task Force on Geometric Design, *AASHTO Guide for the Development of Bicycle Facilities*. American Association of State Highway and Transportation Officials, Washington, DC: 2012.
[179] Federal Highway Administration, *Designing Sidewalks and Trails for Access: Best Practices Design Guide*, Chapter 14, 2001. http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalk2/pdf.cfm.

designated as an NRT by the Secretary of the Interior to recognize exemplary trails of local or regional significance.[180] While the NRT database includes trails that would not be considered SUPs, the database did have information on trails that were identified as SUPs in the RTC database. This sample of 122 SUPs that exist in both databases covers 3,536.5 miles. Approximately 78% of trail miles or 2,765 miles of SUPs in this sample had an average grade that does not exceed 1:20 (5.0%), 13% or 454 miles had an average grade exceeding 1:20 (5.0%), and the remaining 9% or 318 miles were missing information on grade. As for the maximum grade on the trails, 2,487 miles (70%) had a maximum grade that does not exceed 1:20 (5.0%), 672 miles (19%) had a maximum grade exceeding 1:20 (5.0%), and 377 miles (11%) were missing information on grade.

When combined with the likely grade of the adjacent roadways when within the street right of way and the exception for physical constraints, it is unlikely that more than a few proposed paths will be at all affected by the 1:20 (5.0%) maximum grade requirement. Accordingly, the economic impact of this regulation is likely to be minimal for almost all SUPs. Unfortunately, the cost of compliance for the few paths that do not fall in either of these categories cannot be readily estimated, but is likely high, and it is possible that a small number of paths will not be built, or will have their routes significantly altered, due to the rule.

4.5.4.2.2 Surface

The rule requires that trail surfaces be firm, stable, and slip resistant. Firm surfaces such as asphalt and concrete are recommended by the AASHTO Guide and are necessary for use by road (narrow-tired) bicycles. There should be no impact where jurisdictions use the AASHTO Guide; however, evidence suggests that a large share of existing SUP trail miles use unstable surface materials.

Approximately 53% of SUP trail miles in the RTC database as of 2022 are paved exclusively with asphalt or concrete. The remaining 47% of trails in the RTD database have surfaces that include gravel, crushed stone, ballast, brick, wood chips, and dirt. Some unpaved trails may satisfy requirements with proper maintenance when compacted and treated. For trails that have a mix of pavement and other surface materials, the RTC database does not address their relative proportions, so a trail with 95% asphalt and 5% gravel could not be distinguished from a trail with the inverse shares of those materials. Nearly 81% of all SUP trail miles list asphalt and/or concrete as one of the trail surface materials. Thus, 19% of all SUP trail miles do not appear to use any asphalt or concrete.

The 2015 RTC report, *Maintenance Practices and Costs of Rail-Trails*, found a substantial increase in the use of asphalt as a trail surface and decrease in crushed stone between 2005 and 2014.[181] Therefore, this analysis assumes that the SUPs trail miles that are currently partially paved, will become fully paved regardless of the PROWAG requirements.

Therefore, as an upper bound, the analysis assumes that the 19% of existing SUP trail miles that do not use any asphalt or concrete would be required to be re-surfaced when reconstructed, at an additional cost.

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[180] American Trails, *About the National Recreation Trails Program,* https://www.americantrails.org/national-recreation-trails/about

[181] Rails-to-Trails Conservancy, *Maintenance Practices and Costs of Rail-Trails* (2015), https://www.railstotrails.org/resourcehandler.ashx?name=maintenance-practices-and-costs-of-rail--trails&id=6336&fileName=Maintenance%20Practices%20and%20Costs%20of%20Rail-Trails

In the absence of this requirement, it would be reasonable to assume that 19% of future trail miles would also be constructed with unpaved, unstable surfaces. As a result of this requirement, those future trail miles may be paved instead and incur additional costs. For the SUPs that are currently fully paved, 68% of trail miles are paved with asphalt, 13% are paved with concrete, and 19% are paved with a mix of those materials.[182] While the rule does not require a paved surface, it is reasonable to assume that this distribution of pavement materials applies to the resurfaced trail miles.

Two sources for SUP surface cost estimates were identified: Anasazi Trails, Inc.'s 2008 *Trail Surfacing Report* for New Mexico State Parks and Alta Planning + Design's 2003 report *What's Under Foot? Multi-use Trail Surfacing Options*.[183] For Anasazi Trails, Inc.'s report, the price ranges of the different surface materials were derived from government agency trail budgets, trail grant application sources, and past trail projects throughout the US.[184] Alta Planning + Design's report reflected research on trail surfacing options for a multi-use trail in Oregon. Table 25 presents the estimated cost per mile of a 10-foot-wide trail in real 2021 dollars derived from each source.

Table 25. Estimated Trail Surface Costs per Mile (in thousands)

Surface	Anasazi Trails, Inc.	Alta Planning + Design
Asphalt	$266-$745	$209
Concrete	$333-$1,134	$361
Crusher fines/Gravel	$101-$151	$190

The 2022 Public Works Costbook provides an estimate of between $123 and $199 thousand per mile for a 10-foot-wide asphalt trail. Therefore, this analysis considers all three sources and assumes a mid-range cost of asphalt of $200 thousand per mile. For the other surface materials, this analysis assume a mid-range cost of the two sources presented in Table 25. To summarize, trail surface costs are assumed to be

- $200,000 per mile of asphalt,
- $350,000 per mile of concrete, and
- $180,000 per mile of gravel.

Assuming 68% of fully unpaved trail miles are re-surfaced with asphalt, 13% with concrete, and 19% with a mix of those materials would increase the cost per mile by $53,750 on average relative to the cost of gravel.[185] This value was chosen to represent a realistic estimate for the surface material. In some

[182] This analysis makes the simplifying assumption that when trails use both asphalt and concrete, the materials are used in equal proportion.
[183] Anasavi Trails, Inc., New Mexico State Parks Energy, Minerals and Natural Resources Department, *Rio Grande Trail Corridor Study Trail Surfacing* (August 2008), https://cdn2.assets-servd.host/material-civet/production/images/documents/Rio-Grande-Trail-Corridor-Study-Trail-Surfacing-Report.pdf
Alta Planning + Design, *What's Under Foot? Multi-use Trail Surfacing Options* (December 2003), https://www.railstotrails.org/resourcehandler.ashx?name=whats-under-foot&id=4587&fileName=AltaTrailSurface.pdf
[184] Prices include the cost of materials, labor, equipment, and installation supplies.
[185] The cost increase is calculated as follows, $(percent\ to\ be\ paved\ with\ asphalt \times cost\ of\ asphalt) + (percent\ concrete \times cost\ of\ concrete) + (percent\ mix\ of\ asphalt\ and\ concrete \times (cost\ of\ asphalt + cost\ of\ concrte) \div 2) - cost\ of\ gravel = (68\% \times \$200{,}000) + (13\% \times \$350{,}000) + (19\% \times (\$200{,}000 + \$350{,}000) \div 2) - \$180{,}000 = \$53{,}750$

cases, more expensive treatments may be chosen, but it is assumed that more expensive options will only be chosen when they are perceived to have additional benefits that justify the larger capital cost (for example, user preferences or lifecycle cost savings). Total annual compliance costs will depend on the number of SUPs added each year and the number of existing SUPs that are substantially altered. Applying the $53,750 figure to 19% of the estimated trail miles yields an annualized cost of $33 million for future SUP construction with 7% discounting over a 15-year analysis period. Table 26 presents a breakdown of costs by year.

This cost estimate may overstate compliance costs. When accounting for routine maintenance, the lifecycle costs of gravel can exceed those of asphalt and concrete depending on the local environment and traffic volumes. However, according to the 2015 RTC report on trail maintenance costs, paved trails in the survey sample had higher annual average maintenance costs per mile than unpaved trails in 2014, though the reverse was true in 2004. The frequency and sources of damage to trail surfaces varies by location, so the components of routine maintenance estimates are not consistent. Given this variability, the study team assumed that the difference in maintenance costs was likely insignificant.

Table 26. Estimated Surface Material Compliance Costs by Year

Year	Total Impacted Miles (Reconstructed and Added Miles)	Miles Requiring Re-surfacing (19% of Impacted Miles)	Annual Surface Material Compliance Costs (Miles Requiring Re-surfacing x $53,750)	Discounted Compliance Cost (7% Discount Rate)
2023	3,087	589	$31,668,050	$27,660,101
2024	3,212	613	$32,953,160	$26,899,594
2025	3,343	638	$34,290,421	$26,159,998
2026	3,478	664	$35,681,949	$25,440,736
2027	3,620	691	$37,129,946	$24,741,251
2028	3,655	697	$37,490,479	$23,347,186
2029	3,676	702	$37,707,985	$21,946,390
2030	3,683	703	$37,777,352	$20,548,377
2031	3,675	701	$37,694,948	$19,162,200
2032	3,652	697	$37,458,712	$17,796,364
2033	3,614	690	$37,068,229	$16,458,737
2034	3,561	680	$36,524,770	$15,156,481
2035	3,493	667	$35,831,311	$13,896,000
2036	3,411	651	$34,992,519	$12,682,899
2037	3,316	633	$34,014,706	$11,521,958

4.5.4.2.3 Detectable Warning Surfaces

The rule requires that there be detectable warning surfaces (DWS) at road crossings, extending the full width of the path and a minimum of two feet in the direction of pedestrian travel. When the study team prepared the Initial PROWAG Cost Report, the review found that some states do not require DWS, while others require them at intersections with roadways.

For the Initial PROWAG Cost Report, a random sample of 94 SUPs covering 542.45 miles was selected from the RTC database. These trails were plotted on Google Earth and each crossing of a road was manually counted. A subset of these paths were sampled a second time for more in-depth examination of the specific type of crossing and intersection layout. This breakdown can be seen in Table 27. The current analysis assumes that the average number of crossings per mile is relatively constant over time, such that the 2010 value is still a reasonable estimate.

Table 27. Detectable Warning Surface Cost by Crossing Type

Crossing Type	Crossings per Mile	Detectable Warning Surface Cost
Road	1.63	$1,000-$3,000 per intersection $1,630-$4,890 average per mile
Rotaries/Plazas	0.03	Project-specific and very infrequent

In places where a SUP crosses a road, DWS are required across the full width of the SUP. Research on the costs of DWS, presented in a prior section, estimated that detectable warning surface costs are approximately $25 to $75 per square foot for materials and labor. (There are significant variations in DWS material choice and labor costs across location.) Costs are calculated using an assumed 10-foot width for SUPs, with detectable warning surfaces that are thus 10 feet wide by 2 feet deep (20 square feet) on each crossing. Road crossings would require a detectable warning surface on either side of the road, for a total of 40 square feet of material, at a cost of $1,000 to $3,000.

Many of the SUPs in the sample already had detectable warning surfaces in place for road crossings. The estimated cost per mile is therefore an upper bound that would reflect the case where detectable warning surfaces would not otherwise be present.

Comments from the NPRM estimated that current construction costs for SUPs average between $100,000 and $900,000 per mile. The estimated $1,630 to $4,890 per mile cost for detectable warning surfaces is therefore equal to an approximate cost increase of 0.2% to 4.9%. Total annual compliance costs will depend on the number of existing SUPs that are substantially altered and the number of SUPs added each year.

Applying the $1,630 to $4,890 figures to the estimated trail miles yields an annualized cost of $5 million to $16 million for future SUP construction with 7% discounting over a 15-year analysis period. Again, the range of costs reflects the differences in cost across DWS materials such as composite and cast iron.

Table 28. Estimated Detectable Warning Surface Material Compliance Costs by Year

Year	Total Impacted Miles (Reconstructed and Added Miles)	Annual DWS Compliance Costs (Total Impacted Miles x $1,630), Low Estimate	Annual DWS Compliance Costs (Total Impacted Miles x $4,890), High Estimate	Discounted Compliance Cost (7% Discount Rate)
2023	3,087	$5,032,113	$15,096,340	$4,395,243 to $13,185,728
2024	3,212	$5,236,320	$15,708,959	$4,274,397 to $12,823,190
2025	3,343	$5,448,813	$16,346,439	$4,156,873 to $12,470,620
2026	3,478	$5,669,929	$17,009,788	$4,042,581 to $12,127,744
2027	3,620	$5,900,019	$17,700,056	$3,931,432 to $11,794,295

Year	Total Impacted Miles (Reconstructed and Added Miles)	Annual DWS Compliance Costs (Total Impacted Miles x $1,630), Low Estimate	Annual DWS Compliance Costs (Total Impacted Miles x $4,890), High Estimate	Discounted Compliance Cost (7% Discount Rate)
2028	3,655	$5,957,308	$17,871,925	$3,709,912 to $11,129,736
2029	3,676	$5,991,870	$17,975,611	$3,487,323 to $10,461,969
2030	3,683	$6,002,893	$18,008,679	$3,265,176 to $9,795,528
2031	3,675	$5,989,799	$17,969,396	$3,044,910 to $9,134,730
2032	3,652	$5,952,260	$17,856,781	$2,827,876 to $8,483,628
2033	3,614	$5,890,212	$17,670,636	$2,615,325 to $7,845,974
2034	3,561	$5,803,855	$17,411,566	$2,408,394 to $7,225,181
2035	3,493	$5,693,663	$17,080,990	$2,208,101 to $6,624,302
2036	3,411	$5,560,378	$16,681,133	$2,015,337 to $6,046,010
2037	3,316	$5,405,001	$16,215,004	$1,830,861 to $5,492,583

4.5.4.3 Summary

The PROWAG requirements for cross-slope, vertical clearance, and curb ramps are no more stringent than most design standards in current practice, so the rule is unlikely to have substantive cost impacts associated with these features. The requirements on grade align with the AASHTO Guide, and it is unlikely that more than a few proposed paths will be at all affected when also considering the exceptions for physical constraints and SUPs within a highway right of way. Thus, the economic impact of this regulation is likely to be minimal for almost all SUPs. However, the cost of compliance for the few paths that are impacted is likely high, and it is possible that a small number of paths will not be built, or will have their routes significantly altered, due to the rule.

For the provision on surface materials, total costs are calculated based on the number of expected SUP miles installed or reconstructed each year that are likely to be unpaved (19%) times the average additional cost of paving the trail rather than installing gravel ($53,750). The total cost of the detectable warning surface provision is calculated based on the number of expected SUP miles installed or reconstructed each year times the average installation costs per mile ($1,630 to $4,890). The installation costs are calculated based on the average number of trail crossings per mile (1.63), multiplied by the square footage of material required (40) and the material costs per square foot ($25 to $75).

Over a 15-year analysis period with 7% discounting, the annualized total present value of costs is estimated at:

- $33 million for surface materials and
- $5 million to $16 million for detectable warning surfaces.

Assuming the midpoint of the detectable warning surfaces costs, the equivalent annualized value is $43.9 million (7% discount rate) or $60.0 million (3% discount rate).

The annual discounted compliance costs are presented in Table 29.

Table 29. Estimated Total Compliance Costs by Year

Year	Discounted Surface Material Compliance Costs (7% Discount Rate)	Discounted DWS Compliance Costs (7% Discount Rate)	Discounted Surface Material Compliance Costs (3% Discount Rate)	Discounted DWS Compliance Costs (3% Discount Rate)
2023	$27,660,101	$4,395,243 to $13,185,728	$29,850,174	$4,743,249 to $14,229,748
2024	$26,899,594	$4,274,397 to $12,823,190	$30,156,809	$4,791,974 to $14,375,923
2025	$26,159,998	$4,156,873 to $12,470,620	$30,466,595	$4,841,200 to $14,523,599
2026	$25,440,736	$4,042,581 to $12,127,744	$30,779,562	$4,890,931 to $14,672,793
2027	$24,741,251	$3,931,432 to $11,794,295	$31,095,745	$4,941,173 to $14,823,519
2028	$23,347,186	$3,709,912 to $11,129,736	$30,483,190	$4,843,837 to $14,531,510
2029	$21,946,390	$3,487,323 to $10,461,969	$29,767,031	$4,730,038 to $14,190,113
2030	$20,548,377	$3,265,176 to $9,795,528	$28,953,195	$4,600,718 to $13,802,153
2031	$19,162,200	$3,044,910 to $9,134,730	$28,048,582	$4,456,973 to $13,370,919
2032	$17,796,364	$2,827,876 to $8,483,628	$27,060,971	$4,300,040 to $12,900,119
2033	$16,458,737	$2,615,325 to $7,845,974	$25,998,910	$4,131,276 to $12,393,828
2034	$15,156,481	$2,408,394 to $7,225,181	$24,871,591	$3,952,143 to $11,856,429
2035	$13,896,000	$2,208,101 to $6,624,302	$23,688,718	$3,764,182 to $11,292,547
2036	$12,682,899	$2,015,337 to $6,046,010	$22,460,367	$3,568,995 to $10,706,985
2037	$11,521,958	$1,830,861 to $5,492,583	$21,196,840	$3,368,218 to $10,104,654

4.6 Pedestrian Overpasses and Underpasses

4.6.1 Background

The PROWAG guidelines provide accessibility requirements standards for overpasses and underpasses dedicated to non-motorized vehicle traffic, such as pedestrian access routes and shared use paths (SUPs). Pedestrian access routes or SUPs located on bridges that also carry motor vehicle traffic, such as a sidewalk on a road continuing over the bridge, are covered under the provisions for pedestrian circulation paths generally. Typically, the facilities this provision applies to include pedestrian and shared use bridges and tunnels dedicated to carrying pedestrians, or pedestrians and bicyclists over or under a major highway. Some pedestrian access routes may be classified as underpasses even when at ground level, such as when they pass under a bridge.

The updated standards below would apply to new construction and alterations.

- Width: Pedestrian access routes, or sidewalks, on or under a bridge must be a minimum of 48 inches (4 feet) unless physical constraints exist.
- Slope: The slope of pedestrian access routes may not exceed 1:20 (5.0%) unless following the grade of the adjacent street.
- Facility Access: The grade of ramps to access pedestrian access routes may not exceed 1:12, or 8.3% with landings required at each 30" of rise. Where an overpass, underpass, bridge, or similar structure is designed for pedestrian use and the approach slope to the structure exceeds 1:20 (5.0%), a ramp; elevator; or limited use/limited application elevator shall be provided. Elevators and limited use/limited application elevators shall be unlocked and independently usable during the operating hours of the pedestrian facility served.
- Handrails: Handrails shall be continuous within the full length of each ramp or stair run. Ramp runs with a rise greater than 6 inches (150 mm), as well as all stairs, shall have handrails. The top of gripping surfaces of handrails shall be 34 inches (865 mm) minimum and 38 inches (965 mm) maximum vertically above walking surfaces, ramp surfaces, and stair nosings. Handrails shall be at a consistent height above walking surfaces, ramp surfaces, and stair nosings. Where handrails are provided, the clear width between handrails shall be 48 inches (1220 mm) minimum.

4.6.2 Methodology, Overview, Terminology, and Key Assumptions

A previous cost analysis was conducted for pedestrian access routes in the "Cost Analysis of Public Rights-of-Way Accessibility Guidelines," but that analysis did not analyze the additional costs of access routes that are underpasses or overpasses.[186] This analysis extends the earlier analysis by evaluating the costs of the PROWAG's proposed guidelines for the width, slope, facility access, and handrail availability of pedestrian access routes and SUPs on or under bridges.

Conceptually, compliance costs are the total of construction and maintenance costs with compliant pedestrian access routes on and under bridges, less the costs that would be incurred under current practices in the no-action baseline. Such costs would be calculated in present value terms over the course of the over- or underpass lifecycle or other reasonable period.

A national inventory does not exist for the width, slope, facility access, and handrail availability for pedestrian access routes on or under bridges. Across the states, the no-action baseline, however, is not unregulated. In lieu of a national database, the study team conducted a review of state standards to assess current practices. Sources of state standards include bridge design manuals, and in some cases, pedestrian facilities' guidelines.

In many states, bridge design guides reference various AASHTO standards, including the Guide for Load and Resistance Factor Design (LRFD); the LRFD Guide Specifications for Design of Pedestrian Bridges; and the Guide for the Planning, Design, and Operation of Pedestrian Facilities (AASHTO Pedestrian Guide). Where state guidance relies on AASHTO standards for other aspects of bridge design, it is assumed that the state also relies on AASHTO guidance for pedestrian facilities on or under bridges. For example, many States' guidelines do not explicitly give guidance for pedestrian or SUP-only bridges; this analysis assumes that States following AASHTO standards for bridges generally are also using AASHTO

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[186] Volpe Center, Cost Analysis of Public Rights-of-Way Accessibility Guidelines (PROWAG) (Nov. 2010), available via regulations.gov, Docket ID: ATBCB-2011-0004-0002.

guidance for appropriate pedestrian and bicyclist accommodations. This analysis also assumes that local governments follow their state's guidance, which is typical in pedestrian facility design.

The AASHTO design standards closely match the PROWAG specifications:

- Width: "Pedestrian facilities across bridges and through underpasses should be the same width or wider than the existing connecting sidewalk, though a minimum clear width of 4 feet is recommended and a width of 8 feet is desirable."[187] The AASHTO and PROWAG standards agree on a minimum width of 4 feet. While the AASHTO standards recommend widths of 8 feet this would not conflict with the minimum standard in the PROWAG.
- Slope: Sidewalks and other walkways must be designed with a maximum grade of 1:20 (5.0%) unless following (but not exceeding) the slope of the roadway.[188]
- Facility Access: Stairs cannot be the only way to access an overpass. Elevator access or ADA-compliant ramps (a maximum slope of 1:12 (8.3%) with handrails) must be provided for facility access.[189]
- Handrails: ADA-compliant handrails must be provided on these stairs and ramps.[190]

Based on this comparison, States relying on AASHTO standards would not face additional costs due to the implementation of PROWAG.

Some states use other design standards as an alternative to the AASHTO standards, such as the Americans with Disabilities Act (ADA) Accessibility Guidelines (ADAAG), which provide specific standards for pedestrian access routes, ramps, and handrails for buildings and sites. PROWAG applies similar requirements to the public right-of-way. Thus, states that already apply ADAAG requirements to public rights-of-way would face little to no incremental costs from PROWAG relative to current practice, as the specifications are highly similar.

Other general design standards at the state level may also be relevant. For example, sidewalks are required to be at least 48 inches in all states already, as described below, so these guidelines would already be the standard for pedestrian circulation paths on or under bridges.

4.6.3 Affected Locations: State Standards

As Table 30 shows all 51 state-level jurisdictions reference existing standards that already make them consistent with PROWAG. All 51 state-level jurisdictions are sorted into the following categories based on the standards they put in place: AASHTO (referenced); ADA (referenced); Combination of ADA and AASHTO references; and Proprietary State Guidance (the State provides specifications for width, slope, facility entrance, and handrails that meet the requirements of PROWAG). The references resources can be found in Appendix D: Bridge Design Inventory.

These four categories are considered compliant under PROWAG.

Table 30. State Standards Inventory

Standard(s) Referenced	States

[187] "Guide for the Planning, Design, and Operation of Pedestrian Facilities," American Association of State Highway and Transportation Officials (July 2004): 63.
[188] American Association of State Highway and Transportation Officials, 62.
[189] American Association of State Highway and Transportation Officials, 97.
[190] American Association of State Highway and Transportation Officials, 97.

AASHTO	Alabama, Alaska, Arizona, Connecticut, Delaware, District of Columbia, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, Oklahoma, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Vermont, Virginia, West Virginia, Wyoming
ADA, or ADAAG	Arkansas, California, Tennessee, Texas, Washington, Wisconsin
Combination of ADA and AASHTO references	Colorado, Kansas, Maine, Minnesota, North Carolina, Utah
Proprietary State Guidance	Florida, North Dakota

4.6.4 Cost Summary

Evidence from a review of state-level design standards and guidelines suggests that all states already use accessibility standards for pedestrian access routes on overpasses and for underpasses that are similar or identical to PROWAG. Practices may vary by locality, but local governments typically follow state guidance, which is the assumption here. Based on this analysis, there are likely to be few, if any, incremental costs for pedestrian overpasses and underpasses resulting from the final rule.

4.7 Sidewalk Width

4.7.1 Background

The PROWAG guidelines provide the standard clearance of pedestrian access routes, including sidewalks. Whereas the ADAAG standard implemented a 36-inch minimum width, the PROWAG rule standardizes a 48-inch, or four-foot, minimum continuous clear width.[191] PROWAG also requires passing spaces be built at 200-foot maximum intervals where sidewalks are less than 60 inches, or five feet. This rule would apply to new construction and planned improvement projects in the public right-of-way, except where existing physical or historical constraints make it technically infeasible to comply. In these cases, the minimum width of 48 inches should be implemented to the maximum extent feasible. Where sidewalks are less than 60 inches wide, passing spaces must also be provided to the maximum extent feasible. Adequate sidewalk width is necessary to ensure accessibility for all sidewalk users, including users of wheelchairs and other mobility devices.

4.7.2 Methodology, Overview, Terminology, and Key Assumptions

Conceptually, compliance costs are the total future sidewalk construction and maintenance costs with the 48-inch minimum continuous width and passing space provisions in place, less the costs that would be incurred under current practices in the no-action baseline. Such costs would be calculated in present value terms over the course of the sidewalk lifecycle or other reasonable period.

Sidewalk lifespans can vary based on materials, climate, and maintenance practices. FHWA has estimated that concrete sidewalks can last up to 80 years when applying best practices for maintenance.[192] Using a more conservative value of 50 years, and assuming for simplicity that existing sidewalks have a uniform age distribution, then 2% (i.e., 1/50th) of sidewalks will need to be replaced each year. PROWAG's minimum width and passing space requirements would apply to these alterations to the maximum extent feasible. The requirements would also apply to any new sidewalk construction.

A national inventory of sidewalks does not currently exist. In lieu of a national database, the study team conducted a review of state and city design standards to assess current practices regarding sidewalk width. States with minimum sidewalk widths less than 60 inches were also evaluated for whether they include passing spaces as part of their current practices. Sources of state standards include state laws, design manuals, and standard drawings.

For the states without a specified minimum width or with standards less than those required by PROWAG, a similar inventory of their most populated cities was planned. By looking at city design standards that affect the most people and pedestrian spaces in each state, the extent of the rule's effects was conceived to determine whether a cost analysis is necessary. For cities, information was obtained from city codes, ordinances, master street plans, and accessibility requirements. Preference was given to the most recent and relevant standard available online.

4.7.3 Affected Locations: State Standards

As Table 31 shows, 47 out of 51 state-level jurisdictions already meet or exceed the proposed PROWAG rule as confirmed by a combination of state standard drawings, design manuals, and accessibility plans (see Appendix E: State Sidewalk Design Guidelines). The column for *standard widths* includes in inches what states consider the minimum clear, accessible width that should be available to users continuously. In cases where this is less than 60", the table also notes whether the state design standards include passing spaces as in PROWAG. These minimum widths and passing space provisions apply to new and reconstructed sidewalks.

In states where residential, commercial, and industrial sidewalks have differing width standards, the column for minimum widths represents the least of these, often residential. For example, New Jersey requires 48-inch (four feet) sidewalks in residential areas, but in high-density areas, New Jersey requires 72-inch (six feet) sidewalks. In the table, New Jersey's minimum width is listed as four feet because that is the lowest value among the minimums required by the state.[193] PROWAG does not provide different

[192] Federal Highway Administration. (2013). "A Guide for Maintaining Pedestrian Facilities for Enhanced Safety: 6 Construction Techniques to Lessen Maintenance for Sidewalks and Paths," Office of Safety, Federal Highway Administration, https://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa13037/chap6.cfm

[193] The State of New Jersey, New Jersey Administrative Code 5.21-4.5, accessed December 2021. https://www.state.nj.us/dca/divisions/codes/codreg/pdf_regs/njac_5_21.pdf

minimum widths for sidewalks in different areas, so the minimum width required anywhere by the state is appropriate for this analysis.

Table 31. State Sidewalk Standards Inventory

Standard Widths	States
No State Standard	Kansas - width set by cities per state law[194]
48-inch minimum width with no mention of passing spaces	Alaska, New Jersey, Rhode Island
48- inch minimum; typically 60 inches*	Illinois, South Dakota
48-inch minimum width with passing spaces	Colorado, Connecticut, Delaware, Indiana, Iowa, Massachusetts, Nebraska, New Hampshire, New York, Oklahoma, Utah, West Virginia, Wisconsin
60+-inch minimum width	Alabama, Arizona, Arkansas, California, District of Columbia, Florida, Georgia, Hawaii, Idaho, Kentucky, Louisiana, Maine, Maryland, Michigan, Minnesota, Mississippi, Missouri, Montana, Nevada, New Mexico, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Vermont, Virginia, Washington, Wyoming

*These states have both a "minimum" width and a "typical" width. The study team concludes that the typical width would apply except where physical constraints are present.

With the exception of Kansas, every state (and the District of Columbia) provides guidance that meets or exceeds the PROWAG provision for minimum width, shown in Table 31, with minimum widths of 48+ inches standard across the country. While it is possible that one or more of these states allows for its counties or localities to deviate from their standards in some cases, this review indicates that no state has guidance incompatible with PROWAG. It is unclear from available state guidance and design documents whether Kansas, Alaska, New Jersey, and Rhode Island already require passing spaces to be built on sidewalks constructed less than 48 inches wide.

Per Kansas state law, cities and townships in Kansas hold the most responsibility for setting sidewalk standards. Counties are not given broad authority in Kansas; however, where a need exists, such as in "urban areas" outside of city limits, counties manage sidewalks in conjunction with the connected highways or streets.[195]

Looking to Kansas cities to understand the extent of the rule's effects in the state, 2020 census data was referenced to determine the cities that are home to at least one percent of the state's population, which totals 13 cities.[196] These 13 cities are home to nearly half (49.4 percent) of Kansas's population and likely

194 Public Health Law Center, Kansas Bicycling and Walking (June 2016), accessed December 2021. from phlc-fs-kansas-sidewalk-liability-web-2016.pdf (publichealthlawcenter.org)
195 Public Health Law Center, Kansas Bicycling and Walking (June 2016), accessed December 2021. from phlc-fs-kansas-sidewalk-liability-web-2016.pdf (publichealthlawcenter.org)
196 Kansas Cities by Population (2020 update) accessed December 2021. https://www.kansas-demographics.com/cities_by_population

include most sidewalks, given that sidewalks tend to be disproportionately located in more densely populated areas.

Table 32 shows that each city with a population over one percent of Kansas's population has already implemented a 48-inch (or greater) minimum sidewalk width.

Table 32. Kansas Cities Sidewalk Standards Inventory

City	Population (KS: 2,937,880)		Minimum Width (in.)	Source
Wichita	397,532	13.5%	60	Policy Manual for Multi-Modal Transportation
Overland Park	197,238	6.7%	48*	Concrete Sidewalk and Sidewalk Ramp Construction
Kansas City	156,607	5.3%	48*	Construction and Material Specifications
Olathe	141,290	4.8%	60	Unified Development Ordinance 18.30.180
Topeka	126,587	4.3%	60	Complete Streets Design Guidelines
Lawrence	94,934	3.2%	60	Standard Details for Concrete Sidewalk Layouts
Shawnee	67,311	2.3%	60	Design and Construction Manual
Lenexa	57,434	2.0%	60	Design Criteria and Plan Requirements
Manhattan	54,100	1.8%	60	Sidewalk Construction Guide
Salina	46,889	1.6%	60	Specifications for Sidewalk Work
Hutchinson	40,006	1.4%	60	Bicycle and Pedestrian Master Plan
Leavenworth	37,351	1.3%	60	Sec. 3.03. Minimum Design Standards
Leawood	33,902	1.2%	60	Development Ordinance General Provisions
Total	1,451,181	49.40%		

*Indicates that the standard also includes passing spaces as in PROWAG.

4.7.4 Sidewalk Width Cost Summary

The study team concludes that PROWAG's 48-inch minimum is unlikely to result in additional compliance costs, as it is not more costly than the state and local design standards already in place. This is based on two findings:

- In the 49 states and DC with minimum width standards that already align with PROWAG's new rule, those standards apply a minimum width to all new or improved sidewalks statewide.

- While Kansas leaves sidewalk standards to individual cities, a review of Kansas's largest cities indicates that they meet or exceed PROWAG's requirements for sidewalk width and provide passing spaces where the minimum width is less than 60 inches.

PROWAG's requirement for passing spaces where sidewalks are not at least 60 inches wide could entail some potential costs in Alaska, New Jersey, and Rhode Island, to the extent that passing spaces (or 60-inch sidewalks) are not already part of the baseline in those locations. To a large extent, this may be affected by local standards that are stricter than their statewide equivalents. For example, as noted above, New Jersey standards call for wider sidewalks in high-density residential areas. In Alaska, the cities of Anchorage and Juneau, which together account for over 40% of the state population, use a 60 inch minimum sidewalk width in their city design standards.[197] These locations would thus would not incur incremental costs for passing spaces. In Illinois and South Dakota, baseline practice is to build sidewalks 60 inches in width except where constraints are present, thus indicating that additional costs for passing spaces are also likely to be limited.

The unit cost of a passing space, where not part of the current baseline, was calculated using the Public Works Costbook. For cost purposes, it was assumed that the sidewalk in the baseline would be 4 feet wide, such that an area equal to 1 foot wide by 5 feet long would be added to create the passing space. Costs were estimated for grading, base material, and concrete, including labor. The calculated cost is $28.81 per location, or approximately $761 per additional sidewalk mile, a small increase over baseline costs. There could be additional costs for demolition or redesign, depending on site conditions.

The additional paving represents a very small increase compared to baseline conditions. Specifically, one mile of 4-foot wide sidewalk is equivalent to 21,120 square feet of paving (5,280 x 4 = 21,120) while the same sidewalk with 5'x'5' passing areas every 200 feet would require an additional 132 square feet of paving [((5-4)*5) * (5,280 / 200)].This is an increase of less than 1%. Thus, it is expected that incremental compliance costs would be minor. However, no data were available to aggregate these unit costs across the potentially affected projects and locations. Again, this would include new sidewalk construction and alterations in communities in Alaska, New Jersey, and Rhode Island that do not already have either 5'-wide sidewalks or passing spaces as part of their local design standard.

4.8 Roundabouts

Roundabouts are a type of circular intersection that have become increasingly popular in the United States. The PROWAG guidelines provide two sets of standards at roundabouts:

- Accessible pedestrian crossings at multilane roundabouts, which allow for three distinct types of accessible pedestrian crossings or a full traffic signal treatment.
- Edge detection at curb-attached sidewalks along roundabouts

The following analysis discusses these requirements in more depth and estimates the unit costs of the applicable treatments and the number of newly added and altered locations that would be affected

[197] See Municipality of Anchorage, https://www.muni.org/Departments/project_management/Design%20Criteria%20Manual/DCM%201%20Streets.pdf and City and Borough of Juneau, https://juneau.org/index.php?gf-download=2019%2F12%2F111A_000.pdf&form-id=22&field-id=11&hash=2ac6e1cc8a120e66deec68d4d8917c1399a649201fecd0fe19206f33cb0465ab

annually by the accessibility requirements proposed by the Access Board's final rule. The accessible pedestrian crossings are discussed first, followed by the edge detection requirements.

4.8.1 Pedestrian Crossings

The PROWAG guidelines provide standards for pedestrian crossings at multilane roundabouts, which allow for three distinct types of accessible pedestrian crossings or a full traffic signal treatment.

4.8.1.1 Methodology Overview, Terminology and Key Assumptions

Modern multilane roundabouts (hereafter referred to as "roundabouts") have become increasingly popular in the United States as an intersection design. Roundabouts are frequently installed to replace existing stop-controlled or signalized intersections, though many are built for wholly new intersections. As noted above, the final rule defines a roundabout as, "A circular intersection with yield control at entry, which permits a vehicle on the circular roadway to proceed, and with deflection of the approaching vehicle counterclockwise around a central island." This does not include other, similar circular intersections such as rotaries and traffic circles, which are outside the scope of the roundabout provisions and this analysis.

The draft final rule would apply to two types of projects:

1. Newly added multilane roundabouts with pedestrian street crossings (conversion of an existing signalized intersection to a roundabout or as an entirely new intersection); and
2. Alteration or addition of pedestrian street crossings at existing multilane roundabouts.

The final rule requires that each segment of the multilane roundabout that contains a pedestrian street crossing, including the splitter island, shall provide a pedestrian crossing treatment consisting of one or more of the following pedestrian treatments:

- Pedestrian Hybrid Beacon
- Rectangular Rapid Flashing Beacon
- Raised Crossing

Alternatively, a full traffic signal treatment can be installed at roundabout crossings, however this option is viewed as unlikely to be chosen as a treatment, which will be discussed further later in this analysis.

4.8.1.2 Estimated Locations Affected

The requirement in the draft final rule for pedestrian crossing treatments will have an impact on state and local transportation departments who are installing or replacing modern multilane roundabouts that include pedestrian street crossings.

The primary source for estimating the number of affected multilane roundabouts is the Kittelson & Associates Kittelson Roundabouts Inventory (hereafter referred to as the roundabouts database). Kittelson Associates voluntarily maintains this resource, which is the most complete database of roundabouts in the United States. The database includes information on known roundabouts, including location (intersection, city, state, county, latitude/longitude), type of roundabout (single- or multi-lane, or mini roundabout)[198],

[198] The study team used the database's own definition of multilane roundabouts. This may not correspond one-to-one with the PROWAG definition, and there may be cases where a roundabout has both single-lane and multilane components. For the purposes of the analysis, the database definitions were considered.

functional class, diameter, opening year, number of approaches, and additional data. The inventory is developed manually, using a variety of sources including news alerts, input from researchers and consultants, and state DOTs.

As the pace of roundabout adoption in the United States has increased, maintaining a complete census of roundabouts has become more challenging. In September 2021, Kittelson examined their database and conducted an analysis to estimate the number of roundabouts missing from their work—they concluded that their database is likely missing 5.6 percent of all roundabouts in the U.S. through 2020, with unknown sites biased towards more recent deployments.[199]

In addition to the total number of multilane roundabouts, the analysis also requires a breakdown of the number of legs at a typical multilane roundabout—specifically, the number of legs affects the number of treatments required at each new or altered roundabout. In this analysis, it is assumed that affected roundabouts are distributed across different numbers of legs in proportion to their prevalence in the roundabouts database. The percentage of each type of leg in the Roundabouts Inventory between 2010 and 2020 is shown in Table 33 below. The mean multilane roundabout, according to this distribution, has 3.7 legs.

Table 33. Distribution of Roundabout Types

Number of Legs	Number of Multilane Roundabouts in the Kittelson Inventory (2010–2020)	Percent of All Roundabouts (2010–2020)
2	9	0.8%
3	385	32.1%
4	777	64.8%
5	22	1.8%
6	1	0.1%

Not all multilane roundabouts have pedestrian crossings. Accordingly, a spot analysis was conducted using Google Street View to determine what percentage of all roundabouts do not have pedestrian street crossings. A random sampling of roundabouts from the roundabouts database was collected, with roundabouts spread across years, and a total of 82 multilane roundabouts were assessed. This spot checking suggested that 17 percent of roundabouts do not have any pedestrian street crossings, and therefore would not be affected by the rule. Additionally, some roundabouts may have pedestrian crossings at some, but not all, legs. To accurately estimate the number of pedestrian crossings at multilane roundabouts, the spot checking also assessed the number of approaches with a pedestrian crossing for the roundabouts that had at least one pedestrian crossing. This spot checking suggested that 85.0% of legs (at roundabouts with at least one pedestrian crossing) have a pedestrian crossing. Accordingly, the average of 3.7 legs per roundabout was reduced to 3.1 to provide a more accurate estimate of the total number of pedestrian crossings that will be affected.

The inclusion of accessible pedestrian crossing treatments at multilane roundabouts has not previously been required by accessibility guidelines and does not represent a widespread industry practice in the

[199] Kittelson, "How Many Roundabouts are in the United States?" (2021), https://www.kittelson.com/ideas/how-many-roundabouts-are-in-the-united-states/

United States. The same random sampling of 82 roundabouts in Google Street View that was mentioned previously was also used to see if any roundabouts had any of the appropriate pedestrian crossing treatments—however, no roundabouts were found that had any of the appropriate pedestrian crossing treatments. Accordingly, in the absence of PROWAG, the baseline deployment for this analysis is assumed to be minimal to no installation of pedestrian crossing treatments over the 25-year analysis period.

4.8.1.3 New Roundabouts

The roundabout database was examined to derive an annual estimate of newly added multilane roundabouts with pedestrian street crossings. As previously noted, the database notes the opening year for every roundabout. Accordingly, the database can be used to estimate the total number of roundabouts opened in any given year. The construction of roundabouts has been varied over time; in recent years there has been a more consistent number of roundabouts built compared to earlier years. Therefore, only roundabouts opened from 2015 to 2020, based on the data from the database, were used to estimate the average number of roundabouts constructed every year with pedestrian street crossings. The estimate began by looking at all roundabouts, which gave 436 roundabouts per year.

The estimate of 436 roundabouts constructed annually was then increased to account for the 5.6 percent of roundabouts missing from the database, resulting in a new estimate of 462 roundabouts constructed annually. This estimate of 462 roundabouts was then reduced to account for the estimated 17% of roundabouts that lack pedestrian street crossings.

It is worth noting this analysis explicitly only includes multilane roundabouts, as single lane roundabouts are not included in the scope of the final rule. Accordingly, to estimate the percentage of pedestrian crossings at multilane roundabouts, the same data from the roundabouts database from 2015–2020 was examined to develop an estimate of the percentage of all roundabouts that are multilane, as the database includes a field to indicate the number of lanes at a given roundabout. Of the roundabouts listed in the database as constructed between 2015 and 2020, approximately 24.7 percent were multilane.

Accordingly, the estimate was further reduced to account for only multilane roundabouts, resulting in an estimate of 95 multilane roundabouts affected annually. The average number of legs with pedestrian crossings, as previously noted, is assumed to be 3.1 per roundabout. Multiplying the average crossings per roundabout by the total number of roundabouts gives the annual number of newly added pedestrian street crossings affected by the final rule. Table 34 provides a summary of this calculation process.

Table 34. Calculation of Pedestrian Crossings Affected at Roundabouts[200]

Calculation/Estimate	Value	Source
Total roundabout construction, Roundabouts Database, 2015–2020	2,616	Kittelson, 2021
Average annual roundabout construction, Roundabouts Database, 2015–2020	436	Calculated
Roundabouts Database, percent of all roundabouts	94.4%	Estimate from Kittelson, 2021
Average annual roundabout construction, All Roundabouts Estimate, 2015–2020	462	Calculated
Percent of roundabouts that are multilane	24.7%	Kittelson, 2021
Percent without pedestrian street crossings	17%	Study team spot check – aerial photos / Street View
Annual number of sites affected	**94.5**	Calculated
Average legs with street crossings per affected roundabout	3.1	Study team spot check – aerial photos / Street View
Annual number of pedestrian crossings affected	**296**	Calculated

4.8.1.4 Altered Pedestrian Street Crossings at Existing Roundabouts

Pedestrian street crossings at existing multilane roundabouts will also be impacted by the rule when it comes time for the roundabouts to experience major rehabilitation—FHWA currently assumes the useful life of a roundabout to be 25 years.[201] Given that the rate of roundabout adoption has not been consistent over time, the rate at which roundabouts will need resurfacing will also follow a similar growth pattern over time. [202]

Because the growth in roundabouts has been extremely varied over time, it would be inaccurate to make a simplifying assumption that a consistent, fixed percent of all roundabouts are likely to come up for rehabilitation in any given year. Instead, the roundabout database was used in combination with FHWA's estimate of the useful life of a roundabout—25 years—to develop a unique count of the number of roundabouts that could come up for rehabilitation in every analysis year. The roundabout database notes the opening year for almost every roundabout in the database, and accordingly each roundabout was assumed to need rehabilitation 25 years after its opening date. The estimates were also increased

[200] 2,616 roundabouts / 6 years = 436 roundabouts per year → 436 / 0.949 = 462 total roundabouts → 462 x (1-0.18) x 0.247 = 94.5 multilane roundabouts affected → 94.5 multilane roundabouts x 3.1 legs = 296 pedestrian crossings affected

[201] FHWA, Roundabouts Brochure, https://www.fhwa.dot.gov/resourcecenter/teams/safety/teamsafe_rndabout.pdf

[202] As evidence of the inconsistent rate of adoption, the roundabouts database has a record of 2 roundabouts being built in 1990, 115 roundabouts being built in 2000, 201 roundabouts being built in 2003, and 434 roundabouts being built in 2008.

accordingly relative to the assumption that the database has 94.4 percent of all roundabouts, and then reduced to account for the assumption that 17 percent of roundabouts do not have pedestrian street crossings.

As an example—the database estimates that 65 roundabouts were opened in 1998, 52 of which were single lane and 13 of which were multilane. The estimate of 13 multilane roundabouts was increased to 14 to account for potential missing roundabouts, and then reduced to 11 to estimate the number with pedestrian crossings.[203] It was assumed that these 11 roundabouts will need rehabilitation in 2023, as 2023 is 25 years after 1998. Table 35 shows each estimate by analysis year. Note that the final two years of analysis, 2046 and 2047, require information about the number of roundabouts built in 2021 and 2022, which was not available at the time of analysis. Accordingly, it was assumed 94.5 multilane roundabouts would need rehabilitation in 2046 and 2047, based on the assumptions found in the previous section about the expected number of new multilane roundabouts.

Table 35. Reconstructed Roundabouts by Year

Year	Number of Reconstructed Multilane Roundabouts with Crosswalks
2023	11
2024	9
2025	17
2026	29
2027	25
2028	35
2029	36
2030	33
2031	78
2032	89
2033	98
2034	123
2035	83
2036	94
2037	102
2038	110
2039	86
2040	116
2041	116
2042	110
2043	119
2044	70
2045	48
2046	94
2047	94

[203] The exact calculation is as follows: (13 roundabouts) x (1 / 94.4%) x (1 – 17%) = 11 roundabouts with pedestrian crossings.

4.8.1.5 Compliance Costs

Compliance costs can be thought of as the total present-value lifecycle costs of roundabouts with the final rule in place, less the cost of such projects under current baseline conditions, over the pavement or equipment lifecycle of the crossing treatment. The study team developed unit cost and intersection-level cost estimates for providing each of the treatment options.

4.8.1.6 Capital Cost

Cost estimates for all three pedestrian crossing treatments were taken from the *Costs for Pedestrian and Bicyclist Infrastructure Improvements* report, which was published in 2013 by the UNC Highway Safety Research Center for the Federal Highway Administration.[204] FHWA has cited the costs from this report as recently as 2018 in Tech Sheets.[205] The original report did a scan of multiple observations and came up with a low cost estimate, an average cost estimate, a median cost estimate, and a high cost estimate for each treatment based on the available data. Given that the costs were originally published in 2013, the costs have been inflated to 2021 dollars for this analysis[206]. The report does not specify, but it is assumed that these are the total costs of each treatment type. The incremental costs per treatment above a standard crosswalk are listed in Table 36.

Table 36. Incremental Cost per Treatment

Pedestrian Treatment	Low Cost	Median Cost	Average Cost	High Cost
Pedestrian Hybrid Beacon (PHB)	$23,465	$58,545	$65,814	$148,759
Rectangular Rapid Flashing Beacon (RRFB)	$3,693	$14,958	$24,411	$59,328
Raised Crossing	$608	$6,719	$7,958	$34,496

There is a significant difference in the costs for each treatment—if all roundabout pedestrian crossings use a PHB, the capital costs will be significantly higher than if only raised crossings were deployed. It is likely that agencies may choose the option with the lowest capital cost (i.e., raised crossing), but it is not guaranteed. It is worth noting, however, that the rule does not require any individual treatment type, meaning that if an agency chooses to implement an option with a higher capital cost option at its roundabout pedestrian crossings, then that decision lies with the agency. Additionally, if an agency chooses to implement an option that has a higher capital cost, it is likely the case that the agency believes that the benefits of a particular treatment outweigh the added costs.

For purposes of analysis, the median cost was used as the estimate for the cost of each treatment. The median value represents a typical cost for each treatment, while also reducing the influence of high outlier costs. It was assumed that the high-cost estimates may be atypical and may also decrease in likelihood

[204] UNC Highway Safety Research Center, *Costs for Pedestrian and Bicyclist Infrastructure Improvements* (October 2013), https://www.pedbikeinfo.org/cms/downloads/Countermeasure%20Costs_Report_Nov2013.pdf
[205] FHWA, Raised Crosswalk Countermeasure Tech Sheet (June 2018), https://safety.fhwa.dot.gov/ped_bike/step/docs/techSheet_RaisedCW2018.pdf; FHWA, Rectangular Rapid-Flashing Beacon Countermeasure Tech Sheet (June 2018), https://safety.fhwa.dot.gov/ped_bike/step/docs/techSheet_RRFB_2018.pdf; FHWA, Pedestrian Hybrid Beacon Countermeasure Tech Sheet (June 2018), https://safety.fhwa.dot.gov/ped_bike/step/resources/docs/fhwasa18064.pdf
[206] FRED Economic Research, "Gross Domestic Product: Implicit Price Deflator", https://fred.stlouisfed.org/series/GDPDEF#0

over time as more of these treatments are deployed and agencies learn more cost-effective strategies for deployment. Given that the median is less affected by these high outliers than the average, the median is likely better reflective of the actual costs that would be faced by highway agencies and other affected entities.

As noted previously, the final rule also allows for a full traffic signal treatment at roundabout crossings as an additional option for compliance. However, the costs for this treatment are not generally included in the overall analysis, as it is assumed to be unlikely that governmental jurisdictions would choose this option over the other alternatives. A 2012 report from Wyoming DOT states that a traffic signal installation can cost anywhere between $200,000 and $500,000, although this includes costs for related, miscellaneous work.[207] The choice to install a traffic signal may also require a traffic engineering study, which further adds time and costs to the process. It is highly unlikely for a full traffic signal deployment to be chosen as the preferred alternative purely for accessibility purposes, given that there are less expensive options and that some of the perceived benefits of roundabouts stem from the lack of traffic signals in the first place. Roundabout installations may be driven, to a certain extent, by a desire to avoid a full traffic signal installation. Installing a traffic signal can reduce—if not entirely eliminate—the traffic efficiency benefits of a roundabout, further reducing the likelihood that traffic engineers would recommend signal installation over the other options. Accordingly, it is assumed for purposes of the cost analysis that effectively 0% of locations would implement a full signal treatment.

4.8.1.7 Operational and Maintenance Costs

PHBs require electricity and regular maintenance to function—an estimate of $2,000 in annual operational expenses for a PHB unit (per crosswalk) was found.[208] Assuming that this cost would be for each roundabout leg, this would mean that for an average roundabout, with the average number of pedestrian crossings of 3.1, operations and maintenance expenses would be $6,300 annually.

RRFBs are often powered via solar panels and so do not require additional costs to run—FHWA specifically recommends using solar panels to eliminate the need for a power source.[209] An estimate from Virginia DOT reported the maintenance costs for RRFBs at around $390/year[210], which would be equivalent to $1,221 per roundabout with the estimate of 3.1 pedestrian crossings per roundabout.

Raised crosswalks do not have appreciably higher maintenance burdens than standard crosswalks, and so operational and maintenance costs are not calculated.

[207] Wyoming DOT, "WYDOT Quick Facts: Traffic Signals" (March 2012) https://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Traffic%20data/Traffic%20Signals.pdf
[208] TRB, NCHRP Report 674 http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w160.pdf, page 13
[209] FHWA, "Rectangular Rapid Flashing Beacon" (November 2021) https://safety.fhwa.dot.gov/provencountermeasures/rrfb.cfm
[210] Dougald, L. *Evaluation of a Rectangular Rapid Flashing Beacon System at the Belmont Ridge Road and W&OD Trail Mid-Block Crosswalk*, Virginia Center for Transportation Innovation and Research (May 2015) https://www.virginiadot.org/vtrc/main/online_reports/pdf/15-r22.pdf, Page 35

4.8.1.8 Delay Costs

Both PHBs and RRFBs would cause relatively little delay to traffic flow. They only affect the flow of traffic when actuated, and generally would not cause significantly greater delay than an individual crossing the street without a PHB or RRFB.

However, raised crosswalks do present a delay to traffic, as vehicles must always slow for a raised crosswalk, even when there are no pedestrians present. One of the benefits of roundabouts relative to traditional intersection designs (like stop-controlled or signalized) is operational efficiency from vehicles remaining in continuous motion. Raised crosswalks could slow vehicles in such a way as to reduce the operational efficiency from the roundabout form, although the design of a roundabout is also meant, in part, to reduce speeds. According to FHWA, roundabouts are designed for speeds in the range of 15-25 mph, regardless of the speed limit on approaches.[211] Given that speeds are already low, the additional reduction in speeds that occurs from the raised crossing may be relatively small for vehicles that are traveling in compliance with recommended speeds, as it may be possible for vehicles to safely traverse a raised crossing at a speed of 25 mph.[212] A raised crossing is likely to have the largest changes in speed on vehicles traveling above the recommended speed limit; there is undoubtedly a safety benefit from reducing speeds to be in compliance with the speed limit, but it is not the typical practice to quantify increases in travel time as a cost to vehicles that would otherwise be breaking the law. Vehicles that were already traveling under 25 mph are likely to experience only a minor reduction in speed. Overall, this indicates that the delay costs associated with a raised crossing are likely negligible.

Delay costs could not be calculated for this analysis due to the lack of data on many variables that would be necessary to include. Specifically, calculating delay would require information on motor vehicle and pedestrian traffic volumes, travel speeds, and their distribution over the day, along with estimates of the delay caused by the deceleration/acceleration pattern at the raised crossing itself. As congestion is highly nonlinear with respect to the ratio between traffic volume and capacity, this would require detailed site-specific modeling of affected locations. But, as previously noted, the amount of delay is assumed to be small.

4.8.1.9 Summary

The annual cost for implementation of the provision can be estimated, in simple terms, as the costs of a pedestrian crossing treatment multiplied by the annual number of roundabouts with pedestrian street crossings that are newly constructed, added, or altered. All three pedestrian crossing treatments come with distinct costs and benefits that might influence a municipality’s choice. For instance, a PHB, while the highest cost, offers strong protection for pedestrians with minimal traffic disruption, while a raised crosswalk may slightly slow traffic flow even when pedestrians are not present, but would offer significantly reduced costs compared to the alternative interventions. The different pedestrian crossing treatments also offer varied operations and maintenance costs.

[211] FHWA, “Roundabouts and Rural Highways” (n.d.) https://safety.fhwa.dot.gov/intersection/roundabouts/fhwasa14097.pdf

[212] ITE, “Traffic Calming Fact Sheets” (May 2018), https://oth.opengov.com/production/uploads/portals/49/forum/issue/7970/issue_asset/asset/9705/Traffic_Calming_Fact_Sheets.pdf

For purposes of analysis, it is assumed that multilane roundabouts would be evenly divided between PHBs, RRFBs, and raised crossings, due both to the costs of each treatment type as well as the locations in which each treatment is most effective. In reality, there will likely not be an even distribution among multilane roundabouts, but for purposes of cost estimation, these assumptions are assumed to be reasonable. As previously noted, no locations are assumed to use a full traffic signal.

Costs associated with each treatment type are summarized below in Table 37. Operational and maintenance costs are included in the costs for PHB and RRFB, but not for raised crossings as those costs are assumed to be negligible.

Table 37. Summarized Cost Estimates by Treatment Type

	Pedestrian Hybrid Beacon	**Rectangular Rapid Flashing Beacon**	**Raised Crossing**
Average Roundabout Implementation Cost (3.1 pedestrian crossings)	$0.18 million	$0.05 million	$0.02 million
Maintenance Cost per Roundabout (3.1 pedestrian crossings)	$0.006 million	$0.001 million	*Assumed Negligible*
Assumed to be deployed at:	1/3 of Multilane Roundabouts	1/3 of Multilane Roundabouts	1/3 of Multilane Roundabouts

The overall cost estimates across all pedestrian crossings at roundabouts are summarized in Table 38—values are estimated over a 25-year analysis period, from 2023 through 2047, to correspond to the 25-year useful life of a roundabout. Costs are discounted to 2021 as the base year.

Table 38. Summarized Overall Cost Estimates

	Undiscounted	**7% Discount Rate**	**3% Discount Rate**
25-Year Total Cost	$463.6 million	$147.3 million	$293.8 million
Annualized Cost Estimate	$18.5 million	$12.6 million	$16.9 million

4.8.2 Edge Detection

The final rule requires that the street side edge of the sidewalk or shared use path at the approach and along the circulatory roadway of the roundabout shall either be separated from the curb (with landscaping or other nonprepared surface) or have a continuous and detectable vertical edge treatment.

4.8.2.1 Estimated Locations Affected

The estimate of locations affected for edge detection at roundabouts uses the same primary source of data that was used for the pedestrian crossing treatments at roundabouts—the Kittelson Roundabouts database—and the general data processing remains the same. Unlike the pedestrian crossing treatments however, edge detection at sidewalks is required for *all* roundabouts as opposed to only multilane roundabouts. Accordingly, this analysis used a larger sampling of data, but the general approach remained the same.

The spot check analysis used a larger random sampling of 276 roundabouts, with the spot checking assessing whether the roundabouts had curb-attached sidewalks without edge detection. If a roundabout had sidewalks that were partly curb-attached and partly not curb-attached, the roundabout was counted as having curb-attached sidewalks. The spot checking suggested that 19.6 percent of roundabouts require edge detection that currently do not have it, indicating that these roundabouts would be affected by the rule.

A smaller spot-checking analysis was also run to estimate the feet of sidewalk at a roundabout that would require edge detection. Roundabouts vary in size, and also vary in feet of sidewalk (as not all roundabouts have sidewalks along all sides), but in order to appropriately estimate the costs of edge detection, an estimate of the number of feet of sidewalk is needed. The spot-checking analysis used the distance measurement tool in Google Maps to roughly measure the length of sidewalks at roundabouts and found on average that there are 279 feet of sidewalk per roundabout.

For newly added roundabouts, Table 39 shows the calculation process to estimate the number of impacted sites and impacted feet of sidewalk per year.

Table 39. Calculation of Roundabouts Affected by Edge Detection[213]

Calculation/Estimate	Value	Source
Total roundabout construction, Roundabouts Database, 2015–2020	2,616	Kittelson, 2021
Average annual roundabout construction, Roundabouts Database, 2015–2020	436	Calculated
Roundabouts Database, percent of all roundabouts	94.4%	Estimate from Kittelson, 2021
Average annual roundabout construction, All Roundabouts Estimate, 2015–2020	462	Calculated
Percent with curb-attached sidewalks that will require edge detection	16.4%	Study team spot check – aerial photos / Street View
Annual number of sites affected	**76**	Calculated
Feet of sidewalk requiring edge detection	279	Study team spot check – aerial photos / Street View
Annual feet of sidewalk affected	**21,090**	Calculated

For curb-attached sidewalks at existing roundabouts, the useful life of the sidewalk is assumed to be 50 years—FHWA has estimated that concrete sidewalks can last up to 80 years when applying best practices

213 2,616 roundabouts / 6 years = 436 roundabouts per year → 436 / 0.949 = 462 total roundabouts → 462 x (0.196) = 92 roundabouts affected → 92 roundabouts x 279 feet = 21,090 feet of sidewalk affected

for maintenance,[214] but 50 years is used as a more conservative estimate. Historical data from the roundabouts database is used to develop a unique count of the sidewalk locations that could come up for rehabilitation in every analysis year. There are assumed to be virtually no sidewalks at roundabouts that will require rehabilitation until 2040, based on the existing historical data as there were very few roundabouts constructed in the U.S. prior to 1990. For sidewalks at a roundabout constructed in 1990, the sidewalks would not need major reconstruction until 2040, using a 50-year useful life. The analysis period extends to 2072, meaning that there will be rehabilitation costs between 2040 and 2072.

Table 40 shows the estimate of affected roundabout locations by calendar year, and also shows the total feet of sidewalk affected (using the spot-checking estimate of 279 feet per roundabout). The table only begins in 2040, given the aforementioned assumption that there are unlikely to be any affected locations prior to then. The number of effected locations is also reduced using the same assumption that only 16.4% of roundabout locations will newly require edge detection.

[214] Federal Highway Administration. (2013). "A Guide for Maintaining Pedestrian Facilities for Enhanced Safety: 6 Construction Techniques to Lessen Maintenance for Sidewalks and Paths," Office of Safety, Federal Highway Administration, https://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa13037/chap6.cfm

Table 40. Reconstructed Sidewalk Locations by Year

Year	Number of Locations Requiring Edge Detection/Curb Separation	Feet of Sidewalk Affected
2040	0.4	102
2041	0.4	102
2042	0.4	102
2043	0.7	205
2044	2	512
2045	5	1,332
2046	3	820
2047	8	2,101
2048	12	3,371
2049	11	3,075
2050	21	5,893
2051	30	8,250
2052	29	8,199
2053	37	10,300
2054	47	13,169
2055	60	16,654
2056	68	18,959
2057	77	21,419
2058	80	22,239
2059	73	20,240
2060	66	18,447
2061	60	16,756
2062	68	18,959
2063	70	19,523
2064	69	19,318
2065	83	23,059
2066	85	23,674
2067	88	24,596
2068	90	25,108
2069	75	21,009
2070	60	16,602
2071	80	22,341
2072	80	22,341

4.8.2.2 Compliance Costs

The final rule does not require a specific type of vertical edge detection, which means there is not necessarily a clear cost associated with compliance. For purposes of analysis, a variety of possibilities were considered, including the possibility that some sidewalks that would otherwise have been curb-attached would now be separated from the curb. Cost estimates were pulled from the *Costs for Pedestrian and Bicyclist Infrastructure Improvements* report, which was published in 2013 by the UNC Highway

Safety Research Center for the Federal Highway Administration.[215] Given that the costs were originally published in 2013, the costs have been inflated to 2021 dollars for this analysis.[216] The report includes a low, median, average, and high cost estimate for each treatment.

Costs were assessed for two alternatives. None of the cost estimates found were precisely for vertical edge detection or for implementing curb separation with landscaping but using estimates for similar treatment types is likely a reasonable proxy for the actual cost for this element of PROWAG. The cost estimates found can be seen in Table 41.

Table 41. Incremental Cost per Treatment Above Standard Crosswalk

Edge Detection/Curb Separation Proxy	Low Cost	Median Cost	Average Cost	High Cost	Units
Fence	$20	$140	$152	$432	Per Linear Foot
Railing	$8	$111	$116	$806	Per Linear Foot

There is a wide variety in costs across the two proxy options. For purposes of analysis, the median cost for a railing will be used ($111 per linear foot). This value was chosen to represent a relatively lower cost, as there are not strict requirements for the vertical edge detection. In some cases, more expensive treatments may be chosen, but it is assumed that more expensive options will only be chosen when they are perceived to have additional benefits that justify the larger capital cost (for example, additional visual appeal).

4.8.2.3 Summary

The annual cost for implementation of the provision can be estimated, in simple terms, as the costs of the edge detection treatment multiplied by the annual feet of sidewalk at roundabouts that are newly constructed, added, or altered. The estimated cost of $111 per linear foot of treatment (estimated using the median cost of a railing) will be combined with the estimate of total feet of sidewalk affected to estimate the total compliance cost of the rule. As previously noted, there is assumed to be 21,090 feet of curb-attached sidewalks newly constructed/added at roundabouts every year that will be subject to the requirements of this final rule. The total cost is therefore $111/foot multiplied by 21,090 feet for a total estimate of $2.2 million in undiscounted costs per year.

The overall cost estimates across all curb-attached sidewalks at roundabouts are summarized in Table 42—values are estimated over a 50-year analysis period, from 2023 through 2072. Costs are discounted to 2021 as the base year.

[215] UNC Highway Safety Research Center, *Costs for Pedestrian and Bicyclist Infrastructure Improvements* (October 2013), https://www.pedbikeinfo.org/cms/downloads/Countermeasure%20Costs_Report_Nov2013.pdf
[216] FRED Economic Research, "Gross Domestic Product: Implicit Price Deflator", https://fred.stlouisfed.org/series/GDPDEF#0

Table 42. Summarized Overall Cost Estimates

	Undiscounted	7% Discount Rate	3% Discount Rate
50-Year Total Cost	$164.7 million	$33.5 million	$72.9 million
Annualized Cost Estimate	$3.3 million	$2.4 million	$2.8 million

4.9 Multilane Channelized Turns

A multilane channelized turn (MLCT) is a set of lanes (typically right turn lanes) designated for turning and separated from the main direction of travel, typically by an island or curb.

Multilane channelized turns present similar hazards to pedestrians who are blind and have low vision as those presented by multilane roundabouts; thus, the Access Board included pedestrian treatments at multilane channelized turn lane crossings as a required accessibility feature in the final rule. However, unlike multilane roundabouts, pedestrian crossings of multilane channelized turns typically have some form of pedestrian indication. Thus, the baseline for the 25-year analysis period was assumed to be minimal to no installation of raised crossings, pedestrian hybrid beacons, or rectangular rapid flashing beacons at unsignalized MLCTs.

The final rule would apply to two types of projects:

1. Newly added multilane channelized turns with pedestrian street crossings; and
2. Alteration of existing multilane channelized turns with pedestrian street crossings.

4.9.1 Pedestrian Crossing Treatments

The final rule requires that each multilane channelized turn with a pedestrian crossing provide a pedestrian crossing treatment consisting of one or more of the following pedestrian treatments:

- Pedestrian Hybrid Beacon
- Rectangular Rapid Flashing Beacon
- Raised Crossing
- Traffic Control Signal with Pedestrian Indication

For MLCTs without traffic signalization, the first three options would be the likely deployed treatments. For MLCTs with traffic control signals, only additional pedestrian indication is needed at the crosswalk.

4.9.2 Estimated Locations Affected

Overall, the rule is expected to impact zero or very few sites in the analysis period. This is because (1) there are no unsignalized MLCTs and (2) all signalized MLCTs already have pedestrian signals regardless of the rule.

On the topic of unsignalized MLCTs, interviews with Kittelson & Associates traffic engineers (authors of several NCHRP studies on the applicability of accessible pedestrian crossing treatments to roundabouts and multilane channelized turns) indicated that unsignalized multilane channelized turn lanes did not represent standard practice. While single lane unsignalized channelized turns are relatively common, interviewees stated that it was unlikely that engineers would choose to install unsignalized multilane channelized turn lanes. Only one example of an unsignalized MLCT was found, which was in an intersection in Corpus Christi, TX. Neither of two key reports examining crossing solutions at channelized turn lanes provide any analysis or additional examples of unsignalized multilane channelized turns.[217,218]

Review of the existing evidence and expert input therefore supports the finding that unsignalized multilane channelized turns do not appear to be common practice for past and present intersection construction in conventional intersection design or as part of newer alternative intersections.

Accordingly, this means that almost all MLCTs are already signalized. Because the rule only applies to MLCTs with existing crosswalks, it is reasonable to assume that almost any MLCT with a crosswalk and with full traffic control signals also has some form of pedestrian signalization. The baseline scenario without the rule thus assumes that signalized MLCTs have pedestrian signalization, because it is highly uncommon to find large intersections with traffic signalization and designated crosswalks that do not have pedestrian indication. The pedestrian signalization may require alterations to comply with other aspects of the final rule, but those costs would fall under the appropriate general category (such as APS) rather than specifically counting as costs in this MLCT portion of the RIA.

Therefore, this rule is expected to affect none or very few sites in the future study period.

4.9.3 Compliance Costs

Compliance costs can be thought of as the total present-value lifecycle costs of MLCTs with the final rule in place, less the cost of such projects under current baseline conditions, over the pavement or equipment lifecycle, or some other acceptable time period. The cost estimates would be the same as the per-unit estimates provided in the previous Roundabouts section, however these estimates are not reproduced here—as there are expected to be no locations impacted, no costs will be accrued.

4.9.3.1 Summary

The annual cost for implementation of the provision can be estimated, in simple terms, as the costs of a pedestrian crossing treatment times the number of multilane channelized turns altered or constructed annually. As there are not estimated to be any multilane channelized turns impacted by the finale rule, either newly added or available to be altered, no cost calculation can be performed.

Overall, total costs for this provision are expected to be either zero or minimal over the study period.

4.10 Curb Ramps

This section provides an estimate of the incremental costs of the curb ramp provisions in PROWAG, relative to a baseline of existing standards and practices. Specifically, it examines the cost of providing one curb ramp per street crossing at each corner at intersections and an estimate of the number of altered and newly constructed intersection street crossings impacted by the rule.

The final estimated cost of additional curb ramp installation resulting from the proposed rule is

[217] NCHRP Report 674: Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities
[218] NCHRP 3-78b: Guidelines for the Application of Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities

$$Annual\ Cost = Cost\ of\ Curb\ Ramp\ Installation\ \times Additional\ Curb\ Ramps$$

Annual costs are then totaled over the 20-year analysis period and discounted to yield a total estimated cost.

4.10.1 Curb Ramp Overview

Curb ramps are a feature of pedestrian access routes that provide access between the sidewalk and the street for people who use wheelchairs, scooters, and other mobility devices. Curb ramps are needed wherever there is a change in level between sidewalk and intersection to ensure safe passage across a roadway by people with mobility disabilities. Also, curb ramps are often used to provide access between sidewalks and other locations in the public right-of-way, such as on-street parking, passenger loading zones, and midblock crossings.

Existing federal standards for curb ramps set by DOJ and the Department of Transportation (DOT), incorporate ADAAG. The ADAAG requires ramps or curb ramps along accessible routes to span changes in level greater than half an inch (Section R303.4). Curb ramps are utilized at the change in level between a street and a sidewalk. The ADAAG provides technical specifications for curb ramps including their width, slope, landing, and flares. The DOJ's 2010 ADA Standards require curb ramps consistent with the technical requirements in ADAAG at newly constructed or altered streets, highways, and street-level pedestrian walkways as part of an accessible route for pedestrians at intersections [28 CFR 35.151(i)]. Thus, baseline conditions are that the 2010 ADA Standards require accessible curb ramps at pedestrian intersection crossings.

Baseline conditions might only require a single diagonal curb ramp serving two street crossings, but PROWAG would require replacement with a parallel or perpendicular curb ramp for each street crossing (or a single blended transition serving all crossings) upon alteration.

Parallel Curb Ramp. A curb ramp with a running slope that is parallel to the curb or street it serves and that has a landing at its base to facilitate alignment with the pedestrian street crossing.

Perpendicular Curb Ramp. A curb ramp with a running slope that is perpendicular to the curb or the street it serves.

Under PROWAG, construction of an additional curb ramp would be necessary where either:

- A newly constructed intersection corner serving two pedestrian street crossings would, in the absence of PROWAG, have had a diagonal curb ramp constructed to serve both pedestrian crossings, or
- A pedestrian street crossing served by a diagonal curb ramp undergoes alteration or resurfacing, with exceptions for areas where physical constraints limit compliance.

Additional curb ramps are not required where State policy or practice currently requires separate curb ramps for each pedestrian street crossing and does not include intersections where a barrier is in place and no pedestrian crossing exists (or would exist in new construction).

4.10.2 Methodology

The proposed rule would impose additional costs on affected entities in two ways:

1. Additional curb ramp installation during alteration of the pedestrian street crossing or sidewalk that previously would not be required (such as where two curb ramps replace one diagonal curb ramp).
2. For new construction, additional curb ramps at locations that previously only required one diagonal ramp.

To estimate the costs associated with those two elements, the following analysis uses available data and modeling to identify:

- The incremental cost per corner of installing a second curb ramp.
- The average number of corners with pedestrian facilities/sidewalk per intersection.
- The number of intersections where current practice allows diagonal curb ramps that would not be compliant with the proposed rule.
- The rate of street crossing and curb ramp alteration.
- The rate of intersection and curb ramp construction.

The values identified in these analyses are then used to estimate the total annual cost impact for a twenty-year analysis period of 2023 to 2042.

4.10.3 Unit Cost

The incremental cost of installing a second curb ramp was investigated with a literature review that identified six sources with clear estimates of the cost of curb ramp construction (see Appendix F: Curb Ramp Cost Estimates). Installation of a curb ramp generally includes aggregate, concrete, and a detectable warning. Demolition and removal of materials would not generally be included in the cost for this analysis, as the installation is occurring during new construction or during an alteration of the intersection.

Reported costs of single curb ramps ranged from $54 to $6,300, with most reported costs per curb ramp between $1,100 and $4,200. The mean of the midpoint of the eight sources is roughly $2,700 per curb ramp. A value of $2,700 per curb ramp was used for the following analysis, representing the mean value rounded to the nearest $100.[219]

4.10.4 Curb Ramps per Intersection

Historically, national estimates of roadway intersections have been challenging to produce due to the extensive roadway system in the US and the lack of comprehensive data sources. Improvements in GIS and related technologies have made national counts more feasible. According to a 2018 study, there are approximately 13.6 million intersections in the US.[220] Most intersections (79%) are 3-way intersections

[219] Where multiple values were given, a midpoint of the ranges or the median value was used when calculating the average. (Please see the Appendix F: Curb Ramp Cost Estimates for cost estimate sources.)
[220] Boeing, Geoff, 2017, "usa-counties-street_network-stats.tab", U.S. Street Network Analytic Measures, https://doi.org/10.7910/DVN/F5UNSK/1CMSSB, Harvard Dataverse, V2, UNF:6:VENn7wb/bkD+5Jki2sbxDw== [fileUNF]

(also known as "T" intersections). A manual review of GIS data (see Table 43. Manual Review of Intersections.) showed that a majority (62%) of 3-way intersections had a single discernable pedestrian crossing, which would require two curb ramps.[221] Approximately 36% of 3-way intersections had two or three crossings.[222] For approximately 27% of these intersections, the two pedestrian crossings would require four curb ramps under the PROWAG (two curb ramps at one corner, and a single curb ramp at the other corner and one on the continuous sidewalk) but three under baseline conditions (where each corner would have only a single curb ramp). The nearly 10% with three pedestrian crossings would require six curb ramps under the PROWAG (two curb ramps at the two corners, and two separate curb ramps along the continuous sidewalk) but four under baseline conditions (where the two corners would be served by one diagonal curb ramp each).

Table 43. Manual Review of Intersections.

Locations	Intersections Reviewed	Source
Randomly selected regions of Massachusetts, including Williamstown, North Adams, Dedham, Norwood, Haverhill, and areas South of Pittsfield, Massachusetts	164	https://gis.massdot.state.ma.us/dataviewers/CurbRampViewer/
Elk Grove, CA	119	https://gisdata.elkgrovecity.org/datasets/city-of-elk-grove-curb-ramps/explore?location=38.426939%2C-121.480017%2C16.00

An additional 20% of intersections are 4-way intersections. A relatively small share had a single crossing (8%), a smaller share had two crossings (3%), and no sampled 4-way intersections appear to have three crossings. Most 4-way intersections (90%) had four pedestrian crossings. Intersections with a single crossing would not require any additional curb ramp construction under PROWAG. Intersections with two crossings would generally require four curb ramps under PROWAG, but only three under baseline conditions. Intersections with four pedestrian crossings would require eight curb ramps under PROWAG, but four curb ramps under baseline conditions. Other configurations are possible, but for this analysis these common configurations are assumed.

A small number (1%) of intersections are categorized as other. For analysis, these are assumed to be 5-way intersections where 10 curb ramps are required under PROWAG, and five curb ramps under baseline conditions. Due to the small number of 5-way intersections found in the manual review (one), the five-crossing configuration is assumed for all intersections of this type.

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[221] Crossings were only included where the source dataset indicated the presence of a crossing or where visual review showed indicators of a crossing (e.g., marked crosswalk and/or existing curb cut). GIS and satellite map review of intersections were rarely sufficient to determine if sidewalks without apparent crossings had barriers or signage to discourage crossing. As such, this count of crossings may exclude some crossings that meet the PROWAG definition of a crosswalk but were not included in the source data and not identifiable in the manual review.

[222] Less than 2% of 3-way intersections had a single curb ramp, and many of these were difficult to discern their intended pedestrian crossing.

Notably, a significant portion of estimated intersections may not have pedestrian crossings, and would therefore not be included in the analysis. A review of the Maine curb ramp inventory showed that approximately 8.9% of intersections had curb ramps, but this excluded a large number of municipal street crossings, particularly in Portland. A review of Colorado's statewide curb ramp inventory showed a much lower number (approximately 1.5% to 2.5%) though a relatively larger share of municipal intersections were not included in the inventory. A review of Douglas County, CO showed that between 30.3% and 50.3% of intersections contained curb ramps. For this analysis, an assumed 30% of all intersections (new and altered) have pedestrian crossings, reflecting the more representative Douglas County data, and are therefore impacted by the proposed rule. Notably, this value would be higher in suburban and urban areas, and less common in rural areas where pedestrian amenities are less common.

Table 44. Distribution of Intersection Types

Intersection Type	Count (millions)	Share of Total	Intersections with Pedestrian Facilities (30% of Total) (millions)	Average Number of Ramps per Intersection: Baseline	Average Number of Ramps per Intersection under PROWAG[223]	Incremental Number of Ramps per Intersection
Three-way	10.8	79%	3.2	2.3	2.6	0.3
Four-way	2.7	20%	0.8	3.8	7.4	3.6
Other	0.1	1%	0.03	5.0	10.0	5.0
Total/Average	13.6	100%	4.1	2.6	3.6	1.0

As shown in the table above, PROWAG would require additional curb ramps at intersections, relative to a baseline in which a single diagonal curb ramp was the existing practice. The number of additional curb ramps varies by intersection type. Using national data and assumptions about the number and configuration of intersections and the presence of pedestrian facilities, the weighted average number of new curb ramps required is 1.007 per affected intersection.

4.10.5 Number of Affected Intersections

To identify the number of impacted intersections, the team first identified the number of states whose policies comport with the final rule. State policies on curb ramp construction were reviewed to identify which states currently require or recommend constructing curb ramps in a way that is already compliant with the PROWAG rather than the baseline where diagonal curb ramps are permitted. The review included standard drawings or related policy and design guidance for the 50 states and the District of

[223] The number of ramps under PROWAG is based on GIS and review of satellite images for a sample of sites. Where no apparent crossing was intended (e.g., no available crosswalk) but where the presence of sidewalk would indicate a crosswalk, the review was unable to determine if any barrier or signage was present to discourage crossing.

Columbia (see Appendix G: Review of States' Curb Ramp Guidelines).[224] Based on these documents, each state was categorized into one of three groups:

- States with a "PROWAG-Compatible Policy" had language prohibiting or severely restricting the construction of a single diagonal curb ramp (e.g., by requiring special approval), or had language indicating that standards or practice were to be consistent with the proposed PROWAG requirements.
- "PROWAG as Best Practice" states had language stating a preference or recommended best practice towards compliant curb ramps but did not require it. Additionally, states specifically indicating the proposed PROWAG was the curb ramp best practice were included in this category.
- "No Policy." The third category includes states that had no explicit guidance at all and where no guidance indicating a requirement for PROWAG compatible curb ramps was readily available.

Table 45. Current State Practice: 50 States and D.C.

State Policy	For New Construction	For Alteration
PROWAG-Compatible Policy	40	37
PROWAG as Best Practice	7	10
No Policy or Policy Includes Diagonal Ramps	4	4
Total	51	51

For States in which both new and altered curb ramps would be categorized as Best Practice or No Policy, an additional review of municipal policy was conducted. This excluded states with a PROWAG compatible policy in either category, under the assumption that a city would not have a less stringent policy than its state. The review included all cities with a population above 150,000, or the most populous city in states without any cities of this size (see Appendix H: Review of Select Cities within States without Policy Consistent with PROWAG Curb Ramp Guidelines).

Cities were categorized as PROWAG as Best Practice or PROWAG-Compatible Policy where evidence was available. Where no relevant information was available, cities were assumed to have policies consistent with their state.

[224] No relevant guidance could be found for New Mexico due to apparent issue with the State DOT website.

4.10.5.1 Conservative Baseline

To construct the baseline for analysis, in which states continue under current policy through the analysis period, the following assumptions regarding policy implementation were made:

- States with a "PROWAG-compatible policy" will not use single diagonal curb ramps in new construction or alterations (which are not compliant with PROWAG). That is, these states experience no additional costs due to the implementation of PROWAG.
- Best practice states will construct PROWAG-compliant curb ramps 75% of the time and non-PROWAG-compliant single diagonal curb ramps 25% of the time.
    - Where cities within best practice states were found to have PROWAG-compliant policies, these cities were assumed to experience no additional cost due to PROWAG and were excluded from the state (reducing the number of impacted intersections below 25%).[225]
- States with no guidance will construct PROWAG-compliant curb ramps 10% of the time and non-PROWAG-compliant single diagonal curb ramps 90% of the time.
    - Where cities within no-policy states were found to have PROWAG-compliant policies, these cities were assumed to experience no additional cost due to PROWAG and were excluded from the state total.
    - Where cities within no-policy states were found to have PROWAG best practices, the number of non-PROWAG compliant intersections in these cities was reduced from 90% to 25%.

These assumed values are based on the analyst's judgment, as no data were found providing any insight into rates of occurrence for diagonal curb ramps. This baseline is based on a conservative set of assumptions (i.e., to avoid understating total costs).

4.10.5.2 Alternative Baseline

An alternative baseline is also presented, with the following assumptions:

- States with a "PROWAG-compatible policy" will not use single diagonal curb ramps in new construction or alterations (which are not compliant with the PROWAG). That is, these states experience no additional costs due to the PROWAG.
- Best practice states will construct PROWAG-compliant curb ramps 90% of the time and non-PROWAG- compliant single diagonal curb ramps 10% of the time.
- States with no guidance will construct PROWAG-compliant curb ramps 75% of the time and non-PROWAG compliant single diagonal curb ramps 25% of the time.

4.10.6 New Construction and Alteration Rates

4.10.6.1 New Construction

To estimate the number of newly constructed curb ramp sites that would be impacted by the proposed policy, it is necessary to estimate the number of new intersections constructed during the analysis period. While national data on total road mileage are available, no existing national data on the rate of

[225] Intersection data were available at county, rather than city, level. This results in intersections for some smaller cities and unincorporated areas adjacent to reviewed cities being recategorized with the reviewed city.

intersection construction per se was found. The rate of new road mile construction over the prior decade was calculated for each state policy group. Table 46 shows the constant annual growth rate for each state policy group, calculated over a nine-year period based on state centerline miles, excluding functional systems where pedestrian crossings are not present or are rare (i.e., Interstate and "Other Freeways and Expressways") [226]

Table 46. Road Mile Growth Rates[227]

State Practice	Road Mile Growth Rate (Annual)
Policy	0.23%
Best Practice	0.21%
No Policy	0.32%

These rates of road mile construction were then applied to existing intersections to calculate the estimate of newly constructed intersections, and curb ramps, for each year of the analysis period.

4.10.6.2 Alteration

Observable data on alteration rates are available for a number of states (i.e., Colorado) and municipalities engaged in an alteration of curb ramps that do not comply with PROWAG or earlier standards. For example, Colorado is currently engaged in a five-year project to rebuild over 20,000 curb ramps that are not in compliance with PROWAG. [228] Notably, state programs occur in states with a curb ramp policy consistent with PROWAG. For this analysis, states are placed in two groups:

- States with current PROWAG-compliant policies that are assumed to proactively replace curb ramps at a rate higher than natural turnover
- Remaining states that are assumed to only add additional curb ramps to meet PROWAG-compliant layouts as they come up for alteration on their natural lifecycle[229]

To estimate the number of rebuilt curb ramp sites in a given year, a 15-year replacement cycle was applied to the existing intersections based on the expected asset lifespan of asphalt pavement on the adjacent roadway. This is based on general industry practice requiring resurfacing or replacement of pavement approximately every 10 to 15 years. In practice, alteration may be triggered by a need to replace sidewalks or curbs, but this analysis assumed these would generally be scheduled to correspond with improvements to the adjacent roadway, which would generally have a shorter lifecycle.

[226] As an alternative, a model was built to estimate the number of intersections per state population and road miles with similar results. This was not included in the final discussion as it increased the complexity of the analysis.
[227] "Highway Statistics 2019: Length by functional system HM-20," 2019, https://www.fhwa.dot.gov/policyinformation/statistics.cfm
"Highway Statistics 2010: Length by functional system HM-20," 2010, https://www.fhwa.dot.gov/policyinformation/statistics.cfm
[228] "Curb Ramp Accessibility Initiative: Projection of cost and timeline to make ramps ADA and PROWAG compliant," 2017, https://www.codot.gov/business/civilrights/ada/curbramps
[229] This includes both "no-policy" states and "best practice" states, with a smaller share of "best practice" state curb ramps assumed to incur additional costs on alteration.

Table 47. Estimate of Additional Curb Ramps

Category	Total	PROWAG Policy States	Best Practice State	Other States
Total Intersections	13.6 million	11 million	1.8 million	0.9 million
Intersections with Ped Crossings	4.1 million	3.3 million	0.5 million	0.3 million
Annual Altered Intersections with Ped Crossings	272,993	219,771	35,262	17,960
Annual Impacted Intersections[230]	27,332	-	10,705	16,627
Additional Curb Ramps Constructed Under PROWAG	*27,524*	*0*	10,780	16,743

4.10.7 Estimated Cost

Annual costs were then generated by first calculating the expected number of additional curb ramps altered and newly constructed in Best Practice and No Policy states, as shown in **Error! Reference source not found.**. The total cost per year was then calculated by applying the average cost per curb ramp of $2,800.[231] Low and high estimates are included using a cost per curb ramp of $2,400 and $4,100.[232] An annual 7% and 3% discount rate was applied to the cost estimates, with base year 2021.

Under the conservative baseline with a seven percent discount rate, this analysis finds an expected annual cost of $51.9 million in 2023 (annualized across a 20-year analysis period to be $22.0 million at 7%, or $30.6 at 3%), with a range of $44.5 million to $76.0 million. As shown in **Error! Reference source not found.**, a majority of new curb ramps are due to alterations, though these comprise a decreasing share of curb ramp construction as fewer unaltered curb ramps remain, and an increasing number of new construction curb ramps are built.

Under the alternative baseline, this analysis finds an expected annual cost of $17.0 million in 2023, with a range of $14.6 million to $24.9 million. When annualized across a 20-year analysis period, the annualized value is $7.2 million at the 7% discount rate, or $10.1 million at the 3% discount rate). Details may be found in Table 51.

[230] Value presented for analysis year 2023, with the value decreasing over time. As intersections are altered, the number of intersections out of compliance with PROWAG decreases.
[231] Mean of the mid value for each cost source shown in Table 6, rounded to the nearest $100.
[232] Mean of the lowest value, and mean of the highest value for each cost source shown in Table 6, rounded to the nearest $100. Where only a single value was available, that value was used.

Table 48a. Annual Curb Ramp Alteration and New Construction with Cost, Conservative Baseline, 3% Discounting

Year	Altered			Newly Constructed			Overall Total Curb Ramps	Total Cost (w/ 3% Discount Rate)		
	Best Practice - Curb Ramps	No Policy - Curb Ramps	Total Curb Ramps	Best Practice - Curb Ramps	No Policy - Curb Ramps	Total Curb Ramps		Low ($millions)	Mid ($millions)	High ($millions)
2023	6,658	12,208	18,866	1,903	467	2,370	21,235	$48.0	$56.0	$82.1
2024	6,325	11,597	17,922	1,907	467	2,374	20,297	$44.6	$52.0	$76.2
2025	6,009	11,017	17,026	1,912	467	2,379	19,405	$41.4	$48.3	$70.7
2026	5,708	10,467	16,175	1,916	468	2,384	18,559	$38.4	$44.8	$65.6
2027	5,423	9,943	15,366	1,920	468	2,389	17,755	$35.7	$41.6	$61.0
2028	5,152	9,446	14,598	1,925	469	2,394	16,991	$33.2	$38.7	$56.6
2029	4,894	8,974	13,868	1,929	469	2,398	16,266	$30.8	$36.0	$52.6
2030	4,649	8,525	13,175	1,934	470	2,403	15,578	$28.7	$33.4	$49.0
2031	4,417	8,099	12,516	1,938	470	2,408	14,924	$26.7	$31.1	$45.5
2032	4,196	7,694	11,890	1,942	471	2,413	14,303	$24.8	$28.9	$42.4
2033	3,986	7,309	11,295	1,947	471	2,418	13,713	$23.1	$26.9	$39.4
2034	3,787	6,944	10,731	1,951	472	2,423	13,154	$21.5	$25.1	$36.7
2035	3,598	6,597	10,194	1,956	472	2,428	12,622	$20.0	$23.4	$34.2
2036	3,418	6,267	9,684	1,960	473	2,433	12,117	$18.7	$21.8	$31.9
2037	3,247	5,953	9,200	1,965	473	2,438	11,638	$17.4	$20.3	$29.7
2038	3,085	5,656	8,740	1,969	473	2,443	11,183	$16.2	$18.9	$27.7
2039	2,930	5,373	8,303	1,974	474	2,448	10,751	$15.2	$17.7	$25.9
2040	2,784	5,104	7,888	1,978	474	2,452	10,341	$14.2	$16.5	$24.2
2041	2,645	4,849	7,494	1,983	475	2,457	9,951	$13.2	$15.4	$22.6
2042	2,512	4,607	7,119	1,987	475	2,462	9,581	$12.4	$14.4	$21.1
Total	**85,423**	**156,627**	**242,050**	**38,896**	**9,418**	**48,314**	**290,364**	**$524.0**	**$611.3**	**$895.2**

Table 49b. Annual Curb Ramp Alteration and New Construction with Cost, Conservative Baseline, 7% Discounting

Year	Altered			Newly Constructed			Overall Total Curb Ramps	Total Cost (w/ 7% Discount Rate)		
	Best Practice - Curb Ramps	No Policy - Curb Ramps	Total Curb Ramps	Best Practice - Curb Ramps	No Policy - Curb Ramps	Total Curb Ramps		Low ($millions)	Mid ($millions)	High ($millions)
2023	6,658	12,208	18,866	1,903	467	2,370	21,235	$44.5	$51.9	$76.0
2024	6,325	11,597	17,922	1,907	467	2,374	20,297	$39.8	$46.4	$67.9
2025	6,009	11,017	17,026	1,912	467	2,379	19,405	$35.5	$41.5	$60.7
2026	5,708	10,467	16,175	1,916	468	2,384	18,559	$31.8	$37.1	$54.3
2027	5,423	9,943	15,366	1,920	468	2,389	17,755	$28.4	$33.1	$48.5
2028	5,152	9,446	14,598	1,925	469	2,394	16,991	$25.4	$29.6	$43.4
2029	4,894	8,974	13,868	1,929	469	2,398	16,266	$22.7	$26.5	$38.8
2030	4,649	8,525	13,175	1,934	470	2,403	15,578	$20.3	$23.7	$34.7
2031	4,417	8,099	12,516	1,938	470	2,408	14,924	$18.2	$21.2	$31.1
2032	4,196	7,694	11,890	1,942	471	2,413	14,303	$16.3	$19.0	$27.9
2033	3,986	7,309	11,295	1,947	471	2,418	13,713	$14.6	$17.0	$25.0
2034	3,787	6,944	10,731	1,951	472	2,423	13,154	$13.1	$15.3	$22.4
2035	3,598	6,597	10,194	1,956	472	2,428	12,622	$11.7	$13.7	$20.1
2036	3,418	6,267	9,684	1,960	473	2,433	12,117	$10.5	$12.3	$18.0
2037	3,247	5,953	9,200	1,965	473	2,438	11,638	$9.5	$11.0	$16.2
2038	3,085	5,656	8,740	1,969	473	2,443	11,183	$8.5	$9.9	$14.5
2039	2,930	5,373	8,303	1,974	474	2,448	10,751	$7.6	$8.9	$13.0
2040	2,784	5,104	7,888	1,978	474	2,452	10,341	$6.9	$8.0	$11.7
2041	2,645	4,849	7,494	1,983	475	2,457	9,951	$6.2	$7.2	$10.5
2042	2,512	4,607	7,119	1,987	475	2,462	9,581	$5.6	$6.5	$9.5
Total	**85,423**	**156,627**	**242,050**	**38,896**	**9,418**	**48,314**	**290,364**	**$377.1**	**$440.0**	**$644.2**

Table 50a. Annual Curb Ramp Alteration and New Construction with Cost, Alternative Baseline, 3% Discounting

Year	Altered			Newly Constructed			Overall Total Curb Ramps	Total Cost (w/ 3% Discount Rate)		
	Best Practice - Curb Ramps	No Policy - Curb Ramps	Total Curb Ramps	Best Practice - Curb Ramps	No Policy - Curb Ramps	Total Curb Ramps		Low ($millions)	Mid ($millions)	High ($millions)
2023	2,663	3,391	6,054	761	130	891	6,945	$15.7	$18.3	$26.8
2024	2,530	3,221	5,751	763	130	893	6,644	$14.6	$17.0	$24.9
2025	2,404	3,060	5,464	765	130	895	6,358	$13.6	$15.8	$23.2
2026	2,283	2,907	5,191	766	130	896	6,087	$12.6	$14.7	$21.5
2027	2,169	2,762	4,931	768	130	898	5,829	$11.7	$13.7	$20.0
2028	2,061	2,624	4,685	770	130	900	5,585	$10.9	$12.7	$18.6
2029	1,958	2,493	4,450	772	130	902	5,352	$10.1	$11.8	$17.3
2030	1,860	2,368	4,228	773	130	904	5,132	$9.4	$11.0	$16.1
2031	1,767	2,250	4,016	775	131	906	4,922	$8.8	$10.3	$15.0
2032	1,678	2,137	3,816	777	131	908	4,723	$8.2	$9.6	$14.0
2033	1,595	2,030	3,625	779	131	910	4,534	$7.6	$8.9	$13.0
2034	1,515	1,929	3,444	781	131	912	4,355	$7.1	$8.3	$12.2
2035	1,439	1,832	3,271	782	131	913	4,185	$6.6	$7.7	$11.3
2036	1,367	1,741	3,108	784	131	915	4,023	$6.2	$7.2	$10.6
2037	1,299	1,654	2,952	786	131	917	3,870	$5.8	$6.8	$9.9
2038	1,234	1,571	2,805	788	132	919	3,724	$5.4	$6.3	$9.2
2039	1,172	1,492	2,665	789	132	921	3,586	$5.1	$5.9	$8.6
2040	1,114	1,418	2,531	791	132	923	3,454	$4.7	$5.5	$8.1
2041	1,058	1,347	2,405	793	132	925	3,330	$4.4	$5.2	$7.6
2042	1,005	1,280	2,285	795	132	927	3,211	$4.1	$4.8	$7.1
Total	**34,169**	**43,508**	**77,677**	**15,558**	**2,616**	**18,174**	**95,851**	**$172.8**	**$201.6**	**$295.2**

Table 51b. Annual Curb Ramp Alteration and New Construction with Cost, Alternative Baseline, 7% Discounting

Year	Altered			Newly Constructed			Overall Total Curb Ramps	Total Cost (w/ 7% Discount Rate)		
	Best Practice - Curb Ramps	No Policy - Curb Ramps	Total Curb Ramps	Best Practice - Curb Ramps	No Policy - Curb Ramps	Total Curb Ramps		Low ($millions)	Mid ($millions)	High ($millions)
2023	2,663	3,391	6,054	761	130	891	6,945	$14.6	$17.0	$24.9
2024	2,530	3,221	5,751	763	130	893	6,644	$13.0	$15.2	$22.2
2025	2,404	3,060	5,464	765	130	895	6,358	$11.6	$13.6	$19.9
2026	2,283	2,907	5,191	766	130	896	6,087	$10.4	$12.2	$17.8
2027	2,169	2,762	4,931	768	130	898	5,829	$9.3	$10.9	$15.9
2028	2,061	2,624	4,685	770	130	900	5,585	$8.3	$9.7	$14.3
2029	1,958	2,493	4,450	772	130	902	5,352	$7.5	$8.7	$12.8
2030	1,860	2,368	4,228	773	130	904	5,132	$6.7	$7.8	$11.4
2031	1,767	2,250	4,016	775	131	906	4,922	$6.0	$7.0	$10.3
2032	1,678	2,137	3,816	777	131	908	4,723	$5.4	$6.3	$9.2
2033	1,595	2,030	3,625	779	131	910	4,534	$4.8	$5.6	$8.3
2034	1,515	1,929	3,444	781	131	912	4,355	$4.3	$5.1	$7.4
2035	1,439	1,832	3,271	782	131	913	4,185	$3.9	$4.5	$6.7
2036	1,367	1,741	3,108	784	131	915	4,023	$3.5	$4.1	$6.0
2037	1,299	1,654	2,952	786	131	917	3,870	$3.1	$3.7	$5.4
2038	1,234	1,571	2,805	788	132	919	3,724	$2.8	$3.3	$4.8
2039	1,172	1,492	2,665	789	132	921	3,586	$2.5	$3.0	$4.3
2040	1,114	1,418	2,531	791	132	923	3,454	$2.3	$2.7	$3.9
2041	1,058	1,347	2,405	793	132	925	3,330	$2.1	$2.4	$3.5
2042	1,005	1,280	2,285	795	132	927	3,211	$1.9	$2.2	$3.2
Total	**34,169**	**43,508**	**77,677**	**15,558**	**2,616**	**18,174**	**95,851**	**$124.2**	**$144.9**	**$212.1**

4.11 Stair Visual Contrast

4.11.1 Background

Visual contrast on the leading edge of individual stairs is helpful for people with low vision. It provides a visual indication for each stair in a set, preventing the stairs from blending together visually.

PROWAG guidelines note that while stairs are not part of *pedestrian access routes*, stairs that are newly constructed or altered on *pedestrian circulation paths* must have 1-inch stripes of a contrasting color installed at the leading edge on each step tread and top landing. The requirement for the 1-inch stripe will improve stair accessibility for those with low vision. In response to the NPRM, the Access Board received many comments requesting that visual contrast on stairs be included in PROWAG. However, the PROWAG cost analysis for the proposed rule did not cover stair striping[233] and none of the public comments received on the NPRM docket directly provided information on the associated costs.[234]

Visual contrast on stairs is believed to present only minor cost implications, as described below in more detail.

4.11.2 Methodology Overview, Terminology, and Key Assumptions

Implementation costs for stair striping is defined relative to a no-action baseline in which PROWAG requirements are not adopted, and thus state and local entities would follow their own existing guidelines and design standards.

Unit costs for stair striping are estimated based on the cost of materials applied to stairs of multiple widths. Also assumed is that any material used for striping stairs should have anti-slip properties and be acceptable for outdoor use. Depending on the expected traffic, stairs in public rights-of-way are likely to be one of four widths: 44 inches, where 1 to 2 people might use them at once; 49 inches, where 2 people are expected to use the stairs at once; 60 inches, where 2 people will need to pass comfortably; or 74 inches where 3 or more pedestrians will simultaneously use the stairs.[235] Costs were calculated for each of these widths using various anti-slip materials.

Both tape and anti-slip paint can be used to provide safe visual contrast. An internet search revealed that there are a range of options and prices for striping stairs.

A national inventory of stairs on sidewalks or other pedestrian facilities does not exist, and many local databases that cover sidewalks do not specifically indicate the presence of stairs. Based on the limited available data and the difficulties that stairways present for many users, the study team assumes that relatively few staircases have been constructed in public rights-of-way in recent years. However, stairways along or replacing sidewalks (and/or providing walking connections between two streets) do exist in some areas with steep terrain, and these would be subject to PROWAG guidelines if newly constructed or undergoing alteration.

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[233] Volpe Center, Cost Analysis of Public Rights-of-Way Accessibility Guidelines (PROWAG) (Nov. 2010), available via regulations.gov, Docket ID: ATBCB-2011-0004-0002.
[234] Regulations.gov, Docket ID ATBCB-2011-0004.
[235] "Stair Widths," Dimensions.com, accessed from https://www.dimensions.com/element/stair-widths

Some data are available from the City of Pittsburgh, PA, which has a comprehensive database of public stairs. Although this is only one locality, the Pittsburgh data are a valuable reference point because the city has more public staircases than any other city in the United States.[236] According to the City Steps Plan, Pittsburgh has over 800 public staircases, of which 350 are on sidewalks. The study team's review of the associated Pittsburgh dataset found that approximately 90% of public staircases for which data were available were constructed prior to 1970, and that only 16 staircases have been built since the year 2000 – the equivalent of less than one per year.[237] While this again only covers one city, it is an indication that the level of future new construction of staircases in the public right-of-way is likely to be rather low.

The City of Seattle, WA owns and maintains more than 500 stairways across the city, and the city has a Stairway Maintenance Program that governs the repair of existing city stairs. In a document with before and after photos from projects completed in 2018, Seattle shows 10 updated staircases, none of which have stripes on the steps' leading edges.[238] The program has 8 active projects in 2022,[239] of which one is a new construction; the city notes that new construction of stairs is rare.

Thus, while costs for visual contrast treatments can be estimated with some precision on a unit-cost basis, it is difficult to assess the number of locations nationwide for which any incremental costs would be applicable due to limited available data on the rate of stairway construction and alteration projects, as well as the extent to which visual contrast would be included even in the no-action baseline due to other codes and standards.

4.11.3 Unit Costs: Tape

Tape that contrasts with the color of stairs can be applied to the leading edge of stairs to make them compliant with PROWAG guidelines. The unit cost is the price of striping one stair with the appropriate width being cut from a roll of tape. There is a different unit cost dependent on the width of the stair. The unit cost may also change if the tape is purchased in bulk.

Table 52 shows various options for using 1-inch anti-slip tape to stripe stairs. The table shows the cost based on the width of the step and different unit costs based on bulk purchases of tape. Each tape option listed is appropriate for outdoor use. Each roll of tape listed is 60-foot (720 inch) long. One roll would stripe 16 stairs (44 inches wide), 14 stairs (49 inches wide), 12 stairs (60 inches wide), and 9 stairs (74 inches wide).

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[236] City of Pittsburgh, City Steps Plan, https://pittsburghpa.gov/citysteps/

[237] University of Pittsburgh, Western Pennsylvania Regional Data Center, City of Pittsburgh Steps dataset, https://data.wprdc.org/dataset/city-steps .

[238] "Before and After Photos: 2018 completed projects," Seattle Stairway Maintenance Program, accessed October 11, 2022 from https://www.seattle.gov/transportation/projects-and-programs/programs/bridges-stairs-and-other-structures/stairway-maintenance-program

[239] "Stairway Maintenance Program," Seattle, accessed October 11, 2022 from https://www.seattle.gov/transportation/projects-and-programs/programs/bridges-stairs-and-other-structures/stairway-maintenance-program

Table 52. Estimated Cost per Stair Using Tape

Product Information: Name, Color, and Retailer	Cost per roll	44 inches wide	49 inches wide	60 inches wide	74 inches wide	Number of rolls
Safety Grip Abrasive Anti-Slip Tape in black (Safety Direct America)240	$10.42	$0.64	$0.71	$0.87	$1.07	Bulk: 48 ($499.99)
Anti-Slip Tape in black (AbilityOne via Grainger) 241	$45.30	$2.77	$3.08	$3.78	$4.66	4 ($181.19)
Anti-Slip Tape in black (3M via Grainger)	$40.25	$2.46	$2.74	$3.35	$4.14	1 roll
Anti-Slip Tape in yellow (AbilityOne via Grainger)	$43.09	$2.63	$2.93	$3.59	$4.43	4 ($172.34)
Anti-Slip Tape in yellow (3M via Grainger): 1" wide	$61.55	$3.76	$4.19	$5.13	$6.33	1 roll
Anti-Slip Tape in black/yellow (Condor via Grainger)	$23.57	$1.44	$1.60	$1.96	$2.42	1 roll
Anti-Slip Floor Tape in black or red (Brady)242	$35.49	$2.17	$2.42	$2.96	$3.65	1 roll
Safety Grip Abrasive Anti-Slip Tape in various colors (Safety Direct America)	$12.99	$0.79	$0.88	$1.08	$1.34	1 roll

The black tape options from Safety Direct American and Grainger, as well as one yellow option from Grainger, can be purchased in bulk and have cost savings compared to other options in the same colors. It’s reasonable to assume that bulk purchases of tape might be made, especially where stairs are 74 inches wide; agencies might stripe sets of stairs across projects, too. Other options from Grainger and Safety Direct America cannot be purchased in bulk, though the unit price of these options remains lower.

To install tape on stairs, one construction worker may spend 10 minutes per step regardless of width. This would involve the worker cleaning all steps, cutting the tape to the required length, and applying it along the leading edge of each step. Assuming a $40 per hour rate for construction labor (including benefits),[243] each step entails $6.67 in labor costs.

[240] “Self-Adhesive Abrasive Anti-Slip Tapes,” Safety Direct America, accessed October 5, 2022.
[241] “Anti-Slip Tape,” Grainger, accessed October 5, 2022.
[242] “Anti-Slip Floor Tape,” Brady, accessed October 5, 2022.
[243] Bureau of Labor Statistics, OES data (May 2020) for construction laborers in the highway construction industry. Average wage is $23.60. The study team increased this to an assumed $40 to account for non-wage fringe benefits and other costs of compensation. https://www.bls.gov/oes/current/oes472061.htm

The total cost of tape installation depends on the width of the step. For each 44-inch step, combined material and labor costs are $7.31 on the low end and $10.43 on the high end. For each 49-inch step, combined costs are between $7.38 and $10.86; for each 60-inch step, combined costs are between $7.54 and $11.80; and for each 74-inch step, combined costs are between $7.74 and $13.00, respectively.

4.11.4 Unit Costs: Paint

Paint can also be used to provide a stripe of contrasting color to each step. When painted 1-inch wide across each stair, paint can also make stairs PROWAG compliant.

The unit cost is the price of striping one stair with paint. There is a different unit cost dependent on the width of the stair. The unit cost may also change if the paint is purchased in bulk. The expected square footage of coverage of the bucket of paint on a rough or porous surface, such as concrete, was also taken into consideration. The unit cost was determined by multiplying the cost per square foot for the total bucket of paint by the square footage of paint necessary to paint a single stripe.

Table 53 shows various options for using anti-slip paint to stripe stairs. The table shows the cost based on the width of the step and different unit costs based on the amount of paint purchased. One gallon of Behr paint is expected to cover 75 square feet. Each gallon of Behr would stripe approximately 245 stairs (44 inches wide), 220 stairs (49 inches wide), 180 stairs (60 inches wide), and 145 stairs (74 inches wide). One gallon of Dura Grip paint is expected to cover 300 square feet, and a 5-gallon bucket is expected to cover 1,500 square feet. Each gallon of Dura Grip would stripe approximately 981 stairs (44 inches wide), 881 stairs (49 inches wide), 720 stairs (60 inches wide), and 583 stairs (74 inches wide). Both brands can be purchased in various colors to provide contrast.

Table 53. Estimated Cost per Stair Using Paint

Product information: name, color, and retailer	Cost per bucket	44 inches wide	49 inches wide	60 inches wide	74 inches wide	Number and size of buckets
Behr Premium® Porch & Patio Anti-Slip Floor Paint – Textured Low-Lustre Enamel (Behr)[244]	$41.98	$0.17	$0.19	$0.23	$0.29	1 1-gallon bucket
Dura Grip - High Performance Non-Slip Epoxy Paint - 1-gallon buckets (Slip Doctors)[245]	$145.00	$0.15	$0.16	$0.20	$0.25	1 1-gallon bucket
Dura Grip - High Performance Non-Slip Epoxy Paint - 1-gallon buckets (Slip Doctors)	$137.75	$0.14	$0.16	$0.19	$0.24	2-4 1-gallon buckets
Dura Grip - High Performance Non-Slip Epoxy Paint - 1-gallon buckets (Slip Doctors)	$130.50	$0.13	$0.15	$0.18	$0.22	5+ 1-gallon buckets
Dura Grip - High Performance Non-Slip Epoxy Paint - 5-gallon buckets (Slip Doctors)	$725.00	$0.15	$0.16	$0.20	$0.25	1 5-gallon bucket
Dura Grip - High Performance Non-Slip Epoxy Paint - 5-gallon buckets (Slip Doctors)	$688.75	$0.14	$0.16	$0.19	$0.24	2-4 5-gallon buckets
Dura Grip - High Performance Non-Slip Epoxy Paint - 5-gallon buckets (Slip Doctors)	$652.50	$0.13	$0.15	$0.18	$0.22	5+ 5-gallon buckets

Behr can be purchased directly or from retailers, such as Home Depot.

Dura Grip can be ordered in one-gallon and five-gallon buckets from Slip Doctors. The cost per stair—depending on stair width and size of the order—ranges from $0.13 to $0.25.

To paint a contrasting stripe on stairs, one construction worker may spend 15 minutes per step regardless of width. This would involve the worker cleaning all steps, using a mold or painter's tape to create a 1-inch area for painting, and applying the paint along the leading edge of each step. Assuming a $40 per hour rate, each step entails $10 in labor costs.

The total cost of paint installation depends on the width of the step. For each 44-inch step, combined material and labor costs are $10.13 on the low end and $10.17 on the high end. For each 49-inch step, combined costs are between $10.15 and $10.19; for each 60-inch step, combined costs are between $10.18 and $10.23; and for each 74-inch step, combined costs are between $10.22 and $10.29, respectively.

[244] "Porch & Patio Anti-Slip Floor Paint – Textured Low-Lustre Enamel," Behr, accessed August 17, 2022.
[245] "Dura Grip - High Performance Non-Slip Epoxy Paint," Slip Doctors, accessed August 17, 2022.

4.11.5 Cost Per Staircase

The City of Pittsburgh, PA maintains 800 sets of stairs, which average approximately 56 stairs per set.[246] When considering both labor and material costs, tape would be the lower cost option to stripe stairs if altering or constructing new a staircase of 56 steps. Using the lowest cost tape, for 44-inch-wide steps, it would cost $409.36 to stripe the average staircase; for 49-inch-wide steps, the cost would be $413.28 per staircase; for 60-inch-wide steps, the cost would be $422.44 per staircase; and for 74-inch-wide steps, the cost would be $433.44 per staircase.

Using tape to provide stair contrast results in an average combined labor and material cost of $532.42 per staircase ($9.51 per step) given the discussed products and widths.

By painting each step, the average combined labor and material cost is $570.92 per staircase ($10.20 per step) given the discussed products and widths.

The study team was not able to find definitive information on maintenance and lifecycle costs. However, it is likely that re-painting or re-taping would be required every 5 to 10 years, depending on factors such as pedestrian volumes and climate conditions. Other routine maintenance would be minimal.

4.11.6 Existing Standards

A 1- to 2-inch stripe of contrasting color (either dark-on-light or light-on dark) is required by American National Standard (ANSI) through adoption of international building codes (IBC) to help users distinguish each step. [247] ANSI stair striping requirements have been adopted by many states in their building codes, but do not extend to requirements for stairs in public rights-of-way.

AASHTO, the Association of State Highway Departments, has pedestrian guidelines that stipulate that stairs or steps along a sidewalk route must follow ADA requirements,[248] which include the non-binding recommendation to stripe top and bottom stairs in a set. AASHTO is an association representing the state departments of transportation and their recommendations, while not legally binding, carry significant weight in the development of project-level designs and organizational policies.

Overall, some design guidelines and building codes already recommend or require the use of visual contrast on stairs, either for the top and bottom steps or for the entire staircase. However, none of these are legally binding on stairways in the public right-of-way, and it is unclear how many state DOTs and local governments have specific policies documented regarding stair striping.

[246] City of Pittsburgh, City Steps Plan.

[247] "Accessible and Usable Buildings and Facilities," American National Standard (2009): 41, access from ANSI A117.1 (2009): Accessible and Usable Buildings and Facilities (mzarchitects.com)

[248] "Guide for the Planning, Design, and Operation of Pedestrian Facilities," American Association of State Highway and Transportation Officials (July 2004): 63.

Based on information from the city of Seattle, one of the current projects is a new construction with no stripes included in the project renderings. Therefore, it is assumed that City does not have striping in its guidelines.[249]

Aside from Seattle and Pittsburgh, the other two cities with the most documented stairways in the right-of-way are Los Angeles, CA and San Francisco, CA.[250] The study team did not identify any guidance on stair visual contrast in Los Angeles, but San Francisco has a documented policy. In San Francisco's Better Streets Plan, they reference the ADA recommendation to have a contrasting stripe on stair nosing,[251] which the city says should be included as a 2-inch stripe.[252]

4.11.7 Cost Summary

The limited published information on city staircases indicates that four cities represent a large share of the overall total: Pittsburgh, Seattle, San Francisco, and Los Angeles. Of these, San Francisco is the only one for which the study team found a documented policy to provide striping for visual contrast, and Seattle was the only city for which the study team found current project plans that shed light on current standards for visual contrast.

In 2022, Seattle had plans to conduct work on 8 stairways.[253] Assuming that each staircase is about 56 steps (based on the overall average from the Pittsburgh data, as Seattle does not supply this information) and that Seattle conducts alterations for the same number of stairways annually, the PROWAG rule would add about $4,259 in costs per year when using the unit costs for contrast tape.[254]

The number of alterations in Pittsburgh is not known, but with an assumed 50-year lifespan for concrete, roughly 2% of the city's 800 staircases (or 16 staircases) would require reconstruction (alteration) in a given year. Thus, costs for visual contrast, if not already required by local codes, would be in the range of $8,521.[255]

Costs for Los Angeles could not be determined due to a lack of data. In San Francisco, there would be no incremental costs relative to the no-action baseline, as visual contrast is already required by local standards.

Combining the estimated costs for Pittsburgh, Seattle, and San Francisco yields a total of $12,780 per year for initial installation of visual contrast tape. The annualized value is $26,700 when also including the costs of re-taping on an assumed 5-year cycle over a 20-year period (7% discounting). When

[249] "S Henderson Stairway," Seattle, accessed October 11, 2022 from https://www.seattle.gov/transportation/projects-and-programs/programs/bridges-stairs-and-other-structures/bridges/s-henderson-stairway
[250] Mike Maciag, "What Cities Have Longest Public Stairways?" Governing (June 7, 2012), https://www.governing.com/archive/longest-public-stairways-in-us-cities.html
[251] "Chapter 5: General Site and Building Elements: 504 Stairways," Access Board, accessed on October 24, 2022, https://www.access-board.gov/ada/chapter/ch05/#
[252] "San Francisco Better Streets Plan," San Francisco (December 7, 2010). https://sfplanning.org/sites/default/files/archives/BetterStreets/docs/Better-Streets-Plan_Final-Adopted-10-7-2010.pdf
[253] "Stairway Maintenance Program."
[254] Calculated as $9.51 per step * 56 steps per staircase * 8 staircases per year.
[255] Calculated as $9.51 per step * 56 steps per staircase * 16 staircases per year.

accounting for other cities that have stairways in the public right of way, as well as for stairways that may be added in the future, it is likely that the total annual cost is less than $100,000 per year. This is a conservative estimate as these cities represent a large share of the national total, and the level of construction for additional stairways is relatively low. For calculation purposes, an estimate of $100,000 ($0.1 million) is used as the annualized value in both the 7% and 3% discounting cases.

4.12 Crosswalk Cross Slope

This section provides an estimate of the incremental costs of crosswalk cross slope provisions in PROWAG, relative to a baseline of existing standards and practices. Specifically, it estimates the cost of the roadway regrading that would be required to reduce cross slope from baseline conditions to the technical requirements set in PROWAG. That unit cost is then combined with an estimate of the number of affected locations for both new construction and alterations, in order to generate an overall total cost. Analysis of this provision was not originally included in the draft RIA but is included here to be consistent with changes in the PROWAG text.

4.12.1 Background

Cross slope is the slope perpendicular to the direction of pedestrian travel. Cross slope impedes travel on uphill and downhill slopes by pedestrians who use wheeled mobility devices, braces, lower limb prostheses, crutches, or walkers, as well as pedestrians who have gait, balance, or stamina impairments. The rule requires a maximum cross slope of 1:48 (2.1%) where a pedestrian access route (PAR) is contained within a crosswalk at an intersection approach with yield or stop control devices (R302.5.2.1), and a maximum cross slope of 1:20 (5.0%) where a PAR is contained within a crosswalk at an uncontrolled approach or an intersection approach controlled by a traffic control signal or pedestrian hybrid beacon (R302.5.2.2 and .3). This provision applies to intersections that are newly constructed, and existing intersections that are altered to the maximum extent feasible where existing physical constraints, such as adjacent developed facilities, make full compliance technically infeasible. The cross slope requirements only apply to the portion of a pedestrian circulation path that constitutes the PAR, which is usually a 4-foot minimum cross-section of the crosswalk.

In light of the variation in existing design guidelines for crosswalk cross slope used by state and local governments, there will be some locations where PROWAG cross slope requirements will result in incremental costs.[256] In particular, streets in hilly urban areas are typically cut-and-filled at crossroads to produce relatively flat intersections for drainage, safety, and visibility reasons. In some cases, this flatter intersection design may encompass the crosswalks, but in other cases, the crosswalks are far enough up- or downhill from the intersection as to experience significant cross slopes. Under the final rule, pedestrian access routes at newly constructed intersections would have to meet the cross slope requirements. Pedestrian access routes at existing intersections that are altered would have to meet the cross slope requirements to the maximum extent feasible where full compliance is technically infeasible due to existing physical constraints.

[256] The costs of cross slope requirements for sidewalks are distinct from the costs of cross slope requirements for crosswalks. As discussed in Section 4.7 of this document, this analysis finds that the impact of the cross slope requirements for sidewalks will be minimal, as all states currently have sidewalk design guidelines that are consistent with PROWAG, and thus there is little change from the existing baseline.

4.12.2 Methodology

The proposed rule would present incremental costs in cases where adjusting the crosswalk cross slope would require additional grading. Additional grading would be necessary to the area upslope or downslope from the crosswalk to avoid a vertical discontinuity in the roadway.

The estimated cost does not include any alteration to the adjacent sidewalk or curb ramps. These costs may be assumed to be incidental for new construction. For alterations, any changes will be contingent on the existing facility layout. Compliance with R302.5.2 will be required to the maximum extent feasible where existing physical constraints, as discussed in R202.3, make compliance technically infeasible. If existing curbs, gutters, sidewalks, and utilities are not part of the facility being altered, they are generally considered "adjacent developed facilities" which are a type of existing physical constraint under R202.3 that could constrain the technical feasibility of compliance with R302.5.2. Thus, if the public entity is not otherwise altering the adjacent developed facilities as part of its crosswalk alteration and those existing physical constraints would make compliance with R302.5.2 technically infeasible, then compliance is required to the maximum extent feasible without needing to alter the adjacent developed facilities.

4.12.3 Unit Cost

The incremental cost of additional grading to reduce crosswalk cross slope in alterations will vary substantially according to existing conditions. For purposes of generating an average value, unit costs were estimated by calculating the volume of materials that would need to be moved to adjust the roadway grade from baseline conditions to the PROWAG technical requirements, and the associated cost.

The analysis uses an illustrative intersection where the crosswalk's cross slope is determined by baseline conditions, including existing agency practices. It uses a crosswalk width of four feet, set back from the intersection by two feet. The analysis further assumes that there will be 200 linear feet of lead-in roadway that will also need to be graded, up- or downhill from the crosswalk, in order to create a more gradual transition and avoid a discontinuity or drop in the roadway.

The analysis then considers six scenarios based on the relative grade change needed to meet PROWAG specifications, and the number of lanes impacted (two or four lanes on each leg, each lane assumed to be 11 feet in width).

Other relevant assumptions include:

- 60% of affected intersection legs are two lane, and 40% are four lane. There may exist a limited number of high cross slope crosswalks spanning more lanes, but no direct evidence of such was found.
- 4% of affected intersections are signalized or uncontrolled, and 96% are stop sign controlled. This is an approximation based on the number of signalized intersections relative to the total number of intersections.

The relevant volume of graded material is the change in volume from the baseline (existing conditions for alterations or state DOT design standard for new construction) to the volume under PROWAG.

4.12.4 Number of Affected Intersections

A review of State DOT standards showed that 30 states had existing crosswalk cross slope standards consistent with the rule, as shown in Appendix J: Crosswalk Cross Slope Standards by State. In these states, there would be little to no implementation cost for the PROWAG crosswalk cross slope requirements as similar standards would be in place even in the baseline. The remaining 20 states are referred to here as “No Policy” states for ease of reference. The new or altered crosswalks that will be impacted by the final rule would be in these states.

The number of intersections impacted was calculated by estimating the share of high slope lane miles and applying this share to the estimate of total US intersections with pedestrian facilities (see Curb Ramps Section 4.10). To calculate the share of intersections with high slope approaches, the analysis team used Highway Performance and Monitoring System (HPMS) data from the Federal Highway Administration. These data categorize roadways into slope bins. The analysis then assumes that the share of intersections with high cross slope crosswalks roughly correlates with the share of high slope lane miles. That is, the assumption is that the cross slope of the intersecting crosswalk is roughly equal to the running slope of the roadway. This likely overstates the number of high cross slope crosswalks, as one would anticipate some roadway leveling on the approach to the intersection.

HPMS data on slope are available with roadway miles categorized into bins that do not perfectly correspond with the relevant slopes in PROWAG (e.g., the 0.5% to 2.4% grade bin in HPMS spans the 2.1% maximum). To find a reasonable share of high slope values, this analysis calculates the share of lane miles where the crosswalk cross slope is above 2.1% twice. First, the count of lane miles is calculated for grades above 2.4%, and then again for lane miles above 0.5% (i.e., first excluding and then including the bin containing the 2.1% maximum). For example, to calculate the share above 2.1% grade, the analysis adds all lane miles with a grade of 0.5% or greater and divides this by all lane miles, giving the “upper bound” values shown in Table 59. The analysis then adds all lane miles with a grade of 2.5% or greater and divides this by all lane miles, giving the “lower bound” values shown in Table 54. The arithmetic midpoint between the high and low shares is then used in the analysis, since the HPMS data do not provide any further granularity. This calculation is then repeated for lane miles above 5%.

Filtering the HPMS data to perform this calculation only for the No Policy states yields an estimated share of intersections with crosswalk cross slopes that would be impacted by the rule when the roadway undergoes alteration. New intersections are assumed to have the same share of high cross slope crosswalks in the absence of the rule as existing crosswalks. The actual value would depend on the terrain characteristics of locations where new roadways and crosswalks are built.

Table 54. Share of Lane Miles above 2.1% Grade.

	Lower Bound	Upper Bound	Midpoint Estimate
In Policy	19.9%	46%	32.9%
No Policy	10.3%	35%	22.6%

Table 55. Share of Lane Miles above 5% Grade.

	Lower Bound	Upper Bound	Midpoint Estimate
In Policy	1.9%	5%	3.6%
No Policy	0.6%	3%	1.6%

With the assumption that 96% of affected intersections are stop controlled, the analysis estimates that approximately 21.8% of intersections in no policy states would have crosswalk cross slopes with grades greater than the thresholds in the rule (22.6% * 96% + 1.6% * 4% = 21.76%).

4.12.5 Cost of Grading

Grading cost estimates are based on BNi Costbook 2023 estimates. Costs are based on the volume of material moved and the type of equipment used. As such, the final costs present a low and high cost value of $8.83 to $13.25 per cubic yard of material graded.[257]

4.12.6 New Construction and Alteration Costs

For both new construction and alterations, the analysis calculates the share of intersections within No Policy states with approaches where the crosswalk cross slope grade would exceed either 2.1% (at yield or stop control devices) or 5% (uncontrolled approach or an intersection approach controlled by a traffic control signal or pedestrian hybrid beacon). The change in the amount of graded material was calculated using geometric formulas for volume and the dimensions noted above for crosswalk width and offset, lane width, and lead-in roadway length. The cost of grading this material was estimated using the low and high Costbook estimates for grading. When all of the scenarios are combined using a weighted average approach, the resulting value is $155 to $233 per location.

Table 56. Estimated grading cost per intersection type and estimated share of intersections by scenario in the 20 "No Policy" states.

Scenario	Base Case Grade	Grade With Policy	Geometric Total Volume Change (Cubic Yards)	Low Cost Est. (at $8.83 per cubic yard)	High Cost Est. (at $13.25 per cubic yard)	Share of Affected Inter-sections
Signalized, very steep, 1 lane	>5%	<5%	10.34	$91	$137	0.19%
Signalized, very steep, 2 lane	>5%	<5%	20.69	$183	$274	0.12%
Stop sign, very steep, 1 lane	>5%	<2.1%	41.38	$365	$548	4.28%
Stop sign, moderately steep, 1 lane	>3%	<2.1%	10.36	$91	$137	55.54%
Stop sign, very steep, 2 lane	>5%	<2.1%	82.76	$731	$1,097	2.85%
Stop sign, moderately steep, 2 lane	>3%	<2.1%	20.72	$183	$275	37.02%
Total	NA	NA	NA	NA	NA	100%
Average, weighted by share of intersections				$155	$233	

[257] BNi Costbook, Rough Grading (31 - 22130). Unit costs depend on equipment used.

4.12.6.1 New Construction

As with other calculations in this analysis, US population growth is used as the best proxy for future growth in roadways and pedestrian facilities. For No Policy states, there are an estimated 1,662,867 intersections with pedestrian facilities, calculated using the same methodology as described in the Curb Ramps section. Of these, an estimated 21.7% have sufficiently steep grade characteristics to make them relevant to this analysis, broken out by scenario as shown in the table above. Applying an annual growth rate of 0.54% yields a total of 1,948 impacted intersections per year (1,948 = 1,662,867 * 21.7% * 0.54%).

4.12.6.2 Alterations

Consistent with roadway lifespan assumptions as discussed in Section 4.2 on on-street parking, the analysis assumes the intersection roadway will be replaced in a 25-year cycle, such that 4% (1/25) are altered each year. This results in 66,515 intersections, with 14,431 with high slope crosswalk cross slope in No Policy states requiring additional grading each year (66,515 = 1,662,867 * 0.04; 14,474 = 66,515 * 21.76%).

4.12.7 Estimated Cost

Annual costs were estimated by applying the unit cost per impacted intersection to the number of alterations and new intersections in No Policy states with relevant grade characteristics.

Using the midpoint cost values (between low grading cost and high grading cost), this results in an average annualized cost of $3.10 million (discounted at 3%), or $2.98 million (discounted at 7%).

Table 57. Annual Costs for Grading Intersection Crosswalks with Steep Cross Slope. Dollar figures in millions.

Year	Altered Intersection w/ Crosswalks	Newly Constructed Intersections w/ Crosswalks	Overall Total Intersections w/ Crosswalks	Total Cost, Low, 3% Discount Rate	Total Cost, Mid, 3% Discount Rate	Total Cost, High, 3% Discount Rate	Total Cost, Low, 7% Discount Rate	Total Cost, Mid, 7% Discount Rate	Total Cost, High, 7% Discount Rate
2023	14,474	1,948	16,422	$2.41	$3.01	$3.61	$2.23	$2.79	$3.34
2024	14,474	1,948	16,422	$2.34	$2.92	$3.50	$2.08	$2.60	$3.13
2025	14,474	1,948	16,422	$2.27	$2.83	$3.40	$1.95	$2.43	$2.92
2026	14,474	1,948	16,422	$2.20	$2.75	$3.30	$1.82	$2.27	$2.73
2027	14,474	1,948	16,422	$2.14	$2.67	$3.21	$1.70	$2.13	$2.55
2028	14,474	1,948	16,422	$2.07	$2.59	$3.11	$1.59	$1.99	$2.38
2029	14,474	1,948	16,422	$2.01	$2.52	$3.02	$1.49	$1.86	$2.23
2030	14,474	1,948	16,422	$1.96	$2.45	$2.93	$1.39	$1.74	$2.08
2031	14,474	1,948	16,422	$1.90	$2.37	$2.85	$1.30	$1.62	$1.95
2032	14,474	1,948	16,422	$1.84	$2.30	$2.77	$1.21	$1.52	$1.82
2033	14,474	1,948	16,422	$1.79	$2.24	$2.69	$1.13	$1.42	$1.70
2034	14,474	1,948	16,422	$1.74	$2.17	$2.61	$1.06	$1.32	$1.59
2035	14,474	1,948	16,422	$1.69	$2.11	$2.53	$0.99	$1.24	$1.49
2036	14,474	1,948	16,422	$1.64	$2.05	$2.46	$0.92	$1.16	$1.39
2037	14,474	1,948	16,422	$1.59	$1.99	$2.39	$0.86	$1.08	$1.30
2038	14,474	1,948	16,422	$1.54	$1.93	$2.32	$0.81	$1.01	$1.21
2039	14,474	1,948	16,422	$1.50	$1.87	$2.25	$0.76	$0.94	$1.13
2040	14,474	1,948	16,422	$1.46	$1.82	$2.18	$0.71	$0.88	$1.06
2041	14,474	1,948	16,422	$1.41	$1.77	$2.12	$0.66	$0.82	$0.99
2042	14,474	1,948	16,422	$1.37	$1.72	$2.06	$0.62	$0.77	$0.92
2043	14,474	1,948	16,422	$1.33	$1.67	$2.00	$0.58	$0.72	$0.86
2044	14,474	1,948	16,422	$1.29	$1.62	$1.94	$0.54	$0.67	$0.81
2045	14,474	1,948	16,422	$1.26	$1.57	$1.88	$0.50	$0.63	$0.75

Year	Altered Intersection w/ Crosswalks	Newly Constructed Intersections w/ Crosswalks	Overall Total Intersections w/ Crosswalks	Total Cost, Low, 3% Discount Rate	Total Cost, Mid, 3% Discount Rate	Total Cost, High, 3% Discount Rate	Total Cost, Low, 7% Discount Rate	Total Cost, Mid, 7% Discount Rate	Total Cost, High, 7% Discount Rate
2046	14,474	1,948	16,422	$1.22	$1.52	$1.83	$0.47	$0.59	$0.71
2047	14,474	1,948	16,422	$1.18	$1.48	$1.78	$0.44	$0.55	$0.66
Total	**289,480**	**38,960**	**328,440**	**$43.14**	**$53.94**	**$64.74**	**$27.79**	**$34.75**	**$41.71**

5 Other PROWAG Provisions

5.1 Transit Stops and Shelters

PROWAG defines accessibility requirements for transit stops and transit shelters in the public right-of-way.

The updated standards below would apply to new construction and alterations.

- Fare machines: Fare machines must comply with the existing ADA standards set out for fare machines, including clear space, speech output, and user control.
- Detectable Warning Surfaces: Detectable warning surfaces must be provided at transit stops in some situations. This is discussed in more detail in the Detectable Warning Surfaces section of this analysis.
- Boarding and alighting area dimensions: Boarding and alighting areas must have a clear length of at least 96 inches from measured perpendicular to the face of the curb or street edge and a clear width of at least 60 inches measured parallel to the street.
- Boarding and alighting area slope: The slope of boarding and alighting areas measured parallel to the street, must be the same as street grade, and not steeper than 1:48 (2.1%) measured perpendicular to the street.
- Boarding platform slope: The slope of boarding platforms measured parallel to the track or street shall be the same as the grade of the track or street; the slope of the boarding platform measured perpendicular to the track or street must be 1:48 (2.1%) maximum.
- Transit Shelter clear space: transit shelters must comply with PROWAG guidance for clear space. The cross-slope must not exceed 1:48 (2.1%), clear spaces must be at least 30 inches min by 48 inches minimum and located entirely within the shelter.
- Access and Connectivity: Transit shelters must be connected to boarding and alighting areas by pedestrian access routes. In alterations, boarding and alighting areas and boarding platforms must be connected to existing pedestrian circulation paths by pedestrian access routes.
- Provision of Transit Stops During Construction: When construction or similar circumstances render an accessible transit stop inaccessible, an alternate compliant stop must be provided.

A national inventory does not exist for accessibility features of transit stops or shelters. In the absence of a national database, the study team conducted a review of current regulatory standards to assess current practices that would define the baseline for comparison. Sources of guidance include existing Federal regulations concerning accessibility, Federal guidance to transit agencies, and transit agencies' internal standards.

In particular, the ADA 2010 Standards and FTA guidance to transit agencies indicate that existing regulations and regulatory guidance provides standards substantially similar to the final PROWAG rule.

The ADA 2010 Standards[258] closely match the PROWAG specifications. These standards require:

- Provision of a "firm, stable surface"
- Boarding and alighting area clear length of 96 inches on the perpendicular to the curb and a clear width of 60 inches parallel to the roadway
- Slope not to exceed that of the roadway on the parallel, and not steeper than 1:48 on the perpendicular

[258] 2010 ADA Standards for Accessible Design, U.S. Department of Justice (2010), accessed July 14 from https://www.ada.gov/regs2010/2010ADAStandards/2010ADAstandards.htm

- Provision of detectable warning surfaces at boarding platforms
- Provision of at least a 30-inch-by-48-inch clear space within bus shelters
- Provision of an accessible route from any bus boarding and alighting area to a street, sidewalk, or pedestrian path (facilities that are generally part of Pedestrian Access Routes as defined in PROWAG).

Provided that new or altered transit stops and shelters would already be in compliance with the ADA Standards specified above, no further costs from the PROWAG final rule would be expected. This follows from the substantial similarity of the current ADA Standards to the PROWAG final rule; stipulations around clear space, grade, and detectable warning surfaces match exactly.[259]

Furthermore, existing FTA guidance is consistent with the ADA 2010 Standards. A 2015 circular[260] to recipients of FTA funding references the ADA standards and the Final Rule adopted by USDOT incorporating the ADAAG standards into USDOT's regulations. As such, existing transit agency accessibility practices are expected to be in line with existing ADA requirements.

To confirm the understanding that all agencies are likely in compliance with the PROWAG final rule, guidance from some of the largest transit agencies was also examined. While not all transit agencies publish such guidance, documents were found for the Massachusetts Bay Transportation Authority (MBTA)[261], King County Metro[262], Washington Metropolitan Area Transportation Authority (WMATA)[263], and the LA Metro[264]. This analysis indicated that all referenced existing ADA guidance and appeared to be compliant.

Not all design guides explicitly address the issue of maintaining access to transit stops during construction. Providing an ADA-compliant alternative stop is common practice in the transit industry and is explicitly noted in the MBTA guide.[265]

The proposed PROWAG guidelines for transit stops and shelters are expected to have little to no impact on current practices, and are expected to incur few, if any, new costs. Existing ADA requirements, as adopted by the USDOT in 2006 and referenced by the FTA, are substantially the same as the proposed PROWAG guidelines.

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[259] A more detailed analysis of potential compliance costs for Detectable Warning Surfaces as transit boarding platforms is presented in the DWS section.

[260] FTA Circular 4710.1 - Americans With Disabilities Act Guidance, Federal Transit Administration (2015), accessed July 18, 2022 from https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/Final_FTA_ADA_Circular_C_4710.1.pdf

[261] Bus Stop Planning & Design Guide, Massachusetts Bay Transportation Authority (2018), accessed July 15 from https://d2o8eokdkim9o8.cloudfront.net/sites/default/files/engineering/001-design-standards-and-guidelines/2018-04-01-bus-stop-planning-and-design-guide.pdf

[262] King County Metro Transit Route Facilities Guidelines, King County Metro (April 2018), accessed July 15 from https://kingcounty.gov/~/media/depts/metro/design-construction-standards/passenger-facilities/construction/TRF_Guidelines_Final_2020.pdf

[263] Bus Stop Amenity Reference Guide, Washington Metropolitan Area Transit Authority (WMATA) (2019), accessed July 15 from WMATA_MCEP_Bus-Stop-Amenity-Guide_20190809.pdf

[264] 2016 Metro Transit Service Policies & Standards, LA Metro (2016), accessed July 15 from https://la.streetsblog.org/wp-content/uploads/sites/2/2015/10/Attachment-A-2016-Metro-Transit-Service-Policies-and-Standards.pdf

[265] Bus Stop Planning & Design Guide, Massachusetts Bay Transportation Authority (2018), page 68.

5.2 Public Street Toilets

PROWAG requires that public street toilets, where provided, comply with sections 603 through 610 of Appendix D to 36 CFR part 1191 in the ADA & ABA Accessibility Guidelines[266]. This portion of the ADA guidance establishes standards for public restrooms. The below summary identifies the ADA standards relevant to public street toilets located on public rights of way.

- Clearance and Turning Space: A 60-inch turning diameter must be provided in toilet and bathing rooms; likewise, within a water closet or toilet compartment, a 60-inch clearance must be provided from the side wall, and a 56-inch clearance must be provided from the rear wall. Doors must not swing into the clear space.
- Reach and Access: Flush controls and toilet paper dispensers must be operable with one hand and without tight grasping, pinching, or twisting of the wrist.
- Grab bars: Grab bars must be spaced 1.5 inches from the wall; circular grab-bar cross sections must be between 1.25 inches and 2 inches diameter, while non-circular grab bars must have a cross-section dimension no greater than 2 inches and a perimeter between 4 and 4.8 inches. Side wall grab bars must be at least 36 inches long and extend from the centerline 12 inches minimum on one side and 24 inches on the other side. Grab bars must be installed horizontally, 33-36 inches above the finish floor.
- Urinals: Urinals must be of the stall- or wall-hung type with the rim at most 17 inches above the finish floor or ground and a depth of at least 13.5 inches from the outer face of the rim to the back of the fixture.
- Sinks: The rim or counter surface (whichever is higher) can be no greater than 34 inches above the floor or ground.
- Object Placement: Mirrors over sinks or countertops must have the bottom edge no greater than 40 inches above the surface. Toilet paper dispensers must be 7 to 9 inches in front of the water closet.

PROWAG also has separate provisions for multiple single-user *portable* toilets at one location; in these cases, at least 5% or one of each type of toilet must comply with these guidelines. This analysis focuses on permanent public street toilets rather than portable toilets. Portable toilets are subject to different standards under PROWAG and were not analyzed here, as portable toilets are typically not a capital investment in the public right-of-way.

This analysis evaluates the cost of the proposed PROWAG guidelines for public street toilets. In the event that compliance costs were found, costs would be calculated as the cost of constructing and maintaining compliant public street toilets less the costs of the no-action scenario.

A national inventory does not exist for public street toilets in the United States. However, research on recent procurements suggests that public street toilets are limited to a small set of vendors. These vendors reference ADA accessibility standards both in internal materials (e.g., marketing flyers, blueprints for toilets) and in contracts with entities purchasing toilets. Because the proposed PROWAG standards for public street toilets wholly reference existing standards under ADA, compliance with the current ADA rules also generally implies compliance with PROWAG.

[266] United States Department of Justice, 2010 Standards for Accessible Design (Sep. 2010), accessed July 14, 2022 from https://www.ada.gov/regs2010/2010ADAStandards/2010ADAStandards.pdf.

Vendors and current markets for permanent public street toilets were identified by focusing both on public street toilet vendors' marketing materials and specifications and on public street toilet procurement contracts for large US cities. An analysis of current vendors and major procurement contracts confirmed that public street toilets currently for sale in the United States generally meet the PROWAG standards. Table 58, below, identifies major vendors, markets served, and states how the level of current accessibility was assessed by the study team.

Table 58. Current Vendors' Specifications.

Vendor/Product	Major Markets Served	Notes	Source for Accessibility
Portland Loo	Nationwide—notable markets include Portland, OR and Cambridge, MA.	One model, accessible	Website states that Portland Loo is ADA accessible[267] Toilet blueprint on website appeared to match all relevant standards[268]
JCDecaux Sanisette	New York City, San Francisco	San Francisco has some two-stall toilet units (one side accessible, one not)[269]	Procurement documents state that replacement toilets will be accessible
Exeloo	LA, SF Bay Area, Texas	Models sold in the US all accessible	Website states that toilets are accessible Marketing material for "Jupiter" toilet references specific features that comply with the standards[270]

Two of the three vendors, Exeloo and the Portland Loo, exclusively provide prefabricated units, with little option for customization. As such, information on current installations is likely to be applicable to future customers and locations as well. Given the prevalence of accessible models in the current market, it is also likely that any future market entrants would meet accessibility standards.

The proposed PROWAG guidelines for public street toilets are expected to have little to no impact on costs, as existing vendors' standard models already meet ADA requirements and would thus also meet PROWAG requirements. A review of recent contracts for public street toilet installation and relevant manufacturer specifications also indicated that all identified toilets would be compatible with PROWAG. Some existing multi-toilet locations are less than 100% accessible, so it is possible that PROWAG would cause cities to replace these with 100% accessible units when they are due for replacement. However, this does not appear to have major cost implications. Indeed, two of the three major vendors do not offer a non-accessible model.

[267] "Why Loo", The Portland Loo, accessed July 14, 2022 from https://portlandloo.com/why-loo/
[268] Accessed via https://mst.org/wp-content/media/07_Portland-Loo_PC1.pdf
[269] "Review and Comment for SFDPW Replacement of Public Toilets and Kiosks", San Francisco Planning Department, accessed July 14, 2022 from https://commissions.sfplanning.org/hpcpackets/2017-009220COA.pdf
[270] "Jupiter", Exeloo, accessed July 14, 2022 from https://exeloo.com/products/1/jupiter/

5.3 Handrails

5.3.1 Background

The PROWAG guidelines set requirements for handrails on pedestrian circulation paths where ramps or stairs are present. Curb ramps, and slopes following the grade of the adjacent roadway do not require handrails.

Requirements are consistent with existing ADA accessibility standards for Handrails,[271] with some refinements.

Table 59. Handrail Specifications.

Category	**ADA**	**PROWAG**
Where Required	"Handrails shall be provided on both sides of stairs and ramps." With exception for assembly areas.	Handrails provided on both sides of ramps/stairs
Continuity	"Handrails shall be continuous within the full length of each stair flight or ramp run. Inside handrails on switchback or dogleg stairs and ramps shall be continuous between flights or runs." With exception for assembly areas.	Continuous within full length of ramp/stair. Continuous on inner handrail on switchback and dogleg
Height	"Top of gripping surfaces of handrails shall be 34 inches (865 mm) minimum and 38 inches (965 mm) maximum vertically above walking surfaces, stair nosings, and ramp surfaces. Handrails shall be at a consistent height above walking surfaces, stair nosings, and ramp surfaces."	Height (top of grip surface) between 34 and 38 inches (height above surface/ramp/stair nosing)
Clearance	"Clearance between handrail gripping surfaces and adjacent surfaces shall be 1½ inches (38 mm) minimum."	1.5 inches minimum between handrail gripping and adjacent surface
Handrail Surface	"Handrail gripping surfaces shall be continuous along their length and shall not be obstructed along their tops or sides. The bottoms of handrail gripping surfaces shall not be obstructed for more than 20 percent of their length. Where provided, horizontal projections shall occur 1½ (38 mm) minimum below the bottom of the handrail gripping surface." With exceptions.	Handrail surface continuous and not obstructed on top or sides (more details)
Cross section.	Circular Cross Section - Handrail gripping surfaces with a circular cross	… Allows for small (<1 inch) expansion joints

[271] U.S. Access Board. "Americans with Disabilities Act: Accessibility Standards, 505 Handrails." https://www.access-board.gov/ada/#ada-505

Category	ADA	PROWAG
	section shall have an outside diameter of 1¼ inches (32 mm) minimum and 2 inches (51 mm) maximum. Non-Circular Cross Section - Handrail gripping surfaces with a non-circular cross section shall have a perimeter dimension of 4 inches (100 mm) minimum and 6¼ inches (160 mm) maximum, and a cross-section dimension of 2¼ inches (57 mm) maximum.	Outside diameter between 1.25 and 2 inches (circular cross section) For non-circular cross-section, perimeter between 4 and 6.25 inches, and max cross-section dimension of 2.25 inches.
Surface	"Handrail gripping surfaces and any surfaces adjacent to them shall be free of sharp or abrasive elements and shall have rounded edges."	No sharp or abrasive surfaces, must have round edges
Fittings	"Handrails shall not rotate within their fittings."	Must not rotate in fittings (except expansion joint)
Extensions	Various requirements related to extensions	Various requirements related to extensions

5.3.2 Cost Summary

The handrail requirements in PROWAG are expected to have little to no impact on practices at state and local agencies, and therefore only incidental cost impacts. A review of state design standards found states deferring to existing ADA handrail requirements. No notable deviations from practice were noted. Where more detailed state handrail guidelines are available (e.g., California[272]) they are consistent with ADA guidelines, though with some detail omitted. Overall, it appears that states defer to existing ADA guidance when specifying where and how to provide handrails.

Under PROWAG, handrails are required only when a jurisdiction elects to install a ramp or stairs in the public right-of-way. Handrails are specifically not required along sidewalks that track the grade of the street, regardless of slope. Thus, there is no expectation that additional handrails would be installed beyond those installed under current state and local government practices. Further, there is no expectation that a significant number of handrail designs would be impacted by PROWAG guidelines (e.g., current practice is assumed to avoid abrasive surfaces). Where modifications would be required to conform to PROWAG guidelines, it is assumed the change in cost is relatively small, reflecting a change in materials and not a major redesign.

5.4 Alternate Pedestrian Access Routes

PROWAG includes several requirements for alternate pedestrian access routes (PARs). The study team was not able to develop an annual cost estimate for these provisions due to a lack of data on the number of construction projects and other events that would require alternate PARs. While some state and local

[272] State of California, Department of Transportation, Division of Construction. "Permanent Pedestrian Facilities ADA Compliance Handbook" March 2018. https://dot.ca.gov/-/media/dot-media/programs/civil-rights/documents/permanent-pedestrian-facilities-ada-compliance-handbook-a11y.pdf

governments maintain databases on construction projects, these are not comprehensive and do not provide the required level of detail on sidewalk closures and rerouting.

In many cases, compliance with the requirements for alternate PARs will not entail any change from baseline conditions because they closely align with existing MUTCD provisions on temporary traffic control. MUTCD, which is used as the standard for all public roads and sidewalks, includes a requirement that alternate pedestrian routes be accessible. The more specific MUTCD guidance includes the following elements:[273]

- signs to warn pedestrians of an alternate route in advance to encourage crossing to the opposite side of the roadway,
- a smooth, continuous alternate pedestrian route that complies with the ADAAG, including curb ramps (or an absence of curbs),
- accessible pedestrian signals, audible information devices, or detectable barriers and channelizing devices to communicate signal information to travelers with low vision,
- continuous detectable edging with a bottom surface no higher than 2 inches above the ground and a top surface no lower than 32 inches above the ground,
- and pedestrian signals or accessible pedestrian signals where the engineer determines they are necessary as temporary crossings.

Overall, the close correspondence between PROWAG and MUTCD indicates that there would be little or no incremental compliance costs relative to the baseline, with the exception of two provisions where the MUTCD provisions are non-binding or permit other approaches: audible signage and accessible pedestrian signals.

PROWAG provides that information on signage that directs pedestrians to and from the alternate PAR must also be provided via proximity-actuated audible signs or other non-visual format so that it is accessible to persons with vision disabilities. MUTCD also includes a non-binding recommendation for audible signs,[274] and a number of state DOTs are already using proximity-actuated audible signs and similar technologies in their work zones, including Virginia,[275] Minnesota[276], and North Carolina[277].

For states and localities that do not currently use proximity-actuated audible signs, there would be incremental costs relative to the baseline. Only limited costs are expected per location, as a number of commercially available products can provide the required audible signs using infrared or other motion sensors. The retail cost of these products is approximately $170, and because they can accept customized

[273] Manual on Uniform Traffic Control Devices, Chapter 6D.
[274] Manual on Uniform Traffic Control Devices, Chapter 6D.
[275] American Road and Transportation Builders Association, Work Zone Safety Consortium, "Pedestrian Accommodation in Work Zones: A Field Guide," February 2018. See pp.8-9 for an example from Virginia. Available at: https://workzonesafety-media.s3.amazonaws.com/workzonesafety/files/documents/training/fhwa_wz_grant/artba_pedestrian_accommodation_wz.pdf
[276] Minnesota DOT, Temporary Pedestrian Access Routes Audible Message Content, January 2018. http://www.dot.state.mn.us/trafficeng/workzone/doc/TPARaudiblemessagecontentguidelines.pdf
[277] North Carolina DOT, ADA Compliant Pedestrian Traffic Control Devices, June 2022. https://connect.ncdot.gov/projects/WZTC/Documents/F_ADA_Compliant_Pedestrian_Traffic_Control_Devices_APP.docx

audible messages, they can be re-used for multiple construction projects over time.[278] There are minimal maintenance costs with the units, though one docket comment noted that they could be susceptible to theft, so there could be small additional costs for securing the device.

Using an assumed product lifespan of 3 years and 250 working days per year, the cost per unit per day is approximately $0.23 (i.e., $170/750). Although multiple units could be necessary for larger or more complex alternate PARs, the incremental cost of this provision is likely to represent a very small share of the overall construction or repair costs for the underlying project that necessitates the establishment of an alternate PAR.

PROWAG also requires accessible pedestrian signals (APS) where temporary pedestrian signals are provided on alternate routes. This requirement ensures that pedestrians with vision disabilities have access to the same information as provided by the temporary visual pedestrian signals. The provision of APS on alternate routes is not universal practice as the MUTCD recommendation is non-binding. Some states only provide APS in work zones if APS were already present.[279] In these cases, there would be an incremental cost for the APS relative to visual-only signals. APS technologies and associated costs are discussed in more detail in the APS section of this FRIA. The estimated incremental cost is $450 per signal location. As with audible signs, these costs could be spread across multiple construction projects over the lifespan of the APS, such that the net cost per construction day would be very low.

[278] An example product is the A.D.A. Audible Type 1 Barrier Light. Information, accessed February 1, 2023, https://www.trans-supply.com/pg/55/ada-audible-type-i-barricade-light

[279] See, e.g., Colorado DOT, Accessible Pedestrian Signal Protocol, https://www.codot.gov/business/civilrights/ada/assets/cdot_aps_protocol_march_2017.pdf

6 Benefits

Executive Order 13563 states that to the extent permitted by law federal agencies must “propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify)” and that “where appropriate and permitted by law, each agency may consider and (discuss qualitatively) values that are difficult or impossible to quantify, including equity, human dignity, fairness, and distributive impacts.”

The final rule promotes important societal values that are difficult or impossible to quantify. The focus in the subsections below is on benefits that can at least potentially be quantified, though in some cases not enough data were available to fully quantify the impacts. The initial subsection begins by providing an overview of the relevant U.S. population and trip-making statistics that are relevant for the final rule. The next subsection describes the overall benefits of the rule—both qualitatively and quantitatively—that apply across the entirety of PROWAG and that are not necessarily specific to a provision. Finally, benefits that are specific to key provisions are discussed.

6.1 U.S. Population Statistics

The provisions in the final rule will primarily benefit travelers with disabilities. The U.S. Census Bureau reported that 12.7% of the total civilian population in the U.S. had a disability in 2019[280]. A further breakdown of specific populations that are likely to benefit from the final rule is as follows:

- 55.9 million people are 65 years or older[281]
- 4.2 million people aged 18-64 with a vision difficulty[282]
- 8.9 million people aged 18-64 with an ambulatory difficulty[283]
- 10.8 million children under 3 years old (reflecting the stroller population)[284]

Americans with disabilities also have unique travel patterns relative to those without disabilities. The National Household Travel Survey, last conducted in 2017, is the primary source of travel behavior for the American public and allows analysts to assess trends in personal and household travel. The survey asks respondents whether they have a “travel-limiting disability,” allowing the data to be separately analyzed for those with and without disabilities. The data shows that Americans with travel limiting disabilities take fewer trips than those without disabilities, but they walk for a greater percentage of those trips. Workers aged 18-64 with a disability walk for 9.2% of trips, while nonworkers aged 18-64 with a disability walk for 14.4% of trips.[285] Additionally, workers with disabilities are more likely to live in zero-vehicle households than workers without disabilities,[286] further emphasizing the importance of accessible pedestrian infrastructure.

Combining the data from the NHTS on travel patterns with the US Census Bureau data on the population with disabilities gives a total estimate of 7.7 million walking trips per day that may be impacted by the proposed rule. The relevant data and calculations can be seen in Table 60.

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280 Anniversary of Americans With Disabilities Act: July 26, 2021 (census.gov)
281 S1810: DISABILITY CHARACTERISTICS - Census Bureau Table
282 S1810: DISABILITY CHARACTERISTICS - Census Bureau Table
283 S1810: DISABILITY CHARACTERISTICS - Census Bureau Table
284 B09001: POPULATION UNDER 18 YEARS BY... - Census Bureau Table
285 https://www.bts.gov/travel-patterns-with-disabilities
286 https://www.bts.gov/travel-patterns-with-disabilities

Table 60. Walking Trips per Day

Data	Value	Source
Population with Visual Disabilities, 18-64	3,869,339	ACS, 2021
Population with Mobility Disabilities, 18-64	9,715,370	ACS, 2021
Average Trips per Day, 18-64, with Travel Limiting Disability	2.6	NHTS, 2017
Walk Mode Share, 18-64, with Travel Limiting Disability	14.3%	NHTS, 2017
Total Walking Trips per Day, Travel Limiting Disability, 18-64	5,042,601	Calculated
Population with Visual Disabilities, 65+	3,118,010	ACS, 2021
Population with Mobility Disabilities, 65+	10,863,610	ACS, 2021
Average Trips per Day, 65+, with Travel Limiting Disability	2.1	NHTS, 2017
Walk Mode Share, 65+, with Travel Limiting Disability	9.2%	NHTS, 2017
Total Walking Trips per Day, Travel Limiting Disability, 65+	2,701,249	Calculated
Total Walking Trips per Day, Travel Limiting Disability	**7,743,849**	**Calculated**

It is also worth noting that many provisions of the final rule can benefit *everyone*, regardless of age, disability status, or other demographics. The rule has particular benefits targeted toward people with disabilities, but many parts of the rule will have spillover benefit effects to all people who use the improved facilities. There are also elements of the rule targeted toward vehicular travel for improved accessibility for on-street parking and passenger loading zones—the number of relevant driving trips can also be estimated using Census and NHTS data and the general same methodology as was used for the walking trip estimate.

6.2 Benefits Methodology

For benefits that are able to be quantified, the analysis had to carefully consider the difference between the public right-of-way both with and without the final rule. As has been noted throughout the cost analysis, some elements of the public right-of-way are assumed to already be compliant with the rule, some are partially compliant, and some are not compliant at all. Additionally, it is possible that in the absence of PROAWG even the infrastructure that is not currently compliant could still *eventually* become compliant at some point outside of the analysis periods considered, potentially many decades from now. Accordingly, some of the benefit of the final PROWAG rule is the benefit of achieving accessibility sooner than would be expected without clear, national guidelines. To appropriately analyze the benefits of the final rule, the analysis looks both at the expected impacts on traveler behavior and trip-making with and without the rule over the next 30 years.[287] The benefits of the final rule therefore vary by year based both on how much infrastructure is accessible with the rule as well as the baseline assumptions of the level of accessibility without the rule in any given year. Specific assumptions are detailed within relevant sections, but the general principle is always aimed at estimating solely the difference in outcomes between the world *with* the final rule and the world *without* the final rule.

6.3 General Benefits

The final rule has a variety of benefits that apply across the entirety of the rule. It is difficult to attribute benefits specifically to smaller aspects of the rule, such as trying to distinguish between the incremental benefit of compliant surface materials on shared use paths and compliant sidewalk widths, for example. However, when the rule is viewed in totality, it is easier to discuss various benefits related to the overall improvements to accessibility in the public right-of-way.

6.3.1 Quality of Life

The final rule is expected to have significant quality of life impacts for people with disabilities. This includes benefits related to happiness, health, and improved connectivity to various services. These benefits are realized in two ways. First, there are quality of life benefits on existing pedestrian trips that are now improved in some way through the rule. Second, there are quality of life benefits resulting from people with disabilities being able to take new pedestrian trips that they otherwise would not have taken or would have taken using an alternative mode.

Based on data from the NHTS and the Census Bureau, there are a substantial number of pedestrian trips taken every day by people with various travel-limiting disabilities. As shown previously in this section, it is estimated that there are 7.7 million pedestrian trips per day that may possibly benefit from the PROWAG final rule.

These 7.7 million existing trips per day are likely to experience benefits in journey quality from the final rule. Travelers have various preferences for facility improvements, even those that do not directly impact their travel time or safety. This can be seen typically in a revealed preference study, where route choices are analyzed to observe whether people will go out of their way to travel on specific routes that have better amenities. For example, USDOT recommends monetizing an added foot of sidewalk width at $0.10 per person-mile walked, monetizing installing a marked crosswalk at $0.18 per use, and installing a signal for pedestrian crossing at $0.46 per use.[288] These values were estimated from studies that showed pedestrians would choose to take longer, more circuitous routes in order to have a wider sidewalk or to cross at a designated crosswalk with a signal. These monetization values do not correspond precisely to

[287] Note that in cases where benefits derived from a ***single*** provision, such as on-street parking or APS, the benefit analysis timeframe was matched to that of the cost calculations. Where benefits derive from *multiple* provisions, as for newly enabled mobility, benefits were analyzed over a composite 30-year analysis period that reflects the multiple time periods used in cost estimation. Costs and benefits are provided in annualized terms in summary tables, meaning that differences in analysis periods are adjusted appropriately.
[288] Benefit Cost Analysis Guidance 2022 (Revised).pdf (transportation.gov)

the PROWAG final rule, as sidewalk width is assumed to be compliant and the value for pedestrian crossing signalization is not specific to *accessible* pedestrian signals, but they provide a benchmark for understanding how improvements in facility quality can provide a direct quality of life improvement to travelers. Rule elements that may provide this type of amenity benefit to existing pedestrian travelers include accessible crossings at multilane roundabouts, accessible pedestrian signals, curb ramp improvements, and detectable warning surfaces on shared use paths.

The rule also allows for improved connectivity to jobs, healthcare, businesses, and education. For someone with travel limiting disabilities, the impact of improving accessibility can be equivalent to the impact on someone without a disability of adding an entirely new route. If the route is inaccessible, then it essentially does not exist as an option for certain groups of people with disabilities. Once the route is accessible, it opens up new possibilities for people to connect to various key destinations.

6.3.2 Induced Trip-Making

For new pedestrian trip-making, it is assumed that there would only be a small increase in the number of pedestrian trips taken by people with travel-limiting disabilities. Many of the rule elements that may have the most direct impact on traveler behavior—for example, sidewalk width, sidewalk cross-slope, and detectable warning surfaces—are assumed to already be compliant with the final PROWAG rule. However, the final rule will result in improvements to accessibility that may induce travelers in certain areas to make new pedestrian trips. Elements of the final rule that may induce new pedestrian trips include, but are not strictly limited to: APS, accessible crosswalks at roundabouts, curb ramp installation or improvements, and detectable warning surfaces on shared use paths.

It is difficult to estimate what the size of induced trip-making may be, particularly as each rule element has a differing level of baseline compliance with the rule. For purposes of analysis, it is assumed that over 30 years (an approximate midpoint of the assumed useful life of the rule elements analyzed, which is therefore equivalent to the time frame by which all rehabilitation will be completed and the public right-of-way will be fully accessible per the final rule), the rate of walking trips for people with travel-limiting disabilities will gradually rise to match the rate of walking trips for people without travel-limiting disabilities.

While the accessibility of the public right-of-way is expected to increase as a result of the final rule, accessibility is also expected to increase in the absence of the rule, albeit at a much slower pace. That is, even the infrastructure that is not currently compliant could still *eventually* become compliant at some point outside of the analysis periods considered, potentially many decades from now. For purposes of analysis, it is assumed that over 150 years the public right-of-way will slowly become accessible (5% of rehabilitated facilities with a 30-year useful life are made accessible each year). Therefore, the benefits generated as a result of the final rule are compared with the benefits generated far more gradually by the natural increase in accessibility in the absence of the rule.

The data suggest that the population with a travel limiting disability, ages 18-64, take roughly 0.004 fewer daily walking trips, and the population with a travel limiting disability, ages 65+, take 0.16 fewer daily walking trips, compared to their non-disabled counter parts in the same age categories.[289] This means, at

[289] U.S. Department of Transportation, Federal Highway Administration, 2017 National Household Travel Survey

the end of the 30-year analysis period, people with a travel limiting disability, aged 18-64, will take an additional 1.14 walking trips per year and people with a travel limiting disability, aged 65+, will take an additional 48.09 walking trips per year.[290] In other terms, people with a travel limiting disability, aged 18-64, will take, on average, 1 additional walking trip every 11 months[291] and people with a travel limiting disability, aged 65+, will take, on average, 1 additional walking trip every week.[292] This full value of induced trip-making is only applied in the final year of analysis, as trip-making is assumed to grow slowly and linearly over time to align with the rehabilitation cycle of various assets.

To estimate the value of an induced trip by purpose, a literature review was conducted of studies that included estimates of the value of additional or forgone trips. The monetary value for medical trips, obtained from Godavarthy et al. (2014), was based on the impact that missing medical trips would have on an individual's quality of life and the need for more costly care in the future. The value of an induced shopping trip, obtained from a study conducted by Skolnick and Schreiner (1998), was based on data regarding average shopping expenditures per trip.[293] The value for induced social trips was the default value used in a 2002 study by Southworth et al.— the authors noted that the value may be an underestimate, but used it due to the lack of evidence regarding the true value of social and recreation trips.[294] It is worth noting that the valuation for both the shopping and social trips are imperfect proxies for the true inherent value of these trips to the traveler. It is difficult, if not impossible, to accurately determine the true value for these trips, because they vary according to traveler and situation. Nonetheless, these values from the published literature appear to be reasonable proxies for purposes of this analysis because they account for the value to the traveler and/or the societal cost of a trip that is forgone.

All values were inflated to 2021 dollars from the values presented in the applicable studies using the GDP deflator, resulting in the following trip values in 2021 dollars:

- Shopping Trips— $40
- Social Trips— $40
- Medical Trips— $417

Data from the NHTS was used to separate out the number of trips by trip purpose. Shopping trips comprise 47.3% of trips for those aged 18-64, and 47.6% of shopping trips for those aged 65+. Social trips comprise 32.1% of trips for those aged 18-64, and 38.1% of trips for those aged 65+. Medical trips comprise 11.2% of trips for those aged 18-64, and 9.5% of trips for those aged 65+. All numbers are based on people with travel-limiting disabilities. Percentages do not sum to 100%, as certain trip types were excluded from analysis due to a lack of data on how to monetize other trip purposes. In reality, all trip types likely have some value to the traveler, and exclusion of other trips (such as work trips) accordingly under-estimates the true benefit.

The total annual benefits for these new trips were calculated by monetizing the daily induced trips under each trip category (social, shopping, medical) using the assumed trip value and multiplying this daily

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290 Using an assumption of 300 viable walking days per year.
291 Using an assumption of 24 viable walking days per month.
292 Using an assumption of 6 viable walking days per week.
293 Skolnik, and Schreiner. "Benefits of Transit in Small Urban Areas: A Case Study." (1998)
294 Southworth, et al. "An Assessment of Future Demands for and Benefits of Public Transit Services in Tennessee." (2002)

value by the number of affected individuals (people with visual and mobility related disabilities, taken from ACS 2021 Census data) and an annualization factor of 300. Population is also grown over time at a rate of 0.524 percent annually across the analysis period.

Induced pedestrian trips can also provide a health benefit to the newly active travelers. This benefit is also sometimes referred to as a reduced mortality benefit, and it is based on the idea that increased physical activity will reduce an individual's risk for a variety of health conditions. The 2022 USDOT's benefit-cost guidance recommends monetizing the health benefits of increased walking from induced pedestrian trips at $7.08 per trip (in 2020 dollars).[295] The value is based on public health studies and represents an overall average mortality reduction benefit for individuals within the relevant age range (20-74 years). The value was inflated to 2021 dollars using the GDP deflator, arriving at a new estimate of $7.40 per trip.

As previously mentioned, induced trips are calculated by assuming that people with disabilities will increase their walking trip rate to the level of people without disabilities in response to sidewalk accessibility improvements. This assumes that people with disabilities ages 18-64 experience 0.004 induced daily pedestrian trips. It is worth noting that the population aged 18-64 is not the same as the relevant age range noted in USDOT guidance of 20-74. Given the limitations of the available population data from the ACS, it was determined that using the 18-64 population would likely provide a reasonable, conservative proxy.

To calculate annual health benefits, the $7.40 value is multiplied by the number of daily induced trips, the affected population (people with visual impairments per ACS data in 2021), and a 300-day annualization factor.[296] See Table 60 for total population estimates and daily trip-making rates—the same assumptions and calculations for the induced trip-making are replicated here. Population is grown over time at a rate of 0.524 percent annually. This benefit only applies to new, induced trips, and does not impact existing travelers. It is also worth noting that this benefit is only applied to people with visual impairments—given that people with mobility impairments may utilize various assistive devices (such as wheelchairs) that affect the size of the reduced mortality benefit they receive from pedestrian trips, people with mobility impairments were excluded from this analysis to be conservative. In reality, some people with mobility impairments will likely receive a health benefit from increased pedestrian trips.

The results of the analysis for both the health benefit and the valuation for new, induced trip-making can be seen in Table 61.

Table 61. Induced Trip Benefits (millions)

Induced Trip Benefit	Undiscounted	Discounted, 7%	Discounted, 3%
Health Benefit	$1.6	$0.4	$0.9
Foregone Trip Valuation	$731,303.1	$179,674.4	$383,685.4
Total Benefit	$731,304.7	$179,674.9	$383,686.3
Annualized	$24,376.8	$14,479.3	$19,575.4

[295] USDOT, Benefit-Cost Guidance for Discretionary Grant Programs (2022).

[296] (1) Value Per Trip Per Person x Trips per Day = Value per Day per Person; (2) Value per Day per Person x Affected Population = Total Value per Day; (3) Total Value per Day x 300 Days = Total Value per Year

6.3.3 Economic Benefits

There may be economic benefits through improved connections to local businesses. These benefits would be very localized and would vary heavily from location to location depending on the degree of the accessibility improvements and the size of the disabled population, but generally speaking, improved accessibility can increase business. The Victoria Transport Policy Institute published a report on the economic value of walkability[297] that synthesized results from various other studies as follows:

- One study found that more business owners tend to believe that a widened sidewalk and/or a bike lane increase business relative to merchants who believe these changes hurt business.
- In Manhattan, the New York City DOT found that expanding walking facilities in Union Square reduced commercial vacancies 49%, relative to a smaller 5% increase borough-wide.
- Another survey found that shoppers who valued wider sidewalks over parking spent more money in the aggregate than those who valued parking over sidewalks.

Although sidewalk width is already assumed to be compliant with the PROWAG final rule, there may be other rule elements that provide similar types of economic benefits to local businesses through new accessibility for people with disabilities. Some elements of the rule will also generally improve walkability for all people, regardless of disability status, further increasing the possible economic benefits. These benefits are impossible to quantify, and these types of benefits are also not always fully appropriate for inclusion in a benefit-cost analysis, but there is potentially a large qualitative benefit here that can be attributed to the PROWAG final rule.

6.3.4 Safety

The final rule would be expected to reduce the risk of pedestrian-involved crashes. The benefits of roadway safety interventions are typically calculated by identifying the universe of total crashes that are relevant to the intervention, often using historical crash data that have been filtered to reflect the set of pre-crash scenarios, risk factors, or other crash characteristics (e.g., speed, roadway type, lighting conditions). The crash totals are then multiplied by the estimated effectiveness rate of the intervention to yield the total number of crashes prevented. This analysis may also break down the avoided crashes by injury severity level. The avoided injuries can then be monetized using values from the literature or agency guidance on the societal willingness to pay to avoid transportation injuries.

In the case of the PROWAG final rule, there are national data on pedestrian-involved crashes available through the National Highway Traffic Safety Administration's General Estimates System (GES). These can be further filtered to identify crashes involving pedestrians who were at a signalized intersection, and where the pedestrian had a disability. However, GES data do not provide the more detailed causation-related data that would be needed to identify the very specific types of crashes that would be avoided due to the proposed rule. There are also very few incidents in the data that clearly recorded whether the pedestrian had a disability. Thus, it would be challenging to identify the appropriate set of crashes that are potentially avoidable with the improvements in the final rule. Moreover, the study team found that there are no published studies listing the safety effectiveness of most of the rule elements in the Crash Modification Factors Clearinghouse or other source. Without these two key pieces of data, it is not possible to estimate the safety benefits with any precision. The one area where it is possible to provide

[297] Economic Value of Walkability (vtpi.org)

some quantification for safety benefits is for accessible pedestrian crossing treatments at roundabouts—this is discussed further later.

In addition to the direct impact on crashes, the final rule could also provide a benefit through an increased perception of safety—that is, travelers may experience a small additional benefit from *feeling* safer, even if the number of crashes does not materially change. Literature on this topic does not provide any clear estimates for how to monetize such a concept, although there is literature more generally on pedestrian route choice preferences and how pedestrians may value particular improvements. USDOT's benefit-cost guidance notes that installing a marked crosswalk can be valued at $0.18 per use for pedestrians, independent of the direct safety improvements. This value is not directly applicable to all elements of the final rule but provides a useful benchmark for the potential magnitude of these impacts. Because there is no well-established value for monetizing the perception of safety, it cannot be quantified in this analysis. Qualitatively, there is likely a small benefit here for all pedestrians.

6.3.5 Reduction in Paratransit Costs

An increase in walking trips may also lead to a small reduction in paratransit use. It is likely that many individuals using paratransit would not choose to switch to walking, even with improvements to pedestrian infrastructure, but there may be some people with disabilities who are able to reduce their use of paratransit and choose instead to walk. This could result in a cost savings for transit agencies who provide paratransit services. One estimate suggests that a paratransit trip costs between $60 and $90 per trip, [298] which could add up to significant savings for agencies. It was not possible to estimate how many paratransit trips could be reduced, as more information would be needed on the users of various services and the trips they are taking, so an overall benefit for this category cannot be quantified.

6.4 Provision-Specific Benefits

6.4.1 Pedestrian Crossings at Roundabouts

The added pedestrian crossing treatments at roundabouts are expected to reduce collisions and the severity of collisions.

A 2015 report from FHWA studied accidents at roundabouts, with specific data including fatal crashes across the U.S. and injury crashes in Washington and Wisconsin.[299] The data showed no fatal crashes that involved pedestrians, so fatal crashes are excluded from further analysis in this RIA. For injury crashes, the study showed that there were no pedestrian-involved injury crashes in Wisconsin, but that 2% of injury crashes in Washington were pedestrian-involved. With 602 total injury crashes at roundabouts in Washington, this is approximately 12 total pedestrian-involved incidents over the analysis period from 2001 through 2013. The study does not clearly identify what year(s) the injury crashes occurred; therefore this RIA used the number of roundabouts in Washington in 2013 to develop a conservative estimate of crashes per-roundabout. The roundabouts database has 269 roundabouts in Washington in 2013, meaning that there were roughly 0.0034 annual pedestrian injury crashes per roundabout in Washington. This small number of crashes is used as a basis for the possible crash reductions from the final rule.

[298] Transit agencies are paying the price for inefficient paratransit - Via Transportation (ridewithvia.com)
[299] A Review of Fatal and Severe Injury Crashes at Roundabouts (dot.gov)

To estimate the reduction in crashes, data was pulled from the Crash Modification Factor Clearinghouse. A crash modification factor gives the proportion of crashes that *remain* after a treatment. In other words, a CMF of 0.9 would mean that 90% of crashes remain after the treatment, or that 10% of crashes have been eliminated. Multiple CMFs for vehicle/pedestrian crashes are available in CMF Clearinghouse for various pedestrian crossings, including 0.31 for installing an RRFB, 0.309 for installing a PHB, and 0.55 for installing a raised pedestrian crosswalk.[300] Because the cost analysis assumes an equal split between RRFBs, PHBs, and raised crosswalks, the benefits analysis will do the same and will take an equal average between the three CMFs to give an overall assumed rate of reduction in vehicle/pedestrian crashes.

Using the estimate from the cost analysis of the rehabilitated and added multilane roundabouts that will be affected each year, the crashes per roundabout are converted to yearly totals and monetized using USDOT's estimate of the general cost for an injury crash of unspecified severity. Overall, there is an annualized benefit of $0.09 million per year (discounted at 7%) for this benefit category across 25 years of analysis.

Table 62. Roundabout Safety Benefits (millions)

Roundabout Safety Benefit	Undiscounted	Discounted, 7%	Discounted, 3%
Total Benefit	$2.8	$1.1	$1.8
Annualized	$0.1	$0.09	$0.1

These benefits are likely underestimated. As previously noted, the rate of injury crashes per roundabout is conservative, meaning that the true number of injury crashes for pedestrians is likely higher. It is also possible that the crash rate is even higher specifically at *multilane* roundabouts, which are the type of roundabout affected by the final rule. The analysis also does not include any estimate for benefits relating to property damage only (PDO) crashes, and the FHWA study had no data on pedestrian fatalities at roundabouts from which to draw any conclusions. Accordingly, this safety benefit for roundabout crossings is assumed to be a conservative underestimate of the true potential benefit.

Unlike with induced trips, this benefit calculation does not require the assumption that existing roundabouts without accessible pedestrian crossing treatments will gradually become accessible over a longer time frame. As the costs analysis stated, the inclusion of accessible pedestrian crossings at multilane roundabouts has not previously been required by accessibility guidelines and does not represent a widespread industry practice in the United States. This finding was corroborated by the random sampling of 82 roundabouts in Google Street View, of which no roundabouts were found that had any of the appropriate pedestrian crossing treatments.

6.4.2 Curb Ramps

Curb ramps are likely to have specific economic and livability benefits, separate from those provided by the rule as a whole. A study of pedestrian behavior at a Sarasota, FL, shopping mall revealed that nine out of 10 "unencumbered pedestrians" go out of their way to use a curb cut".[301] Although there is not a clear

[300] http://www.cmfclearinghouse.org/, CMF IDs #11158, #2922, and #136
[301] The Curb-Cut Effect (ssir.org)

monetization value available for this preference for using a curb ramp, this is still a benefit category worth noting, given that studies have found that pedestrians prefer using curb ramps even if a pedestrian does not "need" a curb ramp per se. There is some inherent value to curb ramps that is not captured elsewhere in this rule's analysis of benefits, and if it was possible to quantify this benefit, it would likely only be a very small benefit per trip but could add up significantly across millions of affected trips every year.

6.4.3 Accessible Pedestrian Signals

Pedestrians who are blind or have low vision use a variety of strategies to assess whether it is safe to cross a street at a signalized intersection. Many of these involve using auditory cues about the direction of motor vehicle and pedestrian movements. Because these assessments can require some time, it is expected that APS would produce travel time savings; that is, the APS would provide information about the signal status much more immediately, allowing the pedestrian to begin crossing with minimal delay. In some cases, this would eliminate only the time needed for the auditory assessment, while in other cases, the ability to cross immediately with APS would eliminate the need to wait for the next "walk" phase. The study team conducted an illustrative calculation of these savings using data on the population with visual disabilities, average daily trip rates for the walking mode, and other assumptions.

For the purposes of the calculation, it was assumed that APS would yield a 30-second time savings on average per signalized intersection crossing, based on the typical length of signal cycles in urban areas, which is 60 to 90 seconds. This is a rough approximation based on the ability to save part or all of a signal phase when APS is present, as described above. Of course, some pedestrians will save less time with APS because they are already able to cross with minimal delay even without APS, while others may experience greater time savings with APS.

A further assumption was that each affected traveler uses one signalized intersection per one-way walking trip. This parameter will vary greatly across trips of different lengths and in different geographic areas, as some locations have no signalized intersections at all while some central cities have them at intervals of 300 feet or less. As a point of reference, the average walking trip in the U.S. is 0.86 miles,[302] which would equate to approximately 17 Manhattan blocks in the uptown/downtown direction. Thus, although the study team is not able to estimate a precise value for this element, it is highly likely to be between 0 and 20, and 1 may be a conservative value as overall average.

The time savings will be fairly small in the first years after the rule is implemented, as only signals at rehabilitated or added crossings will be affected in any given year. After 25 years, when all signals are assumed to have come up for rehabilitation and been replaced with accessible signals, the savings will be much larger. As there are roughly 3.9 million people aged 18-64 with visual disabilities and 3.1 million people aged 65+ with visual disabilities (per Census data), taking 0.37 or 0.19 walking trips per day per person (respectively for each age group), this is a total of approximately 2 million trips per day that could benefit in the final years of analysis when all signals have become compliant with the final rule.

To appropriately estimate the benefit by year, benefits are appropriately reduced by the percentage increase in APS under the rule versus what would occur in the baseline scenario without the final rule. These values are drawn from the cost analysis for APS and begin at an assumption of 4.9% improved

[302] USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, 2022. Calculated from 2017 National Household Travel Survey.

APS in 2023 and end at an assumption of 90% in the final year of analysis, 2047. This means that only 4.9% of trips are assumed to experience mobility savings in 2023 whereas 90% of trips experience mobility savings in the final year of analysis.

Estimates per day are annualized to yearly values using a factor of 300 days and are monetized using a value of $32.40 per hour, which is USDOT's recommended value for monetizing walking time. Overall, there is an annualized benefit of $64.4 million per year for this benefit category.

Table 63. APS Mobility Benefits (millions)

APS Mobility Benefit	Undiscounted	Discounted, 7%	Discounted, 3%
Total Benefit	$2,243.7	$750.4	$1,453.7
Annualized	$89.7	$64.4	$83.5

6.4.4 On-Street Parking

Every year, a total of 72,745 on-street parallel parking locations are expected to be impacted by the rulemaking, requiring installation of signage and a connection to the pedestrian circulation path (and, in cases where the available right-of-way exceeds the regulation's threshold, larger physical dimensions for the parking space itself). This includes both rehabilitated and added locations; on-street parking impacted by the rulemaking is expected to be added each year increasing the number of impacted parking locations by 0.524%. For this benefit analysis, consistent with the cost analysis, 0.144% of existing noncompliant facilities are made accessible each year.[303]

It is likely that the primary benefit of this provision is improved safety, as persons with disabilities will be safer entering and exiting their vehicles in these accessible on-street parking locations than they would be with a non-accessible space. This is particularly true for the spaces with larger dimensions, but all accessible spaces will also benefit from the reduction in obstructions along the sidewalk adjacent to the accessible parking space. A secondary benefit is that the greater provision of accessible on-street parking spaces will yield travel time savings, as it reduces the average distance between an available accessible parking space and the traveler's ultimate destination. It is challenging to measure the safety impacts directly due to a lack of crash causation data covering these scenarios. As an alternative, the safety and travel time benefits were considered jointly. That is, the analysis models the scenario where a traveler uses an off-street parking facility (garage or lot) because the on-street spaces are not accessible and cannot be safely used, even though the off-street facility is more distant from the trip's endpoint.

The analysis requires an estimate of the number of users of accessible on-street parking. While no direct calculation of the number of users of on-street parking is available, the analysis team assumes each available space would serve three vehicles per day. This is based on approximately ten hours of active use, two hours per vehicle, and an occupancy rate of 60%. The two-hour assumption is based on the prevalence of two-hour limits for many parking spaces, though notably this value will vary by trip maker and municipality. Combined with an estimated 72,745 accessible parking spaces per year, this results in approximately 218,235 daily trips with access to accessible on-street parking in year one, rising to 4.6 million daily trips with access annually after 20 years.[304]

Since standard monetization factors are typically presented in dollars per person-hour, this count of vehicles per day is then multiplied by 1.67, the average vehicle occupancy for automobile trips, to translate the count from vehicles to persons.[305] Notably, travel time savings benefit both the person with

[303] 3.6% x 4% = 0.144%
[304] 72,745 spaces x 3 per day = 218,235 daily trips
[305] NHTS 2017, as cited in USDOT Benefit-Cost Guidance, 2022. https://www.transportation.gov/sites/dot.gov/files/2022-03/Benefit%20Cost%20Analysis%20Guidance%202022%20%28Revised%29.pdf

travel related disability and their travel companions. This yields a total of 364,452 person-trips per day in year one, rising to 7.7 million person-trips per day by year 20. [306][307]

Daily trip-making is then multiplied by 300 to annualize the value. This annualization factor reflects an assumption that Sundays and holidays would have lower travel demand. This yields a total of 109.3 million person-trips annually in year one, rising to 2,299 million person-trips annually in year 20 involving accessible on-street parking per year.

Next, the analysis requires an estimate of per trip time savings. The analysis team assumes a two-minute time savings. This is equivalent to between 280 and 560 feet of additional travel outside a vehicle to access and return to their vehicle, or roughly a quarter to half a block of travel.[308] At two-minutes of time saved per trip, this results in 3.6 million hours in year one and 76.6 million hours of travel time saved per year in year 20.[309]

Finally, the time savings was monetized by applying a value of travel time savings of $33.85 per hour in 2021$, the USDOT recommended value for walking (or similar). This results in an annual undiscounted travel time savings for existing accessible on-street parking of $123.4 million in year one, rising to $2,594.4 million undiscounted in year 20. Table 64 shows the results of the on-street parking mobility benefits analysis over 20 years.

Table 64. On Street Parking Mobility Benefits (millions)

On Street Parking Mobility Benefit	Undiscounted	Discounted, 7%	Discounted, 3%
Total Benefit	$24,196.6	$9,831.2	$16,120.5
Annualized	$1,209.8	$928.0	$1,083.6

6.5 Summary

As previously noted, many benefits of the final PROWAG rule are unable to be quantified, with only some benefits lending themselves to quantification. Table 65 summarizes both the quantitative and qualitative benefits discussed in this section, and Table 66 presents the discounted benefit values by year for the quantified benefits.

306 218,235 trips per day x 1.67 persons/vehicle = 364,452 person-trips
307 364,452 person-trips daily x 300 days = 109.3 million person-trips annually
308 USDOT Discretionary Grant Guidance provides an average 3.2 MPH walking speed. 2 min x 1hr/60min x 1/3.2 MPH x 5280 ft/1 mile= 536 ft. For the lower value in the range, the analysis team assumed a 1.6 MPH speed of travel.
309 16.2 million person-trips x 2 minutes savings x 1 hours/60 minutes = 0.5 million

Table 65. Overall Benefits of PROWAG Rule[310]

Benefit Category	Annualized Value (7% Discount)	Annualized Value (3% Discount)	Qualitative Description
Quality of Life	*Not Quantified*	*Not Quantified*	Journey quality/amenity value from improved facilities; improved connectivity
Induced Trip Making	$14,479.3 million	$19,575.3 million	Previously foregone trips are now possible
Health Benefits from Increased Physical Activity	$0.03 million	$0.04 million	Increased physical activity from new trips reduces mortality risk
Economic Benefits	*Not Quantified*	*Not Quantified*	Increased accessibility of the public right-of-way may improve local economics and increase traffic to local businesses
Safety – General	*Not Quantified*	*Not Quantified*	Many rule elements likely to increase the *perception* of safety, even if crash reduction cannot be quantified
Safety – Roundabouts	$0.09 million	$0.1 million	Reduced pedestrian-vehicle crashes
Mobility – APS	$68.9 million	$83.5 million	Time savings crossing the road
Mobility – On Street Parking	$928.0 million	$1,083.6 million	Time savings from accessible parking
Reduction in Paratransit Costs	*Not Quantified*	*Not Quantified*	If individuals are able to switch from paratransit to pedestrian routes, transit agencies will save operating costs from reduced paratransit operations
Total Quantified Benefit	**$15,476.3 million**	**$20,742.5 million**	**Summed across all quantifiable benefits of the final rule**

[310] Because benefit categories vary in terms of their analysis period, care should be taken when summing across categories for a total benefit—it is recommended to consider the annualized values to account for differences in analysis periods.

Table 66. Quantified Benefits by Year, Discounted at 7%, Values in Million $

Year	Induced Trip Making	Health Benefits from Increased Activity	Safety - Roundabouts	Mobility – APS	Mobility – On Street Parking
2023	$1,240.8	$0.01	$0.06	$7.9	$107.8
2024	$2,178.8	$0.01	$0.06	$14.6	$202.0
2025	$3,070.4	$0.01	$0.06	$20.2	$283.9
2026	$3,846.1	$0.01	$0.06	$24.8	$354.7
2027	$4,516.7	$0.01	$0.05	$28.6	$415.4
2028	$5,092.0	$0.01	$0.05	$31.7	$467.1
2029	$5,581.1	$0.01	$0.05	$34.1	$510.6
2030	$5,992.4	$0.01	$0.05	$36.0	$546.9
2031	$6,333.4	$0.02	$0.06	$37.3	$576.5
2032	$6,611.2	$0.02	$0.06	$38.3	$600.2
2033	$6,832.2	$0.02	$0.06	$38.8	$618.7
2034	$7,002.2	$0.02	$0.06	$39.1	$632.4
2035	$7,126.6	$0.02	$0.05	$39.1	$642.0
2036	$7,210.3	$0.02	$0.05	$38.8	$647.9
2037	$7,257.8	$0.02	$0.04	$38.4	$650.4
2038	$7,273.1	$0.02	$0.04	$37.8	$650.1
2039	$7,259.9	$0.02	$0.04	$37.0	$647.3
2040	$7,221.7	$0.02	$0.04	$36.2	$642.2
2041	$7,161.6	$0.02	$0.04	$35.2	$635.2
2042	$7,082.2	$0.02	$0.03	$34.2	$626.6
2043	$6,986.3	$0.02	$0.03	$33.1	$616.5
2044	$6,876.0	$0.02	$0.02	$32.0	$605.2
2045	$6,753.5	$0.02	$0.02	$30.9	$592.9
2046	$6,620.6	$0.02	$0.02	$29.8	$579.8
2047	$6,479.0	$0.02	$0.02	$28.6	$565.9

7 Equity Impacts

Equity impacts can be an important dimension of regulatory impact analyses. In addition, Executive Order 13985 more specifically requires Federal agencies to assess the equity impacts of their policies and programs.

Equity has many dimensions and definitions of equity can vary, making it difficult to present a definitive assessment. As a starting point, E.O. 13985 refers to it as “the consistent and systematic fair, just, and impartial treatment of all individuals, including individuals that have been denied such treatment.” Persons with disabilities are specifically noted in the Executive Order as a group that has been denied equal treatment. Indeed, as discussed above under the Need for Rulemaking, when enacting the Americans with Disabilities Act, Congress found “the discriminatory effects of architectural, transportation, and communication barriers” to be a continuing problem that “denies people with disabilities the opportunity to compete on an equal basis and to pursue those opportunities for which our free society is justifiably famous, and costs the United States billions of dollars in unnecessary expenses resulting from dependency and nonproductivity.” 42 U.S.C. 12101 (a) (5) and (9). Congress declared that "the Nation's proper goals regarding individuals with disabilities are to assure equality of opportunity, full participation, independent living, and economic self-sufficiency." 42 U.S.C. 12101 (a) (8).

The final rule advances the equity-related goals declared by Congress by eliminating the discriminatory effects of architectural, transportation, and communication barriers in the design and construction of pedestrian facilities in the public right-of-way. The final rule is also important to achieving the benefits of the other parts of the Americans with Disabilities Act. As the House Report for the Americans with Disabilities Act stated, "[t]he employment, transportation, and public accommodation sections . . . would be meaningless if people who use wheelchairs were not afforded the opportunity to travel on and between the streets." H.R. 485, 101st Cong., 2d Sess. 84 (1990).

Equity analysis also considers the distribution of benefits and burdens of a particular policy or action. In this case, the Census data and National Household Travel Survey data cited above indicate that millions of Americans have forms of disability that affect their ability to travel. PROWAG provisions are designed to address the inequities of current infrastructure and ensure that pedestrian travelers with disabilities are able to access jobs and services, and more broadly to participate in the life of their community, on an equal basis. Thus, the primary beneficiaries of the final rule are persons with disabilities. Several provisions do have ancillary benefits to other travelers; for example, accessible pedestrian signals can provide a useful reminder of the status of the walk phase even for pedestrians who do not have vision limitations. In the benefit section above, benefits were calculated primarily for the population of travelers with disabilities, and not enough detailed data were available on other impacts to estimate the share of benefit that would accrue to persons with disabilities.

8 Sensitivity Analysis

8.1 Conservative Benefits

Due to the uncertainty surrounding multiple elements of the induced trip-making benefits, a sensitivity test was conducted using conservative assumptions. The general approach to the benefits and the calculations remains the same, however several input values have been lowered. The changes to the induced trip-making benefits include:

- Reduction in the number of new daily trips for people with travel-limiting disabilities aged 65+ from 0.16 to 0.004 (the value for people aged 18-64)
- Reduction in the value for shopping trips by half to reflect that the source value is several years old and may not consider the increased ease of online shopping
- Reduction in the proportion of medical trips by 75% to provide a very conservative estimate of the number of foregone medical trips

Information on how the calculations are performed is available in Section 6.3.2.

With these adjustments, the total annualized benefit from induced trip-making falls from $14,479.3 million to $295.8 million. This is a significant drop in the total benefit value, however this estimate is still larger than the total annualized costs, and this estimate also does not include the other quantified and qualitative benefit categories.

9 Final Regulatory Flexibility Analysis

The impacts of the proposed guidelines on small governmental jurisdictions with a population of less than 50,000 are discussed below. This information is required by the Regulatory Flexibility Act (5 U.S.C. §603).

9.1 A statement of the need for, and objectives of, the rule

The Access Board's current accessibility guidelines, the 2004 ADA and ABA Accessibility Guidelines, were developed primarily for buildings and facilities on sites. Some of the requirements in the 2004 ADA and ABA Accessibility Guidelines can be readily applied to pedestrian facilities in the public right-of-way, but other requirements are developed specifically for pedestrian facilities in the public right-of-way and address conditions and constraints that exist in the public right-of-way.

The Access Board is required to issue accessibility guidelines by the Americans with Disabilities Act (ADA) (42 U.S.C. §12204) and Section 502 of the Rehabilitation Act (29 U.S.C. §792) to ensure that newly constructed and altered facilities are readily accessible to and usable by pedestrians with disabilities.

9.2 Statement of significant issues raised by public comments in response to the initial RFA

The NPRM received 14 comments from entities considered "small", i.e., government entities with a population under 50,000. In these comments, the most common concern was about the cost of APS, although in at least some instances this was due to a misunderstanding that the final rule requires retrofitting equipment, which is not the case. This final rule applies only to new construction and alterations.

Other comments asked clarifying questions about definitions and the applicability of the proposed rule, and one commentor explicitly supported the proposed rule in its entirety.

The Access Board carefully considered all comments, including those from small government entities, and revised the final rule in light of those comments. No changes were made, however, that solely affect small government entities.

9.3 Response of the agency to any comments filed by the Chief Counsel for Advocacy of the Small Business Administration in Response to the Proposed Rule

No comments were filed by the Chief Counsel for Advocacy of the Small Business Administration in response to the proposed rule.

9.4 Small governmental jurisdictions affected by proposed accessibility guidelines

The number of small governmental jurisdictions with a population less than 50,000 affected by the proposed guidelines is shown in the table below. The total number of jurisdictions with populations under 50,000 is 36,931.

Table 67. Count of Jurisdictions with Population Under 50,000[311]

Governmental Jurisdictions	Population Under 10,000	Population 10,000 to 24,999	Population 25,000 to 49,999
County	687	807	611
Municipal	16,432	1,559	738
Town or Township	14,997	784	316
Total	32,206	3,150	1,665

More than 65 percent of municipal governments (12,701) and almost 75 percent of towns and townships (12,062) have a population of less than 2,500. Many of these small governmental jurisdictions are located in rural areas, which generally do not construct pedestrian transportation networks (e.g., sidewalks, pedestrian street crossings, and pedestrian signals).

In addition, some jurisdictions do not have full responsibility for all rights-of-way within their town or county boundaries, and accordingly would only be affected by this final rule with respect to the right-of-way that is in their purview. For example, in Delaware, North Carolina, and West Virginia, the State DOT is responsible for the management of roadways, which means that small governmental jurisdictions in these states[312] are less likely to be burdened by the final rule, as the State DOTs may be primarily responsible for the affected infrastructure.

9.5 Compliance requirements

The public rights-of-way accessibility guidelines address the design, construction, and alteration of pedestrian facilities in the public right-of-way, including sidewalks, pedestrian street crossings, pedestrian overpasses and underpasses, curb ramps and blended transitions at pedestrian street crossings, pedestrian signals, street furniture (i.e., drinking fountains, public toilet facilities, tables, counters, and benches), pedestrian signs, transit stops and transit shelters for buses and light rail vehicles, on-street parking that is marked or metered, and passenger loading zones. The Section-by-Section Analysis of the preamble describes the proposed accessibility guidelines. Compliance with the proposed accessibility guidelines is not mandatory until they are adopted, with or without additions and modifications, as accessibility standards by other federal agencies. There are no reporting or recordkeeping requirements.

9.6 Significant alternatives which minimize any significant economic impacts on small entities

The regulatory assessment analyzes the following five requirements in the final rule that will have more than minimal impacts on state and local transportation departments:

- Accessible pedestrian signals and pedestrian pushbuttons required when pedestrian signals newly installed or replaced at signalized intersections. Accessible pedestrian signals and pedestrian pushbuttons communicate the information about the WALK and DON'T WALK intervals at signalized intersections in non-visual formats (i.e., audible tones and vibrotactile surfaces) to pedestrians who are blind or have low vision.

[311] Source: US Census Bureau 2017 Census of Governments available at: https://www.census.gov/data/tables/2017/econ/gus/2017-governments.html
[312] There are 90 counties and 821 municipal governments with population under 50,000 per US Census data in these three states.

- Pedestrian activated signals or beacons, or raised crossings at roundabouts with pedestrian street crossings. A roundabout is a circular intersection with yield control at entry, which permits a vehicle on the circulatory roadway to proceed, and with deflection of the approaching vehicle counter-clockwise around a central island. Pedestrian activated signals or beacons, or raised crossings are required at roundabouts with pedestrian street crossings to facilitate crossing by pedestrians who are blind or have low vision. Some small governmental jurisdictions with a population less than 50,000 do construct roundabouts, and accordingly may be affected by this requirement, although they may only construct a small number of roundabouts.
- Accessible shared use paths located in the public right-of-way. The shared use paths requirements that are likely to impose costs include those related to detectable warning surfaces, grade, and trail surface. The existing data suggests that shared use paths in small governmental jurisdictions are not necessarily any more or less compliant than all shared use paths in the U.S., suggesting that this will be an area of costs for small jurisdictions in line with the overall prevalence of shared use paths.
- One curb ramp per street crossing provided at each corner of intersections. Existing guidelines allow for a single diagonal curb ramp serving street crossings; however, the final rule will require two parallel or perpendicular curb ramps. There is no requirement where no pedestrian crossing exists.
- On-street parking must meet minimum thresholds for the number of accessible spaces per block perimeter or other location. On-street parking is typically found along the curbside in retail, office, and mixed-use areas, but it is unknown how common this type of parking is in small governmental jurisdictions.

There are no significant alternatives that will minimize any significant impacts of these requirements on small governmental jurisdictions and achieve the objectives of the ADA, Section 504 of the Rehabilitation Act, and the ABA to eliminate the discriminatory effects of architectural, transportation, and communication barriers in the design and construction of pedestrian facilities in the public right-of-way.

10 Analysis of Other Alternatives Considered

As explained in the preamble to the final rule, consideration of the content of accessibility guidelines for public rights-of-way has been underway for over three decades. In that time, many iterations of these requirements have been considered. The Board here reviews specific alternative approaches considered in this final phase of the rulemaking process. Any references to incremental costs or benefits of the non-selected alternatives are calculated on the same basis as the rest of the document, that is, *as if* PROWAG were adopted by subsequent regulations.

10.1 Use of Engineering Judgment to Determine Installation of Accessible Features

The proposed guidelines incorporated by reference portions of the 2009 edition of the USDOT Federal Highway Administration's (FHWA's) Manual on Uniform Traffic Control Devices (MUTCD), which is the standard for traffic control devices used throughout the United States.

The MUTCD is applied by transportation professionals relying on their engineering judgement to determine when particular transportation features, including accessible features, are warranted (see MUTCD section 1A.09). Because transportation professionals are used to this application of the

MUTCD, many local DOTs understandably submitted comments to the NPRM advocating for provisions allowing reliance on engineering judgment to determine whether a particular accessible feature would be provided.

In its careful consideration of the comments, the Access Board thus contemplated an approach whereby local and state DOTs would use engineering judgment to determine whether an accessible feature would be installed. For example, many local DOTs commented that the Board should allow engineering judgment to determine the installation of accessible pedestrian signals (APS).

Allowing engineering judgment would undoubtedly have resulted in a less costly rule, as some jurisdictions would decline to install accessible features, such as APS, in some percentage of cases where installation would otherwise have been mandatory. However, the Board ultimately concluded that allowing the use of engineering judgment would invite subjective determinations on the need for accessibility. This would result in an uneven application of accessible features in the public right-of-way, perpetuating the current situation where some areas of the country are more accessible than others. To ensure equity for all persons with disabilities throughout the United States who use pedestrian facilities, PROWAG requires mandatory installation of accessible features as specified in its scoping section. In addition, in the final rule, the Board eliminated references to the MUTCD to further clarify the mandatory nature of the requirements. See Preamble, section V(A)(5).

Under this alternative, installations of APS and other features would likely be less than in the selected alternative, reducing both compliance costs and user benefits. As an illustrative calculation, if allowing the use of engineering judgment reduced the adoption of APS by 50% compared to the selected alternative, there would be incremental cost savings of approximately $49.4 million on an annualized basis (7% discount rate). Associated benefits of APS would also be correspondingly lower. However, the Access Board was not able to estimate the incremental benefits and costs of this alternative with any precision due to the very nature of the engineering judgment, which makes it difficult to forecast the actual level of implementation.

10.2 Treatment of Added Facilities

In the proposed rule, the Board identified three types of pedestrian facilities subject to PROWAG: newly constructed facilities, added facilities, and altered facilities. The NPRM specified that newly constructed and added facilities were subject to full compliance with PROWAG (NPRM R201.1; NPRM R202.2), while alterations were expected to comply to the maximum extent practicable where existing physical constraints make it impracticable to fully comply (NPRM R202.3.1).

These three classifications of facilities were carried over from the accessibility guidelines for buildings and sites, where they have been used successfully for many years. 69 FR 44083, 36 CFR Part 1191 (July 23, 2004) and 56 FR 35408 (July 26, 1991). In the proposed rule, “added elements” were to comply with the applicable requirements for new construction (NPRM R202.2). This means that any element added to the public right-of-way would have been required to fully comply with all technical requirements, without regard for any physical constraints.

However, in response to the PROWAG NPRM, the Board received comments from state DOTs and others indicating confusion as to how to distinguish between new, added, and altered facilities in the public right-of-way. In addition, since publication of the NPRM, the Board has regularly received technical assistance inquiries from individuals seeking to determine whether a particular public right-of-way construction project must fully comply with requirements for new construction or is subject to considerations for existing physical constraints for alterations.

In the final rule, “added” facilities are considered alterations, which comply with requirements to the maximum extent feasible where existing physical constraints make compliance technically infeasible (*see* definition of “Alteration” at R104.3; *see also* R202.3). This change, in addition to providing clarity for regulated entities, will result in a less costly rule. Requiring entities to alter developed facilities, such as underground utilities, to fully comply with requirements where a new facility is added to an existing facility would have involved substantial expense in many circumstances. There are thus incremental cost savings relative to the selected alternative, but the magnitude of these savings could not be estimated due to the highly site-specific nature of existing physical constraints and the variability in costs associated with achieving compliance in these settings.

10.3 Crossing Treatments at Roundabouts

As described in more detail below in the Roundabouts section, the final PROWAG rule requires additional treatments at multilane crosswalks at roundabouts to make these complex pedestrian street crossings more accessible to people who are blind or have low vision. While developing the final requirements, the Board considered a regulatory approach requiring additional treatments at *all* crosswalks at roundabouts, including single lane pedestrian crossings. The Board considered this approach because disability rights organizations that commented on the NPRM requested that single lane crossings be covered, and research published since the NPRM was issued indicated that some single lane roundabouts pose challenges to pedestrians with disabilities attempting to cross[313]. A requirement for additional treatments at crosswalks at single lane roundabouts would result in additional costs; an estimated 75 percent of roundabout crossings in the United States are single lane.

Looking specifically at the total costs for pedestrian crossing treatments at roundabouts, the estimated costs for including single lane roundabouts in the final rule at a discount rate of 7% would be $183.3 million over 25 years, or $15.7 million annualized. This is an additional $36.0 million over the entire analysis period, and an additional $3.1 million annualized, relative to inclusion only of multi-lane roundabouts. The coverage of single lane roundabouts would also translate into higher mobility benefits, as pedestrians would experience greater ease of crossing at all roundabouts rather than solely at multilane roundabouts. These mobility benefits could not be estimated due to the limited available information about the crossing challenges associated with single lane roundabouts. Aside from these mobility benefits, the incremental safety benefits were estimated at $3.4 million for a total of $4.5 million in benefits over the entire 25-year analysis period, discounted at 7%.

Upon careful consideration, and in consultation with USDOT, the Access Board concluded that while the limited available research and anecdotal evidence indicates that some single lane crossings at roundabouts pose additional challenges for pedestrians who are blind or have low vision, additional research is needed to identify the specific factors (such as traffic volumes or roundabout geometry) that warrant installation of additional pedestrian treatments at a single lane crossing. Thus, in the final rule, the Board maintains the requirement for additional treatments only at multilane pedestrian crossings at roundabouts. USDOT

[313] David A. Guth et. al., Blind and Sighted Pedestrians’ Road Crossing Judgments at a Single-Lane Roundabout, 55 Human Factors, 632 (June 2013).

plans to undertake research to study the conditions under which single lane crossings at roundabouts present challenges for pedestrians who are blind.

11 Summary and Conclusion

The PROWAG final rule provides technical standards for ensuring that sidewalks, crosswalks, shared-use paths, pedestrian signals, on-street parking, and other pedestrian facilities are accessible under the Americans with Disabilities Act. These technical standards are not legally enforceable until they are adopted by regulation, so there are no direct benefits or costs associated with the adoption of this final rule in itself, only in any future DOJ/DOT rulemakings that are based on PROWAG. However, the estimates in this FRIA have been calculated *as if* PROWAG's provisions were legally binding in order to provide more meaningful information.

In the sections above, this FRIA has identified the need for the PROWAG rule, defined the selected alternative and the baseline, and presented information on the methodology used to calculate compliance costs and associated benefits. This methodology was then applied to estimate the costs and benefits of major PROWAG provisions on a lifecycle basis, relative to a no-action baseline. The FRFA assessed the potential impact of these provisions on small entities, primarily small governmental units.

Table 68 summarizes the quantified cost and benefit estimates that were developed. The document also presents a discussion of potential compliance costs for pedestrian overpasses and underpasses; sidewalk dimensions and materials; handrails; public street toilets; and transit stops and shelters. However, these are not listed in the summary table because they are expected to have little to no overall cost impact relative to the baseline. Similarly, a number of other benefits were identified that could not be monetized using the available data.

As the relevant analysis time periods can vary by provision, the costs and benefits have been converted to annualized equivalents (using a 7% discount rate) to ease comparisons. As the figures indicate, estimated monetized benefits exceed estimated compliance costs by a considerable margin. However, some of the most important benefits of this rule, in the form of equal access to public facilities, personal freedom and independence, and the elimination of accessibility barriers to mobility, are not quantified due to the inherent difficulty in monetizing such impacts.

Table 68. Summary of Estimated Benefits and Costs (2021 dollars).

PROWAG Provision	Annualized Cost / Benefit ($ millions, 7% discounting)	Annualized Cost / Benefit ($ millions, 3% discounting)	Time Period Analyzed (Years)
Detectable Warning	$1.0	$1.0	50
On-Street Parking	$11.4	$17.0	20
Passenger Loading Zones	$1.4	$1.4	20
Accessible Pedestrian Signals	$98.8	$103.6	25
Shared-Use Paths	$43.9	$60.0	15
Pedestrian Overpasses and Underpasses	$0.0	$0.0	30
Sidewalk Width	$0.0	$0.0	50
Roundabouts - Crossings	$12.6	$16.9	25
Roundabouts - Edge Detection	$2.4	$2.8	50
Curb Ramps	$22.0	$30.6	20
Stair Visual Contrast	$0.1	$0.1	50
Crosswalk Cross Slope	$3.0	$3.1	25
TOTAL COSTS	**$196.7**	**$236.5**	**-**

PROWAG Provision	Annualized Cost / Benefit ($ millions, 7% discounting)	Annualized Cost / Benefit ($ millions, 3% discounting)	Time Period Analyzed (Years)
Accessible Pedestrian Signals: Mobility Component	$68.9	$83.5	25
Roundabouts: Safety Component	$0.1	$0.1	25
On-Street Parking: Mobility Component	$928.0	$1,083.6	20
Multiple Provisions: New Trips Value	$14,479.3	$19,575.3	30
Multiple Provisions: Health Benefit	$0.03	$0.04	30
Multiple Provisions: Equality of Access, Personal Freedom, Independence	**Not quantified or monetized**	**Not quantified or monetized**	**-**
TOTAL BENEFITS	**$15,476.3**	**$20,742.5**	**-**

12 Appendices

12.1 Appendix A: Methodology for Estimating Number of Affected Locations and Total Costs: Detectable Warning Surfaces for At-Grade Railroad Crossings

The following data sets were used in estimation:

- BTS NTAD 2015 Crossing Layer linked to FRA Crossing table (12/15) – public at-grade crossings
- BTS NTAD 2015 Railroad Layer
- Census Place 2010 Layer
- Census Block 2010 Group Layer
- ESRI 2014 Street layer
- Sidewalk GIS layers downloaded from public websites (see table below)

Name	State	Source
Atlanta	GA	http://gis.atlantaga.gov/apps/gislayers/
Chapel Hill	NC	http://www.midlandtexas.gov/230/GIS-Data
Denver	CO	http://data.opencolorado.org/tag/gis
Hartford	CT	http://www.hartford.gov/mhis/hartford-gis/available-digital-data
Middletown	CT	
Savannah	GA	http://www.thempc.org/SAGIS/Q_Export/default.htm
Chicago	IL	https://data.cityofchicago.org/Transportation/Sidewalks/77cn-6x4c
Kansas City	KS	https://www.wycokck.org/InternetDept.aspx?id=19356&menu_id=1426
Boston	MA	http://bostonopendata.boston.opendata.arcgis.com/
Cambridge	MA	https://www.cambridgema.gov/GIS/gisdatadictionary/Trans/TRANS_SidewalkCenterlines
Needham	MA	http://www.needhamma.gov/index.aspx?NID=2795
Somerville	MA	https://data.somervillema.gov/browse?category=GIS+data&tags=sidewalks&utf8=%E2%9C%93
Jefferson City	MO	http://www.midmogis.org/
Asheville	NC	http://www.ashevillenc.gov/Departments/ITServices/OnlineServices/mapAsheville.aspx
Lee County/Sanford	NC	http://www.leecountync.gov/Departments/GISStrategicServices/DownloadGISLayers.aspx
Mecklenburg County/Charlotte	NC	http://maps.co.mecklenburg.nc.us/openmapping/data.html
Cincinnati Area	OH	http://cagismaps.hamilton-co.org/cagisportal/mapdata/download
MORPC_MPO/ Columbus	OH	http://www.morpc.org/our-region/data-maps-tools/gis-files/index
Portland	OR	https://library.uoregon.edu/map/gis_data/OR_Cities_Portland_Greater_Area.html
College Station	TX	http://www.cstx.gov/index.aspx?page=3683
Midland	TX	http://www.midlandtexas.gov/230/GIS-Data
Spanish Fork	UT	http://www.spanishfork.org/dept/pubworks/engineering/maps/dataDownload.php
Charlottesville	VA	http://www.charlottesville.org/online-services/maps-and-gis-data/download-gis-data
Bellingham	WA	http://www.cob.org/services/maps/gis

A Python script was developed using the sidewalk GIS layers for several cities and surrounding areas. The GIS layers used are of various resolutions and therefore do not overlay each other exactly (i.e., crossings are not located directly on rail/street intersections). Therefore, several steps in the algorithm were necessary to deal with this issue. The script included the following steps to identify the crossings with sidewalks for each sidewalk layer area.

1. Identify the Census Places that contains each crossing layer. Clip sidewalk, crossing, rail layers to Census Place boundaries to decrease processing time.
2. Create an intersection layer of the railroad – street intersections.
3. Identify which railroad/street intersections are within a certain radius to a sidewalk to create a rail/street intersection with sidewalk layer.
4. Identify at-grade crossings that are within a certain radius of each sidewalk/street /rail intersection located in Step 3. (Layers have different resolution so crossings don't fall exactly on street/rail line intersections).
5. Add block group population density attribute to the crossings with sidewalks from Step 4.
6. Write output by census place to a file including total number of grade crossings, number of grade crossings with sidewalks, census place populations, block group population density.

A table was then created from the output of the test case which lists by census place the percentage of crossings that have sidewalks. The results were manually checked in ArcMap for several Census Places using the input data layers with base map imagery. Because of the difference in data resolution and using sidewalk layers from numerous sources, it was determined that the output averaged 80% accuracy depending on census place and sidewalk layer used.

12.1.1 Crossing with Sidewalk Algorithm

An algorithm was developed to estimate the number of crossings with sidewalks for the whole United States. The crossings with sidewalks identified from the test case were used to determine which crossing variables and variables from other layers could be used to approximate the results. The algorithm was first run on the crossings located in the same census places used for the test case so the results could be compared. The algorithm makes the assumptions listed below for crossings that do not have sidewalks and then the opposite set of crossing were selected to identify the crossings that do have sidewalks.

Variables used to identify crossings without sidewalks:

- Crossing on rural and urban interstates and freeways
- Crossing in development type 'Open Space' and has a block group population density less than 500
- Crossing in development type 'Open Space' and on a rural or urban local road
- Crossing in development type 'Industrial'
- Crossing in development type 'Commercial' and on an urban local road
- Crossing with 'no warning signs or signals', or with 'other signs or signals'
- Crossing in a block group with population density less than 100
- Crossings that are not type 'pedestrian crossing'

The table below shows the comparison of the results of the test case and the results of the final sidewalk algorithm including the percent difference of the results for each census place. The results show that the total percent of crossing with sidewalks for all the census places tested for the test case is 54% and the final algorithm is 50%. Due to the differences in the resolutions of the GIS layers used limiting the accuracy of the output, and the approximation of crossing variables used to estimate the number of crossings with sidewalks, this result is considered an acceptable estimate. The algorithm was then applied to all the at-grade public crossings in the United States to estimate the number and percent of crossings with sidewalks. The results are presented by state in Table 69.

Table 69. Comparison of Test Case and Results of Final Sidewalk Algorithm

Census Place 2010	2010 Population	# Of Crossings	# Of Crossings With Sidewalks: GIS Analysis	% Of Crossing With Sidewalks: GIS Analysis	# Of Crossings: Algorithm	# Of Crossings With Sidewalks: Algorithm	% Of Crossing With Sidewalks: Algorithm	Difference: GIS Vs. Algorithm
Marble Cliff OH	573	1	1	100%	1	1	100%	0%
Valleyview OH	620	1	1	100%	1	1	100%	0%
Cleves OH	3234	1	1	100%	1	1	100%	0%
Obetz OH	4532	1	1	100%	1	1	100%	0%
Lake Darby OH	4592	1	1	100%	1	1	100%	0%
Gladstone OR	11497	1	1	100%	1	1	100%	0%
Mint Hill NC	22722	1	1	100%	1	1	100%	0%
Hilliard OH	28435	1	1	100%	1	1	100%	0%
Dublin OH	41751	1	1	100%	1	1	100%	0%
Brice OH	114	1	1	100%	1	0	0%	100%
Druid Hills GA	14568	2	1	50%	2	2	100%	-50%
Arlington Heights OH	745	2	2	100%	2	2	100%	0%
Woodlawn OH	3294	2	1	50%	2	1	50%	0%
Grandview Heights OH	6536	2	2	100%	2	2	100%	0%
Powell OH	11500	2	2	100%	2	2	100%	0%
Whitehall OH	18062	2	2	100%	2	2	100%	0%
Loveland OH	12081	3	1	33%	3	3	100%	-67%
Glendale OH	2155	3	2	67%	3	3	100%	-33%
Newtown OH	2672	3	2	67%	3	3	100%	-33%
Ashley OH	1330	3	3	100%	3	3	100%	0%
Rossmoyne OH	2230	3	2	67%	3	2	67%	0%
Madeira OH	8726	3	2	67%	3	2	67%	0%
Wilsonville OR	19509	3	2	67%	3	2	67%	0%
Cornelius NC	24866	3	2	67%	3	1	33%	33%
Gresham OR	105594	3	1	33%	3	0	0%	33%
Urbancrest OH	960	3	3	100%	3	2	67%	33%

Census Place 2010	2010 Population	# Of Crossings	# Of Crossings With Sidewalks: GIS Analysis	% Of Crossing With Sidewalks: GIS Analysis	# Of Crossings: Algorithm	# Of Crossings With Sidewalks: Algorithm	% Of Crossing With Sidewalks: Algorithm	Difference: GIS Vs. Algorithm
Canal Winchester OH	7101	3	3	100%	3	2	67%	33%
Aloha OR	49425	4	1	25%	4	4	100%	-75%
Riverdale IL	13549	4	1	25%	4	3	75%	-50%
Chapel Hill NC	57233	4	2	50%	4	4	100%	-50%
Somerville MA	75754	4	1	25%	4	2	50%	-25%
Silverton OH	4788	4	4	100%	4	4	100%	0%
Groveport OH	5363	4	4	100%	4	4	100%	0%
Deer Park OH	5736	4	4	100%	4	4	100%	0%
Oregon City OR	31859	4	2	50%	4	2	50%	0%
Grove City OH	35575	4	4	100%	4	4	100%	0%
Edwardsville KS	4340	4	1	25%	4	0	0%	25%
Pineville NC	7479	4	2	50%	4	1	25%	25%
Pickerington OH	18291	4	4	100%	4	3	75%	25%
Elmwood Place OH	2188	5	5	100%	5	5	100%	0%
Bonner Springs KS	7314	5	1	20%	5	1	20%	0%
Reading OH	10385	5	5	100%	5	5	100%	0%
Matthews NC	27198	5	3	60%	5	3	60%	0%
Davidson NC	10944	5	4	80%	5	3	60%	20%
Hartford CT	124775	6	3	50%	6	3	50%	0%
Worthington OH	13575	6	6	100%	6	4	67%	33%
Norwood OH	19207	6	6	100%	6	3	50%	50%
Blue Ash OH	12114	7	5	71%	7	6	86%	-14%
Lockland OH	3449	7	6	86%	7	6	86%	0%
Sharonville OH	13560	8	2	25%	8	7	88%	-63%
College Station TX	93857	8	3	38%	8	5	63%	-25%
Millersburg OR	1329	8	1	13%	8	0	0%	13%
Pataskala OH	14962	8	8	100%	8	6	75%	25%
Cambridge MA	105162	9	9	100%	9	7	78%	22%
Sherwood OR	18194	10	5	50%	10	7	70%	-20%
Needham MA	28886	10	7	70%	10	8	80%	-10%

Census Place 2010	2010 Population	# Of Crossings	# Of Crossings With Sidewalks: GIS Analysis	% Of Crossing With Sidewalks: GIS Analysis	# Of Crossings: Algorithm	# Of Crossings With Sidewalks: Algorithm	% Of Crossing With Sidewalks: Algorithm	Difference: GIS Vs. Algorithm
Forest Grove OR	21083	10	6	60%	10	6	60%	0%
Charlottesville VA	43475	10	9	90%	10	9	90%	0%
Tigard OR	48035	10	5	50%	10	5	50%	0%
Spanish Fork UT	34691	10	6	60%	10	2	20%	40%
Boston MA	617594	10	7	70%	10	2	20%	50%
Lake Oswego OR	36619	11	3	27%	11	10	91%	-64%
Huntersville NC	46773	11	5	45%	11	9	82%	-36%
Delaware OH	34753	11	10	91%	11	9	82%	9%
Tualatin OR	26054	12	9	75%	12	8	67%	8%
Middletown CT	47648	13	5	38%	13	10	77%	-38%
Bellingham WA	80885	15	13	87%	15	3	20%	67%
Midland TX	111147	16	7	44%	16	10	63%	-19%
Aurora CO	325078	16	4	25%	16	1	6%	19%
Milwaukie OR	20291	17	4	24%	17	14	82%	-59%
Cornelius OR	11869	17	10	59%	17	10	59%	0%
Jefferson City MO	43079	18	5	28%	18	12	67%	-39%
Asheville NC	83393	19	13	68%	19	13	68%	0%
Beaverton OR	89803	21	11	52%	21	18	86%	-33%
Hillsboro OR	91611	22	10	45%	22	17	77%	-32%
Sanford NC	28094	24	9	38%	24	15	63%	-25%
Cincinnati OH	296943	40	26	65%	40	22	55%	10%
Commerce City CO	45913	43	1	2%	43	11	26%	-23%
Albany OR	50158	45	37	82%	45	25	56%	27%
Atlanta GA	420003	48	26	54%	48	33	69%	-15%
Columbus OH	787033	54	44	81%	54	43	80%	2%
Savannah GA	136286	71	32	45%	71	37	52%	-7%
Kansas City KS	145786	76	18	24%	76	3	4%	20%
Portland OR	583776	141	46	33%	141	18	13%	20%
Denver CO	600158	146	83	57%	146	43	29%	27%
Charlotte NC	731424	164	76	46%	164	74	45%	1%
Chicago IL	2695598	271	181	67%	271	165	61%	6%
Average % crossings				67%			68%	

Census Place 2010	2010 Population	# Of Crossings	# Of Crossings With Sidewalks: GIS Analysis	% Of Crossing With Sidewalks: GIS Analysis	# Of Crossings: Algorithm	# Of Crossings With Sidewalks: Algorithm	% Of Crossing With Sidewalks: Algorithm	Difference: GIS Vs. Algorithm
Average % change								-1%
TOTAL % CROSSINGS		**1613**	**873**	**54%**	**1613**	**814**	**50%**	

12.2 Appendix B: Bus Rapid Transit Platforms

Transit System Name	City	State	Listed as BRT in NTD? (Y/N)	Boarding platforms above standard curb height?	DWS provided?	Website	Other Notes / References
Valley Metro	Phoenix	AZ	N	N/A	N/A		BRT is "coming soon:" https://www.valleymetro.org/blog/operations-service/2020/09/phoenix-seeks-input-bus-rapid-transit-system
City of Fresno	Fresno	CA	Y	No	No	https://www.fresno.gov/transportation/fax/fax-q/	Unofficial photos show normal curb height without DWS. https://en.wikipedia.org/wiki/Fresno_Area_Express#/media/File:Fresno_Area_Express_Q_BRT_bus.jpg
Los Angeles County Metropolitan Transportation Authority (LACMTA)	Los Angeles	CA	Y	No	No	https://www.metro.net/about/brt/	Difficult to discern from official website. Unofficial photos show curb-height boarding and no DWS, and TCRP report describes as curb-height. http://la.streetsblog.org/2015/06/05/metro-piloting-fast-convenient-all-door-boarding-on-wilshire-rapid-bus/
Omnitrans	San Bernardino	CA	N	Yes	Yes	https://omnitrans.org/routes/sbx-green-line/	Photos show DWS in place with platforms elevated above curb height for near-level boarding. https://www.itdp.org/2014/04/28/san-bernardinos-new-sbx-green-line-is-latest-example-of-true-brt-in-the-us/
MTS	San Diego	CA	Y	No	No	https://www.sdmts.com/schedules-real-time/rapid	Unofficial photos show curb-level platforms. DWS not present at all locations. https://en.wikipedia.org/wiki/Rapid_(San_Diego)
AC Transit: Tempo	Oakland and San Leandro	CA	N	No	Yes	https://www.actransit.org/tempo	See website for photos. More photos: https://www.masstransitmag.com/bus/article/21149531/ac-transit-begins-service-on-east-bays-first-brt-line
SFMTA: MUNI	San Francisco	CA	N	N/A	N/A	https://www.sfmta.com/project-updates/what-van-ness-bus-rapid-transit	Coming this year: https://www.sfexaminer.com/news/van-ness-avenue-brt-to-finally-begin-service-early-next-year/
San Joaquin RTD BRT Express	Stockton	CA	N	No	No	https://sanjoaquinrtd.com/1/brt-express/	Unofficial photos show boarding at normal curb height. Yellow painted line but not a full DWS. https://twitter.com/SanJoaquinRTD/status/1243309340842287104/photo/1
City of Fort Collins dba Transfort	Fort Collins	CO	Y	No	Yes	http://www.ridetransfort.com/max	Unofficial photos online show low-floor buses with boarding platforms at approximately curb height. DWS are in place. https://en.wikipedia.org/wiki/MAX_Bus_Rapid_Transit_(Colorado)#/media/File:MAX_Bus_Rapid_Transit_(Colorado).JPG

Transit System Name	City	State	Listed as BRT in NTD? (Y/N)	Boarding platforms above standard curb height?	DWS provided?	Website	Other Notes / References
Roaring Fork Transportation Authority	Non-UZA	CO	Y	No	Some	https://www.rfta.com/routes/velocirfta-brt/	Agency photos show curb-height boarding with DWS in place in some locations but not others. https://www.rfta.com/routes/roaring-fork-valley/
Connecticut Department of Transportation (CTTransit)	Hartford	CT	Y	No	Yes	https://www.cttransit.com/services/ctfastrak	Unofficial photos online show low-floor buses with boarding platforms at approximately curb height. DWS are in place. https://en.wikipedia.org/wiki/CT_Fastrak
Central Florida Regional Transportation Authority (LYNX)	Orlando	FL	Y	No	No	https://www.golynx.com/plan-trip/riding-lynx/lymmo/	Unofficial photos online show low-floor buses with boarding platforms at approximately curb height. No DWS. https://commons.wikimedia.org/wiki/File:Lynx_Lymmo_bus_163_(30365230705).jpg https://www.flickr.com/photos/drum118/39451884085
JTA	Jacksonville	FL	Y	No	No	https://fcf.jtafla.com/	Unofficial photos show platforms at curb height with no DWS. https://www.roadsbridges.com/jacksonville-transportation-authority-opens-new-bus-rapid-transit-line
Pace	Chicago	IL	Y	No	No	https://www.pacebus.com/sites/default/files/2020-07/Pace_PulseDEMPT_PM3Exhibits_2018-02-06.pdf	Agency website shows low-floor buses with curb-level stops and stations. No DWS.
Indianapolis and Marion County Public Transportation (IndyGo)	Indianapolis	IN	Y	No	Some	https://www.indygo.net/how-to-ride/	Agency photos show curb-height boarding with no DWS at curbside stop. https://www.indygo.net/how-to-ride/. However, unofficial station photos show DWS present. https://en.wikipedia.org/wiki/Red_Line_(IndyGo)#/media/File:IndyGo_Red_Line_BRT.jpg
Transit Authority of River City (TARC)	Louisville	KY	N	No	No	https://www.ridetarc.org/	Photos without DWS (unspecified TARC bus, may not be BRT): https://www.newsandtribune.com/news/new-tarc-route-to-service-ivy-tech-downtown-louisville/article_5f597045-0790-5f4c-b602-a80bb4189fc3.html
Massachusetts Bay Transportation Authority (MBTA)	Boston	MA	Y	No	No	https://www.mbta.com/schedules/741/line	Uses low-floor buses. Boarding area at normal curb height. See p. 11 of FTA report: https://www.transit.dot.gov/sites/fta.dot.gov/files/FINALBOSTONBRTREPORT062507.pdf

Transit System Name	City	State	Listed as BRT in NTD? (Y/N)	Boarding platforms above standard curb height?	DWS provided?	Website	Other Notes / References
Capital Area Transportation Authority	Lansing	MI	Y	No	Unknown	http://cata-brt.org/	Project suspended as of April 2017. https://www.cata.org/about/bus-rapid-transit
Interurban Transit Partnership (The Rapid)	Grand Rapids	MI	Y	No	Yes	https://www.ridetherapid.org/howtoride/silver-line	Online rider guide notes that platforms match bus entrance height. Photos of stops show yellow DWS surfaces but platforms appear to be normal curb height, not raised. https://www.ridetherapid.org/howtoride/silver-line
Metro Transit	Minneapolis	MN	Y	No	Yes	https://www.metrotransit.org/a-line	How-to-ride video shows stops at normal curb height with DWS provided. https://www.youtube.com/watch?v=RSxgXlKzxv4
Kansas City Area Transportation Authority (KCATA)	Kansas City	MO	Y	No	No	http://www.kcata.org/light_rail_max/max_and_bus_rapid_transit	Official video and unofficial online images show roughly curb-height boarding areas with no DWS. TCRP report describes as normal curb height. Additional online photos show curb-height boarding: https://www.kcata.org/transit-initiatives/prospect_max https://twitter.com/RideKCTransit/status/1276600646083457026/photo/2
NJ Transit (go bus)	Newark	NJ	N	No	No	https://www.njtransit.com/	Describes reduced stops and signal prioritization on one line: https://www.njtransit.com/go28 Photo shows a colored strip that seems to have no texture and thus is not DWS: https://www.flickr.com/photos/davidwilson1949/4985155700
Albuquerque Rapid Transit	Albuquerque	NM	Y	No	Yes	https://www.cabq.gov/transit/art-information	Google Street View shows DWS present at stations. Approximately normal curb height based on slope down to street level. Google Street View - West Central Station
RTC of Washoe County	Reno	NV	N	Yes	Yes	https://www.rtcwashoe.com/public-transportation/rtc-rapid/	Photos and video show platform as slightly higher than nearby curbs, with DWS provided. https://www.masstransitmag.com/bus/infrastructure/press-release/21202540/regional-transportation-commission-of-washoe-county-new-rtc-washoe-county-rapid-transit-station-near-virginia-stplumb-ln-complete https://www.proterra.com/testimonial/reno-rtc/ (e.g., at 1:32 mark)
MTA New York City Transit (NYCT)	New York	NY	Y	No	Yes	http://web.mta.info/mta/planning/sbs/whatis.htm	Called "Select Bus Service." Some unofficial photos show DWS, though still curb height, see e.g., https://www.flickr.com/photos/mtaphotos/10930770364

Transit System Name	City	State	Listed as BRT in NTD? (Y/N)	Boarding platforms above standard curb height?	DWS provided?	Website	Other Notes / References
Capital District Transportation Authority: Bus Plus	Albany and Schenectady	NY	N	No	No	https://www.cdta.org/brt	The website FAQs say, "Accessibility: BusPlus vehicles are low-floor, no-step buses for easy and quick boarding…" Photos on website show standard-looking curbs.
COTA	Columbus	OH	Y	No	No	https://www.cota.com/services/cmax/	Unofficial photos show standard curb height platforms with no DWS. https://upload.wikimedia.org/wikipedia/commons/4/47/Columbus%2C_OH_-_COTA_bus_stop.jpg
Greater Cleveland Regional Transit Authority (GCRTA)	Cleveland	OH	Y	Yes, at stations	Yes, at stations	http://www.riderta.com/healthline/about	Online rider guide has distinction between "stations" (with level boarding) and "curbside stops" (which use bridgeplates/ramps); stations have "tactile pavers that define the station location and platform edges" (DWS). http://www.rtahealthline.com/healthline-how-works-ada.asp
Tulsa Transit	Tulsa	OK	Y	Varies	Varies	https://aerobrt.tulsatransit.org/	Two different station designs, "constrained" and "standard." The former appear to be normal curb height with no DWS, while the latter are slightly elevated beyond curb height and have DWS. Shown in agency diagrams and confirmed in unofficial photos: https://gtrnews.com/tulsa-transit-and-city-of-tulsa-showcase-first-completed-for-the-aero-bus-rapid-transit/
Lane Transit District (LTD)	Eugene	OR	Y	Yes	Yes	http://ltd.org	Official website has little info. Unofficial photos via Wikipedia show elevated boarding area with DWS provided. https://en.wikipedia.org/wiki/Emerald_Express#/media/File:EmX_Hilyard_Station.jpg Other online photos show platforms at normal curb height. For example: https://www.transit.dot.gov/about/news/us-department-transportation-announces-77-million-expand-bus-rapid-transit-service-eugene
Trimet Division Transit Project	Portland	OR	N	N/A	N/A		Will be built 2022
Port Authority of Allegheny County	Pittsburgh	PA	N	N/A	N/A		BRT here is proposed: https://www.portauthority.org/inside-Port-Authority/projects-and-programs/bus-rapid-transit/
Nashville MTA WeGo: BRT lite	Nashville	TN	N	No	No	https://www.wegotransit.com/	Unofficial photos show normal curb height. A DWS is present in some locations but not for full length of platform. https://www.wsmv.com/news/wego-

Transit System Name	City	State	Listed as BRT in NTD? (Y/N)	Boarding platforms above standard curb height?	DWS provided?	Website	Other Notes / References
							bus-crashes-into-another-vehicle-on-nolensville-pike/article_06d93132-efe4-11eb-9327-179cfe18c261.html
CapMetro: MetroRapid	Austin	TX	N	No	Some	https://www.capmetro.org/metrorapid	Example with DWS: https://movabilitytx.org/lets-go-news-blog/training-as-an-intern-during-a-pandemic No DWS: kut.org/transportation/2013-11-12/photos-riding-inside-capital-metros-new-metrorapid-bus Video example showing curb height: https://www.youtube.com/watch?v=mJzsQ51hiA0
Sun Metro: Brio	El Paso	TX	N	No	Yes	http://sunmetrobrio.net/faq.html	Photos of DWS: https://www.masstransitmag.com/bus/press-release/12014445/lockwood-andrews-newnam-inc-sun-metro-and-lan-celebrate-opening-of-rapid-transit-system-in-el-paso Plans for near-level boarding and improved stations: https://sunmetro.net/assets/documents/About/Federal-Agendas/legisagenda1503.pdf
Harris County Metro: Quickline, METRORapid	Houston	TX	N	No	No	https://www.ridemetro.org/Pages/METRORapid.aspx	Photo: https://www.chron.com/news/houston-texas/transportation/article/Buses-do-heavy-work-in-likely-long-range-Houston-13224997.php
VIA Metropolitan Transit: PRIMO	San Antonio	TX	N	No	Some	https://www.viainfo.net/primo_service/	Some photos on the website show DWS, while some show a lack of DWS: https://www.viainfo.net/wp-content/uploads/2019/02/primo.jpg https://www.viainfo.net/readalong_jan2019/via-primo-103/
Utah Transit Authority	Salt Lake City	UT	Y	Yes	Yes	https://www.rideuta.com/Services/Bus-Rapid-Transit	Unofficial photos show platforms slightly higher than curb height with DWS provided. https://www.transit.wiki/File:1uvx.png
Utah Transit Authority: UVX	Provo and Orem	UT	N	Yes	Yes	https://www.rideuta.com/Services/Bus-Rapid-Transit	Appears to be raised beyond curb height: https://www.utahvalley.com/blog/post/5-reasons-to-ride-uvx/
Greater Richmond Transit Company (GRTC)	Richmond	VA	Y	Some	Yes	http://ridegrtc.com/brt/how-to-ride-grtc-pulse/pulse-stations-boarding/	Online rider guide video shows DWS at boarding areas. Some stations have ramps suggesting that the platform is slightly above normal curb height. http://ridegrtc.com/brt/how-to-ride-grtc-pulse/pulse-stations-boarding/

Transit System Name	City	State	Listed as BRT in NTD? (Y/N)	Boarding platforms above standard curb height?	DWS provided?	Website	Other Notes / References
WMATA Metroway	Alexandria	VA	N	No	Some	https://www.wmata.com/service/metroway-video.cfm	Described as “sidewalk-level bus stops”. Photos and videos show boarding area at curb height, with DWS provided in some locations but not others. https://en.wikipedia.org/wiki/Metroway#/media/File:WMATA_Metroway_New_Flyer_XN40.jpg https://www.youtube.com/watch?v=5uQ4iHauaR8 (at 0:54 for location with no DWS, 2:03 for DWS)
Hampton Roads Transit VB Wave	Virginia Beach	Virginia	N	No	No	https://gohrt.com/modes/vb-wave-bayfront-shuttle/	Agency photo shows normal curb height stop with no DWS. https://gohrt.com/modes/vb-wave-bayfront-shuttle/
Clark County Public Transportation Benefit Area Authority (C-Tran)	Vancouver	WA	Y	No	Yes	https://c-tran.com	Project videos show curb-level platforms with detectable warnings. https://c-tran.com/thevine-fourth-plain/vine-faqs
Community Transit	Everett	WA	Y	No	Yes	https://www.communitytransit.org/swiftblue	https://en.wikipedia.org/wiki/Swift_Bus_Rapid_Transit#/media/File:CT_29709_at_Wetmore_Avenue_Swift_station.jpg
King County Metro: RapidRide	Seattle	WA	N	No	Some	https://kingcounty.gov/depts/transportation/metro/travel-options/bus/rapidride.aspx#features	While most photos show no DWS, here is one example: https://auburnexaminer.com/give-your-input-to-king-county-metro-on-future-auburn-rapidride-i-line/ No DWS: https://rapidrideiline.com/
Spokane Transit Authority, City Line	Spokane	WA	N	Yes	Yes	https://citylinespokane.com/#stations	Under construction with opening 2023. Station renderings show DWS present. Boarding platform height is unclear but presence of short ramps and description of “near level boarding” suggest that it may be slightly higher than standard curb height. https://citylinespokane.com/#stations

12.3 Appendix C: Annual Estimates of APS Installations and Costs ($ Millions)

Year	Total Signal-ized Inter-sections	Non-APS Signalized Inter-sections w/ Ped Indication	APS Install-ations: Alterations	APS Install-ations: Added	Total APS Installations	APS Installations: Low-Cost Scenario	APS Installations: High-Cost Scenario	Total Costs	Present Value at 7%
2023	339,109	215,797	8,501	3,635	11,773	7,888	3,885	$101.6	$88.7
2024	340,886	219,119	8,501	3,691	11,823	7,922	3,902	$102.0	$83.3
2025	342,672	222,493	8,501	3,748	11,874	7,956	3,919	$102.5	$78.2
2026	344,467	225,918	8,501	3,806	11,926	7,991	3,936	$102.9	$73.4
2027	346,271	229,396	8,501	3,864	11,979	8,026	3,953	$103.4	$68.9
2028	348,085	232,928	8,501	3,924	12,033	8,062	3,971	$103.8	$64.7
2029	349,909	236,513	8,501	3,984	12,087	8,098	3,989	$104.3	$60.7
2030	351,742	240,155	8,501	4,046	12,142	8,135	4,007	$104.8	$57.0
2031	353,584	243,852	8,501	4,108	12,198	8,173	4,025	$105.3	$53.5
2032	355,437	247,606	8,501	4,171	12,255	8,211	4,044	$105.8	$50.2
2033	357,299	251,418	8,501	4,235	12,313	8,250	4,063	$106.3	$47.2
2034	359,171	255,288	8,501	4,301	12,372	8,289	4,083	$106.8	$44.3
2035	361,052	259,218	8,501	4,367	12,431	8,329	4,102	$107.3	$41.6
2036	362,944	263,209	8,501	4,434	12,492	8,369	4,122	$107.8	$39.1
2037	364,845	267,261	8,501	4,502	12,553	8,411	4,143	$108.3	$36.7
2038	366,756	271,375	8,501	4,572	12,615	8,452	4,163	$108.9	$34.5
2039	368,678	275,553	8,501	4,642	12,679	8,495	4,184	$109.4	$32.4
2040	370,609	279,795	8,501	4,713	12,743	8,538	4,205	$110.0	$30.4
2041	372,550	284,103	8,501	4,786	12,808	8,582	4,227	$110.5	$28.6
2042	374,502	288,477	8,501	4,860	12,875	8,626	4,249	$111.1	$26.8
2043	376,464	292,918	8,501	4,935	12,942	8,671	4,271	$111.7	$25.2
2044	378,436	297,427	8,501	5,010	13,010	8,717	4,293	$112.3	$23.7
2045	380,419	302,006	8,501	5,088	13,080	8,764	4,316	$112.9	$22.3
2046	382,412	306,655	8,501	5,166	13,150	8,811	4,340	$113.5	$20.9
2047	384,415	311,376	8,501	5,245	13,222	8,859	4,363	$114.1	$19.6

12.4 Appendix D: Bridge Design Inventory

State	Source
Alabama	Alabama Structural Design Manual
Alaska	Alaska Bridge Manual
Arizona	Arizona Bridge Design Guidelines
Arkansas	Arkansas Bridge Division Guidelines
California	California Permanent Pedestrian Facilities ADA Compliance Handbook
Colorado	Colorado Bridge Design Manual
Connecticut	Connecticut Bridge Design Manual
Delaware	Delaware Bridge Design Manual
District of Columbia	District of Columbia Design Engineering Manual
Florida	Florida Bike Ped Bridge Guidelines
Georgia	Georgia Bridge and Structures Policy Manual
Hawaii	Hawaii Bridge Management Manual
Idaho	Idaho Bridge Manual
Illinois	Illinois Bridge Manual
Indiana	Indiana Bridge Design Manual
Iowa	Iowa LRFD Bridge Design Manual
Kansas	Kansas Bridge Design Manual
Kentucky	Kentucky Standard Specifications
Louisiana	Louisiana Standard Specifications for Roads and Bridges Manual
Maine	Maine Division General Conditions
Maryland	Maryland Guidelines and Procedures
Massachusetts	Massachusetts Bridge Design Guidelines
Michigan	Michigan Pedestrian Bridge Guidelines
Minnesota	Minnesota LRFD Manual
Mississippi	Mississippi Bridge Design Manual
Missouri	Missouri LRFD Bridge Design Guidelines
Montana	Montana Design Manuals
Nebraska	Nebraska Standard Specifications for Highway Construction
Nevada	Nevada Structures Manual
New Hampshire	New Hampshire Bridge Design Manual
New Jersey	New Jersey Design Manual for Bridges and Structures
New Mexico	New Mexico Pedestrian Facilities Design Manual
New York	New York Bridge Design Manual
North Carolina	North Carolina Bridge Policy
North Dakota	North Dakota Best Practices Guide for Active Public Transportation
Ohio	Ohio Bridge Design Manual
Oklahoma	Oklahoma Standard Specifications for Highway Construction
Oregon	Oregon Bridge Design Manual
Pennsylvania	Pennsylvania Design Manual
Rhode Island	Rhode Island LRFD Bridge Design Manual
South Carolina	South Carolina Bridge Design Manual
South Dakota	South Dakota Bridge Design Manual
Tennessee	Tennessee Accessibility Guidance of Roadway Design Guidelines
Texas	Texas Pedestrian Bridges Considerations
Utah	Utah Structures Design and Detailing Manual
Vermont	Pedestrian and Bicycle Facility Design Manual
Virginia	Virginia Modifications to AASHTO Standard
Washington	Washington Pedestrian Facilities
West Virginia	West Virginia Bridge Design Manual
Wisconsin	Wisconsin Multimodal Ped Guide
Wyoming	Wyoming Bridge Application Manual

12.5 Appendix E: State Sidewalk Design Guidelines

State	Minimum Width (ft.)	Source
Alabama	5	Alabama DOT Standard Drawings
Alaska	4	Alaska DOT Accessible Street Plan
Arizona	5	Arizona DOT Roadway Design Guidelines
Arkansas	5	Arkansas DOT Bike Ped Plan
California	5	California DOT Highway Design Manual
Colorado	4	Colorado DOT Roadway Design Guide
Connecticut	4	Connecticut DOT Highway Standard Details
Delaware	4	Delaware DOT Accessibility Standards
District of Columbia	6	DC DOT Public Space Design Guide
Florida	5	Florida DOT Uniform Minimum Standards
Georgia	5	Georgia DOT Pedestrian and Streetscape Design Guide
Hawaii	5	Hawaii DOT Sidewalks and Walkways Guide
Idaho	5	Idaho DOT Highway Design Guide
Illinois	5 (typical) or 4 (minimum)	Illinois DOT Highway Standards
Indiana	4	Indiana DOT ADA Compliance Regulations
Iowa	4	Iowa DOT Design Manual
Kansas	Width set by cities	Public Law Health Center – KS Sidewalk Liability
Kentucky	5	Kansas DOT Highway Design Memo
Louisiana	5	Louisiana DOT Minimum Design Guidelines
Maine	5	Maine DOT ADA Design Guidance
Maryland	5	Maryland DOT Bicycle and Pedestrian Design Guidelines
Massachusetts	4	Massachusetts DOT Walks and Wheelchair Ramps Design
Michigan	5	Michigan DOT Road Design Manual
Minnesota	5	Minnesota DOT ADA Standards
Mississippi	5	Mississippi DOT Roadway Design Standard Drawings
Missouri	5	Missouri DOT Standard Plans
Montana	5	Montana DOT Road Design Manuel
Nebraska	4	Nebraska DOT Roadway Design Manuel
Nevada	5	Nevada DOT Road Design Guide
New Hampshire	4	New Hampshire DOT Sidewalk Curb Ramp Details
New Jersey	4	New Jersey Administrative Code 5.21-4.5
New Mexico	5	New Mexico ADA Standard Drawings
New York	4	NY DOT Standard Sheets
North Carolina	5	North Carolina DOT Roadway Design Manual
North Dakota	5	North Dakota DOT Best Practices Guide
Ohio	5	Ohio DOT Roadway Design Manual
Oklahoma	4	Oklahoma DOT Standard Revisions
Oregon	6	Oregon DOT Standard Drawings
Pennsylvania	5	Pennsylvania DOT ADA Design Guide
Rhode Island	4	Rhode Island DOT Standard Specifications
South Carolina	5	South Carolina DOT Plan Preparation Guide
South Dakota	5 (typical) or 4 (minimum)	South Dakota DOT Local Roads Plan
Tennessee	5	Tennessee DOT Roadway Standard Drawings
Texas	5	Texas DOT Roadway Design Manual

State	Minimum Width (ft.)	Source
Utah	4	Utah DOT Design Standards
Vermont	5	Vermont DOT Complete Streets Guidance
Virginia	5	Virginia DOT Curb Ramp and Sidewalk Guidelines
Washington	5	Washington DOT Pedestrian Facilities Standards
West Virginia	4	West Virginia DOT Accessibility Standards, Curb Ramps And Sidewalks
Wisconsin	4	Wisconsin DOT Pedestrian Best Practices
Wyoming	5	Wyoming DOT ADA Guidelines for Accessibility

Entity	Low	Mid Value	High	Median	Mean	Unit	Source
Colorado	-	$ 4,250	-	-	-	Recent $	https://www.codot.gov/business/civilrights/ada/curbramps
Ped-Bike Survey	$ 114	$ 950	$ 4,623	$ 950	$ 1,040	2020$	http://www.pedbikesafe.org/pedsafe/countermeasures_detail.cfm?CM_NUM=3
FHWA	$ 800	$ 1,150	$ 1,500	-	-	Unknown	https://safety.fhwa.dot.gov/saferjourney1/library/countermeasures/03.htm
Virginia - New Curb Ramp	$ 2,534	$ 2,788	$ 3,041	-	-	2020$	https://www.virginiadot.org/projects/resources/NorthernVirginia/AppendixL_PlanningLevelCostEstimate.pdf
Virginia - Replace Existing	$ 3,451	$ 3,796	$ 4,141	-	-	2020$	https://www.virginiadot.org/projects/resources/NorthernVirginia/AppendixL_PlanningLevelCostEstimate.pdf
New Jersey	-	$ 1,500	-	-	-	2020$	https://www.dvrpc.org/TAP/NJ/pdf/2020-Design-Treatment-Typical-Costs.pdf
Pennsylvania	-	$ 6,007	-	-	-	2020$	https://www.penndot.gov/ProjectAndPrograms/RoadDesignEnvironment/Documents/ADAbooklet--7-14-15-lowres.pdf
Caltrans	$ 54	$ 1,412	$ 6,300			2021$	https://sv08data.dot.ca.gov/contractcost/results.php?item=curb+ramp&ob=0&DISTRICT%5B%5D=01&DISTRICT%5B%5D=02&DISTRICT%5B%5D=03&DISTRICT%5B%5D=04&DISTRICT%5B%5D=05&DISTRICT%5B%5D=06&DISTRICT%5B%5D=07&DISTRICT%5B%5D=08&DISTRICT%5B%5D=09&DISTRICT%5B%5D=10&DISTRICT%5B%5D=11&DISTRICT%5B%5D=12&Year%5B%5D=y2021&Year%5B%5D=y2020&min=&max=&minU=&maxU=&unit=none&start=Search

12.6 Appendix F: Curb Ramp Cost Estimates

12.7 Appendix G: Review of States' Curb Ramp Guidelines

State	New Construction - Compliant	Alteration - Compliant	Source
Alabama	Yes	Yes	https://alletting.dot.state.al.us/Docs/Standard_Drawings/2020%20English/61800.pdf
Alaska	Best Practice	Best Practice	https://dot.alaska.gov/creg/design/highways/Submittals/ADA/ADACurbRampSurveyInstructions_Final_2018.pdf; https://dot.alaska.gov/stwddes/dcsprecon/stddwgspages/intersect_eng.shtml

State	New Construction - Compliant	Alteration - Compliant	Source
Arizona	Best Practice	Best Practice	https://azdot.gov/sites/default/files/media/2021/01/2021-roadway-design-guidelines.pdf
Arkansas	Yes	Yes	https://www.ardot.gov/wp-content/uploads/2021/10/ADA-TP_Current.pdf
California	Yes	Yes	https://dot.ca.gov/-/media/dot-media/programs/design/documents/hdm-complete-12312020a11y.pdf
Colorado	Yes	Yes	https://www.codot.gov/business/designsupport/bulletins_manuals/cdot-roadway-design-guide-2018/cdot-rdg-2018
Connecticut	Yes	Yes	https://portal.ct.gov/DOT/Highway-Standard-Drawings/Highway-Standard-Details
Delaware	Yes	Yes	https://deldot.gov/Publications/manuals/pedestrianAccessibility/pdfs/2018/PedestrianAccessibilityStandardsFinal-2018-02-19.pdf
Florida	Yes	Yes	https://www.fdot.gov/docs/default-source/roadway/ds/13/idx/00304.pdf
Georgia	Yes	Yes	http://www.dot.ga.gov/PartnerSmart/DesignManuals/TrafficOps/GDOT%20Pedestrian%20and%20Streetscape%20Guide.pdf
Hawaii	Best Practice	Best Practice	https://hidot.hawaii.gov/administration/files/2013/01/curbrampdetails-r03-02-11.pdf; https://health.hawaii.gov/dcab/files/2016/02/DCAB-2011-07-Curb-Ramps.pdf
Idaho	Yes	Yes	https://apps.itd.idaho.gov/apps/manuals/roadwaydesign/files/Roadwaydesignprintable.pdf; https://itd.idaho.gov/wp-content/uploads/2021/03/ITD_ADA_Transition_Plan.pdf
Illinois	Yes	Yes	https://idot.illinois.gov/Assets/uploads/files/About-IDOT/Laws-&-Rules/Accessible%20Public%20ROW%20Field%20Guide%20January%202016.pdf
Indiana	Yes	Yes	https://www.in.gov/dot/div/contracts/standards/GIFE/SECTION%2022.pdf
Iowa	Yes	Yes	https://iowadot.gov/design/dmanual/12a-02.pdf
Kansas	Yes	Yes	http://kcmetro.apwa.net/EventDetails/7472; https://kcparks.org/wp-content/uploads/2013/03/ARB.pdf; https://kcparks.org/wp-content/uploads/2013/03/ARA.pdf
Kentucky	Best Practice	Best Practice	https://transportation.ky.gov/Highway-Design/Memos/Design%2004-06.PDF; https://transportation.ky.gov/Construction/Construction%20Memos/CM%2019-06.pdf
Louisiana	No	No	http://www.dotd.la.gov/Inside_LaDOTD/Divisions/Administration/LPA/Training_Bid_Development/Road%20Design%20Manual%20Chaps%205%20and%208.pdf
Maine	Best Practice	Best Practice	https://www1.maine.gov/mdot/civilrights/docs/ada/ADA_Design_Guidance_1-24-18.pdf; https://www.maine.gov/mdot/civilrights/ada/docs/2019/June2019UpdatedADA_TransitionPlanFinal.docx
Maryland	Yes	Yes	https://www.roads.maryland.gov/ohd/adafinal.pdf
Massachusetts	Yes	Yes	https://www.mass.gov/files/documents/2018/09/17/MunicipalResourcesGuideForWalkability_2018-08-24.pdf
Michigan	Yes	Yes	https://www.michigan.gov/documents/mdot/MDOT_2017_September_Monthly_Update_602216_7.pdf
Minnesota	Yes	Yes	http://www.dot.state.mn.us/ada/pdf/curbramp.pdf

State	New Construction - Compliant	Alteration - Compliant	Source
Mississippi	Yes	Yes	https://mdot.ms.gov/documents/Roadway%20Design/Standards/Manuals/2020%20Roadway%20Design%20Manual.pdf
Missouri	Yes	Yes	https://www.modot.org/sites/default/files/documents/Std_Plans_07_01_2020.pdf
Montana	Yes	Yes	https://www.mdt.mt.gov/other/webdata/external/cadd/RDM/50-RDM-COMPLETE.pdf; https://www.mdt.mt.gov/other/webdata/external/civilrights/ADA-TRANSITION-PLAN.pdf
Nebraska	Yes	Yes	https://dot.nebraska.gov/media/11085/s-february-2016-chap-16-ada-2-7-18.pdf
Nevada	Yes	Yes	https://www.dot.nv.gov/home/showpublisheddocument/16066/636830795175970000
New Hampshire	Yes	Yes	https://www.nh.gov/dot/org/administration/ofc/documents/ada-titleII-transition-plan.pdf
New Jersey	Yes	Yes	https://www.nj.gov/transportation/eng/documents/BDC/pdf/BDC19MR-02Attachment.pdf: https://www.nh.gov/dot/org/projectdevelopment/highwaydesign/detailsheets/documents/curb_ramp_details.pdf
New Mexico	Yes	Yes	https://realfilef260a66b364d453e91ff9b3fedd494dc.s3.amazonaws.com/d2332175-2f36-43ad-9fb8-aee4a93aa201?AWSAccessKeyId=AKIAJBKPT2UF7EZ6B7YA&Expires=1646228070&Signature=8ehUUsNTBY6TAeVFaw8BiuC8UJs%3D&response-content-disposition=inline%3B%20filename%3D%222019%20ADA%20Transition%20Plan.pdf%22&response-content-type=application%2Fpdf
New York	Yes	Yes	https://www.dot.ny.gov/main/business-center/engineering/cadd-info/drawings/standard-sheets-us-repository/608-01_050116.pdf
North Carolina	No	No	https://connect.ncdot.gov/projects/Roadway/RoadwayDesignAdministrativeDocuments/Standard%20Drawings%20for%20Curb%20Ramps%20and%20Handicap%20Access.pdf
North Dakota	Best Practice	Best Practice	https://www.dot.nd.gov/plans/statewide/docs/BestPracticesGuideForActivePublicTransportation.pdf
Ohio	Yes	Best Practice	https://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Location%20and%20Design%20Manual/Entire%20Manual.pdf#page=130
Oklahoma	Yes	Yes	https://www.odot.org/roadway/roadway2009/R-22.pdf
Oregon	Yes	Yes	https://www.oregon.gov/odot/Forms/2ODOT/7345184.pdf
Pennsylvania	Yes	Yes	https://www.dot.state.pa.us/public/Bureaus/design/ADA/PocketGuide.pdf; https://www.dot.state.pa.us/public/Districts/district6/ADA/District_6-0_ADA_Guidance_Document.pdf
Rhode Island	Best Practice	Best Practice	https://www.dot.ri.gov/documents/about/civilrights/ADA_Transition_Plan.pdf: http://www.dot.ri.gov/documents/doingbusiness/RIDOT_Highway_Design_Manual.pdf
South Carolina	No	No	https://falcon.scdot.org/falconwebv4/default.aspx?cmd=logon&hiddenLogon=1
South Dakota	No	No	https://dot.sd.gov/media/documents/localroadsplan.pdf

State	New Construction - Compliant	Alteration - Compliant	Source
Tennessee	Yes	Yes	https://www.tn.gov/content/dam/tn/tdot/roadway-design/documents/instructional-bulletins/2018/IB_18_12.pdf; https://www.tn.gov/content/dam/tn/tdot/roadway-design/documents/instructional-bulletins/2018/IB_18_12.pdf
Texas	Yes	Yes	https://ftp.txdot.gov/pub/txdot-info/ocr/ada/ada-goals-fy2017.pdf; http://onlinemanuals.txdot.gov/txdotmanuals/rdw/cross_sectional_elements.htm#BGBIEJHH; http://onlinemanuals.txdot.gov/txdotmanuals/rdw/rdw.pdf
Utah	Yes	Yes	https://www.udot.utah.gov/main_old/uconowner.gf?n=20556913162367857
Vermont	Yes	Yes	https://vtrans.vermont.gov/sites/aot/files/civilrights/documents/ada/VTrans2020ADATransitionPlanUpdate.pdf
Virginia	Yes	Best Practice	https://www.virginiadot.org/business/resources/LocDes/RDM/Appenda1.pdf
District of Columbia	Yes	Yes	https://ddot.dc.gov/sites/default/files/dc/sites/ddot/publication/attachments/2017-06-30_DDOT_DEM.pdf
Washington	Yes	Best Practice	https://www.wsdot.wa.gov/publications/manuals/fulltext/M22-01/design.pdf
West Virginia	Yes	Yes	https://transportation.wv.gov/highways/engineering/Documents/Publications%20Committee%20Meeting/DD%20811%202016-08-17%20Accessibility%20Standard,%20curb%20ramps%20and%20sidewalks%20Complete.pdf
Wisconsin	Yes	Yes	https://wisconsindot.gov/Documents/projects/multimodal/ped/guide-chap5.pdf
Wyoming	Yes	Yes	https://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Project%20Development/WYDOT-ADA-GUIDELINES-FOR-ACCESSIBILITY-2017-1.pdf

12.8 Appendix H: Review of Select Cities within States without Policy Consistent with PROWAG Curb Ramp Guidelines

City	State	New Construction - Compliant	Alteration - Compliant	Source
Anchorage	Alaska	Best Practice	Best Practice	[No relevant results found]
Phoenix	Arizona	Best Practice	Best Practice	[No relevant results found]
Tucson	Arizona	Best Practice	Best Practice	[No relevant results found]
Mesa	Arizona	Yes	Yes	https://www.mesaaz.gov/Home/ShowDocument?id=23132
Chandler	Arizona	Yes	Yes	https://www.chandleraz.gov/sites/default/files/documents/imported/UDM_TDM4.pdf

City	State	New Construction - Compliant	Alteration - Compliant	Source
Scottsdale	Arizona	Yes	Yes	https://www.access-board.gov/prowag/planning-and-design-for-alterations/chapter1/
Glendale	Arizona	Best Practice	Best Practice	[No relevant results found]
Gilbert	Arizona	Yes	Yes	https://www.gilbertaz.gov/home/showdocument?id=33273
Tempe	Arizona	Best Practice	Best Practice	https://www.tempe.gov/home/showdocument?id=50461
Honolulu City	Hawaii	Best Practice	Best Practice	https://health.hawaii.gov/dcab/files/2018/10/DCAB-2011-07_Curb_Ramps_Amended_Ruling.pdf
Lexington	Kentucky	Best Practice	Best Practice	[No relevant results found]
New Orleans	Louisiana	Yes	Yes	https://www.nola.gov/getattachment/DPW/ADA-Transition-Plan/CNO-DPW-PROW-ADA-Transition-Plan-2-27-2013-DRAFT.pdf/
Baton Rouge	Louisiana	Yes	Yes	https://www.brla.gov/DocumentCenter/View/6456/ADA-Public-Outreach-12-18-18-PDF
Shreveport	Louisiana	Yes	Yes	https://library.municode.com/la/shreveport/codes/unified_development_code?nodeId=ART13SURE
Portland	Maine	Yes	Yes	https://www.portlandmaine.gov/DocumentCenter/View/27259/Portland-Maine-Signal-Policy-Guidance_FINAL_02-2020
Charlotte	North Carolina	Yes	Yes	https://charlottenc.gov/ld/CLDSM/Documents/FIELD%20ADA%20CHECKLIST%20portrait%20-%20Rev5.pdf
Raleigh	North Carolina	Yes	Yes	https://cityofraleigh0drupal.blob.core.usgovcloudapi.net/drupal-prod/COR16/T-20.01.8.pdf
Greensboro	North Carolina	No	No	[No relevant results found]
Durham	North Carolina	Yes	Yes	https://www.durhamnc.gov/DocumentCenter/View/3432/Section-60-Standards-and-Guidelines-PDF
Winston-Salem	North Carolina	Yes	Yes	https://www.cityofws.org/DocumentCenter/View/3057/5---Bicycle-and-Pedestrian-Element-PDF
Fayetteville	North Carolina	No	No	https://www.fayettevillenc.gov/Home/Components/News/News/12579/
Cary	North Carolina	No	No	[No relevant results found]
Fargo	North Dakota	Best Practice	Best Practice	[No relevant results found]
Providence	Rhode Island	Best Practice	Best Practice	http://www.providenceri.gov/wp-content/uploads/2018/12/2018-08-29-City-Walk-Phase-1-Report-Resubmission-With-Cover.pdf
Charleston	South Carolina	No	No	[No relevant results found]
Sioux Falls	South Dakota	Yes	Yes	https://www.siouxfalls.org/public-works/engineering/construction-mgmt/resources/design-standards/design-stds/chapter16

12.9 Appendix I: Additional Parking Data

Town/City	Metered On-Street Spaces (2016 review)	2010 Population	Metered Spaces per 1K Pop. (2016)	Metered On-Street Spaces (2021 review)	2020 Population	Metered Spaces per 1K Pop. (2021)	2016 Source	2021 Source
San Francisco	25,000	805,235	31	28,800	873,965	33	http://sf.streetsblog.org/2010/03/29/san-francisco-first-city-in-the-nation-to-count-its-parking-spaces/	SF MTA https://www.sfmta.com/press-releases/sfmta-completes-citywide-census-street-parking-spaces
New York	81,875 (all meters)	8,175,133	10	N/A (47,000 single space meters but no count of multi-space)	8,804,190	N/A	http://www.streetsblog.org/2011/03/22/new-york-has-81875-metered-parking-spaces-and-millions-of-free-ones/	https://letsgotonyc.com/nyc-parking-meters-and-parking-cards/
Cambridge, MA	3,100	105,162	29	3,100	118,403	26	https://www.cambridgema.gov/traffic/Parking	https://www.cambridgema.gov/traffic/parking
Chicago	36,000	2,695,598	13	36,000	2,746,388	13	http://chicagometers.com/	https://parkchicago.com/
Washington, DC	17,000	601,723	28	18,000	689,545	26	http://ddot.dc.gov/page/parking-meters	https://ddot.dc.gov/page/parking-meters
Phoenix	2,000	1,445,632	1.4	2,000	1,608,139	1.2	https://www.phoenix.gov/streets/parking-meters	https://www.phoenix.gov/streets/parking-meters
Houston	9,200	2,099,451	4	9,200	2,304,580	4	http://www.houstontx.gov/parking	https://www.houstonpermittingcenter.org/parkhouston

Naperville, IL	0	141,853	0	0	149,540	0	http://www.naperville.il.us/downtownparking.aspx	https://www.naperville.il.us/about-naperville/transportation-and-parking/downtown-parking/
Lebanon, NH	0	13,151	0	0	14,282	0	http://www.vnews.com/home/19032823-95/paying-for-parking-takes-a-toll	https://www.vnews.com/Lebanon-Disusses-Parking-Meters-18010503
Nantucket, MA	0	10,172	0	0	14,255	0	http://www.nantucket-ma.gov/DocumentCenter/View/5528	https://www.nantucket-ma.gov/DocumentCenter/View/1195/Downtown-Parking-Study?bidId=
McMinnville, OR	0	32,187	0	0	34,319	0	http://courts.oregon.gov/Yamhill/pages/driving_and_parking.aspx	https://www.mcminnvilleoregon.gov/police/page/parking-enforcement-services

12.10 Appendix J: Crosswalk Cross Slope Standards by State

State	**Existing Policy Matches PROWAG?**	**Source**
Alabama	No	Alabama DOT Standard Drawings
Alaska	Yes	Alaska DOT Accessible Street Plan
Arizona	No	Arizona DOT Roadway Design Guidelines
Arkansas	No	Arkansas DOT Bike Ped Plan

California	No	California DOT Highway Design Manual
Colorado	Yes	Colorado DOT Roadway Design Guide
Connecticut	No	Connecticut DOT Highway Standard Details
Delaware	Yes	Delaware DOT Accessibility Standards
District of Columbia	No	DC DOT Public Space Design Guide
Florida	Yes	Florida DOT Uniform Minimum Standards
Georgia	No	Georgia DOT Pedestrian and Streetscape Design Guide
Hawaii	Yes	Hawaii DOT Sidewalks and Walkways Guide
Idaho	No	Idaho DOT Highway Design Guide
Illinois	No	Illinois DOT Highway Standards
Indiana	Yes	Indiana DOT ADA Compliance Regulations
Iowa	Yes	Iowa DOT Design Manual
Kansas	No	Public Law Health Center – KS Sidewalk Liability
Kentucky	Yes	Kentucky DOT Highway Design Memo
Louisiana	No	Louisiana DOT Minimum Design Guidelines
Maine	No	Maine DOT ADA Design Guidance
Maryland	No	Maryland DOT Bicycle and Pedestrian Design Guidelines
Massachusetts	Yes	Massachusetts DOT Walks and Wheelchair Ramps Design
Michigan	No	Michigan DOT Road Design Manual

Minnesota	Yes	Minnesota DOT ADA Standards
Mississippi	No	Mississippi DOT Roadway Design Standard Drawings
Missouri	Yes	Missouri DOT Standard Plans
Montana	Yes	Montana DOT Road Design Manuel
Nebraska	Yes	Nebraska DOT Roadway Design Manuel
Nevada	Yes	Nevada DOT Road Design Guide
New Hampshire	Yes	New Hampshire DOT Sidewalk Curb Ramp Details
New Jersey	Yes	Design Manual Roadway Section 5 (state.nj.us)
New Mexico	Yes	New Mexico ADA Standard Drawings
New York	Yes	NY DOT Standard Sheets
North Carolina	No	North Carolina DOT Roadway Design Manual
North Dakota	Yes	North Dakota DOT Best Practices Guide
Ohio	No	Ohio DOT Roadway Design Manual
Oklahoma	Yes	Oklahoma DOT Standard Revisions
Oregon	Yes	Oregon DOT Standard Drawings
Pennsylvania	Yes	Pennsylvania DOT ADA Design Guide
Rhode Island	No	Rhode Island DOT Standard Specifications
South Carolina	No	South Carolina DOT Plan Preparation Guide
South Dakota	No	South Dakota DOT Local Roads Plan

Tennessee	Yes	Tennessee DOT Roadway Standard Drawings
Texas	Yes	Texas DOT Roadway Design Manual
Utah	Yes	Utah DOT Design Standards
Vermont	Yes	Vermont DOT Complete Streets Guidance
Virginia	Yes	203_04-Default (virginiadot.org)
Washington	Yes	Washington DOT Pedestrian Facilities Standards
West Virginia	Yes	West Virginia DOT Accessibility Standards, Curb Ramps And Sidewalks
Wisconsin	Yes	Wisconsin DOT Pedestrian Best Practices
Wyoming	Yes	Wyoming DOT ADA Guidelines for Accessibility