Preliminary Investigation

Caltrans Division of Research, Innovation and System Information

Trees on Non-Recoverable and Non-Transversable Slopes: Survey of State Practice

Requested by
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Executive Summary

Background

AASHTO and Federal Highway Administration (FHWA) define the clear recovery zone (CRZ) for recoverable foreslopes as an unobstructed, relatively flat (4:1 or flatter) or gently sloping area beyond the edge of traveled way that affords the driver of errant vehicles the opportunity to regain control. Definitions of the CRZ vary among states.

Caltrans is interested in learning about the practices and requirements of other state departments of transportation (DOTs) with respect to new and existing trees beyond the CRZ, specifically on foreslopes between 4:1 and 3:1 (considered to be non-recoverable slopes) and steeper than 3:1 (considered to be non-traversable slopes). Caltrans would like to know whether other agencies' practices and policies for such slopes differ from those regarding trees within the CRZ.

To assist in this information-gathering effort, CTC & Associates conducted a brief survey of state DOTs to gather information about their guidance, policies and practices with respect to trees on non-recoverable and non-transversable slopes. Publications provided by survey respondents and the results of a limited literature search supplemented survey findings.

Summary of Findings

Survey of State Practice

An email survey of members of several AASHTO committees gathered information about state practices and requirements with respect to trees beyond the CRZ, specifically on non-recoverable and non-traversable slopes. Fifteen states provided 16 responses to the email survey. (We received two responses from Minnesota.)

Removal or Mitigation Requirements for Existing Trees

Respondents most often reported a case-by-case approach when asked about their removal or mitigation requirements for existing trees. Some agency guidelines provide minimum clearances and prescribe an extension of the clear zone under certain conditions. Two agencies require removal of trees on non-recoverable and non-traversable slopes, and five agencies reported no formal policy or guidance that is not specific to slopes.

The table below summarizes the general requirements or practices reported by respondents. Details of each practice appear on page 6 of this Preliminary Investigation.

Removal or Mitigation Requirements for Existing Trees	
Type of Requirement or Practice	**State**
Removal recommended	Illinois, Maine, Michigan
Removal or mitigation recommended on a case-by-case basis	Arkansas, Hawaii, Louisiana, Minnesota 1, Minnesota 2, Ohio

Removal or Mitigation Requirements for Existing Trees	
Type of Requirement or Practice	**State**
Removal required	New Jersey, North Dakota
No formal policy or no guidance specific to slopes	Idaho, Indiana, Nebraska, Nevada, Wisconsin

Planting Requirements for New Trees

Planting requirements and limitations for new trees planted at the limits of or beyond the CRZ varied among respondents. Responding agencies are almost equally likely to limit new plantings in these areas as to allow such plantings. A few agencies reported the same policy for new and existing trees in these locations.

The table below summarizes the general requirements or practices reported by respondents. Details of each practice appear on page 10 of this Preliminary Investigation.

Planting Requirements for New Trees	
Type of Requirement or Practice	**State**
Same policy as for existing trees	Indiana, Maine, New Jersey
New plantings limited	Arkansas, Illinois, North Dakota, Ohio
New plantings allowed	Hawaii, Louisiana, Michigan, Minnesota 1, Minnesota 2, Nebraska
No formal policy	Idaho, Nevada, Wisconsin

Policy Differences

Respondents were asked whether agency practices and policies associated with new and existing trees at the limits of or beyond the CRZ differed from requirements regarding trees within the CRZ. Most respondents reported policy differences. The table that appears on page 13 of this Preliminary Investigation, which highlights agencies' clear zone requirements, can be used to compare CRZ requirements with agency practices associated with non-recoverable and non-transversable slopes.

Basis for Agency Requirements

More than half of the respondents cited the AASHTO Roadside Design Guide as providing the basis for agency requirements with regard to new and existing trees at the limits of or beyond the CRZ; a few agencies reported on state guidance. The Indiana DOT respondent noted that the agency's participation in an International Society of Arboriculture workshop has prompted discussion of tree risk assessment within the agency.

Guidance Documents

Most respondents provided the publications that govern their agencies' management of trees beyond the CRZ. Citations for these publications appear in Appendix A and include state codes, landscape maintenance manuals, road design manuals and memoranda with regard to the clear zone and vegetation management.

Related Resources

The results of a limited literature search supplemented the guidance documents provided by survey respondents.

National Guidance

In addition to the AASHTO Roadside Design Guide that is cited by many survey respondents as the foundation for current management of trees beyond the CRZ, we highlight other national guidance addressing roadside tree management. Included is a project in progress by the National Cooperative Highway Research Program (NCHRP) that will propose guidance for fixed objects; the guidance will be included as a new chapter in a future edition of the Roadside Design Guide.

State Guidance and Related Resources

Publications from California, Iowa, Missouri and Wisconsin related to the area within the clear zone and beyond supplement the guidance documents provided by survey respondents.

Other Research

Other research includes recent journal articles addressing tree planting and crash risk, a 2011 Wisconsin DOT publication that provides roadside grading guidance, and a 2009 South Carolina DOT report that evaluated collision data and roadside clear zone requirements. In a 2005 publication, researchers examined the crash severity of fixed roadside objects on the state highway system in Washington.

Gaps in Findings

Some respondents provided few details of agency practice, and the survey received responses from less than one-third of all state DOTs. Additional contacts may garner information from other state agencies to assist Caltrans in its consideration of how trees are managed on non-recoverable and non-transversable slopes. The survey did not gather information about the possible challenges associated with agency practice or potential changes to current practice. Such an inquiry may provide useful information.

Next Steps

Moving forward, Caltrans could consider consulting with the responding agencies to learn more about current practices and any associated challenges. Caltrans may also wish to conduct an in-depth examination of guidance documents to fill in details not provided in survey responses, and consult with state DOTs not responding to the survey to gather more examples of agency practices and guidance.

Detailed Findings

Survey of State Practice

Survey Approach

We distributed a brief survey to state departments of transportation (DOTs) to gather information about practices and requirements with respect to new and existing trees beyond the clear recovery zone (CRZ), specifically on foreslopes between 4:1 and 3:1 (considered to be non-recoverable slopes) and steeper than 3:1 (considered to be non-traversable slopes).

Note: AASHTO and FHWA define the CRZ for recoverable foreslopes as an unobstructed, relatively flat (4:1 or flatter) or gently sloping area beyond the edge of traveled way that affords the driver of errant vehicles the opportunity to regain control. Individual states' definitions for the CRZ vary.

Survey recipients were selected from the member lists of the following committees of the AASHTO Subcommittee on Design:

- Technical Committee on Geometric Design (14 states).
- Technical Committee on Environmental Design (14 states).
- Twenty-nine states not otherwise included in the above.

AASHTO committee members responded to the following questions by email:

1. For *existing* trees at the limits of or beyond the CRZ (on non-recoverable slopes between 4:1 and 3:1, and on non-traversable slopes greater than 3:1), what are your agency's removal or mitigation requirements?

2. For *new* trees in such locations, what are your agency's planting requirements (such as setback distances on roadsides from freeways/expressways and conventional highways) and limitations (such as tree trunk diameter at maturity or within 10 years)?

3. Do practices and policies described in your answer to questions 1 and 2 differ from your agency's requirements regarding trees within the CRZ?

4. Please provide attachments or links to online guidance or requirements.

5. Upon what research or data are such requirements based? Please provide data, calculations or citations, if possible.

Please feel free to provide any other comments on this topic.

Summary of Survey Results

Fifteen states responded to the email survey:

- Arkansas.
- Hawaii.
- Minnesota (two responses).
- Nebraska.

- Idaho.
- Illinois.
- Indiana.
- Louisiana.
- Maine.
- Michigan.
- Nevada.
- New Jersey.
- North Dakota.
- Ohio.
- Wisconsin.

Below is a summary of survey responses in these topic areas:

- Removal or mitigation requirements for existing trees.
- Planting requirements for new trees.
- Policy differences.
- Basis for agency requirements.
- Guidance documents.

Removal or Mitigation Requirements for Existing Trees

When asked about removal or mitigation requirements for existing trees at the limits of or beyond the CRZ, respondents described requirements and practices in these general categories:

- Removal recommended.
- Removal/mitigation recommended on a case-by-case basis.
- Removal required.
- No formal policy/no guidance related to slopes.

The table below summarizes survey responses.

Removal or Mitigation Requirements for Existing Trees

Type of Requirement or Practice	State	Description of Requirement or Practice
Removal recommended	Illinois	• *Parallel front slopes steeper than 1V:4H but 1V:3H or flatter:* Recommend a clear run-out area beyond the toe of the non-recoverable foreslope. The width of the non-recoverable front slope is not to be counted as part of the clear run-out width. • Additional agency provisions address trees that are “undesirable” because they are within the clear zone.
	Maine	The agency requires a clear run-out area beyond the toe of non-recoverable slopes and normally removes trees from these slopes and the run-out area beyond.

Removal or Mitigation Requirements for Existing Trees		
Type of Requirement or Practice	**State**	**Description of Requirement or Practice**
Removal recommended	Michigan	• The agency recommends removal of existing isolated trees generously beyond the clear zone of non-recoverable slopes. • Freeway guidelines call for a 50-foot minimum clearance from the roadway. Clear run-out is provided where feasible for non-recoverable slopes. • Strong consideration is given for removing or relocating trees that are located at or near the toe of a non-recoverable slope despite being beyond the clear zone. • For barn roof slopes, the clear zone is extended to include the non-recoverable portion to a minimum of 10 feet past the recoverable slope.
Removal or mitigation recommended on a case-by-case basis	Arkansas	If a tree inside the right of way (ROW) but outside the clear zone does not restrict sight distance or pose a maintenance risk, the district engineer may allow it to stay. If the tree is a safety risk, removal is recommended.
	Hawaii	• Mitigation or disposition plans are developed for all tree removals regardless of slopes. • The Outdoor Circle[1] typically requires a 1:1 mitigation plan, which includes location, size and species for replacement trees.
	Louisiana	The agency removes trees or provides positive protection if there is a performance issue.
	Minnesota 1	• Removal is recommended if the tree is structurally deficient and could cause harm to a vehicle or pedestrian. • The agency mitigates for vegetation based on U.S. Environmental Protection Agency regulation or if there are endangered species that require mitigation of plant material.
	Minnesota 2	Action is dependent on the situation (maintenance, preservation or reconstruction). All situations are subject to the same roadside design guidance (essentially the AASHTO Roadside Design Guide as restated in the agency's Road Design Manual, subject to judgment). Action is dependent on project scope, purpose/need and significance of the tree.
	Ohio	The agency does not have a policy governing trees beyond the clear zone unless they are a safety concern, dead and within the fall zone of the roadway, or restricting sight distance.

Removal or Mitigation Requirements for Existing Trees		
Type of Requirement or Practice	**State**	**Description of Requirement or Practice**
Removal required	New Jersey	*Non-recoverable slopes (between 4:1 and 3:1):* Require a clear run-out area, free of fixed objects (including trees), beyond the toe of the non-recoverable fill slope. *Slopes greater than 3:1 (critical slopes):* May warrant a guide rail, depending on the height of the slopes. If guide rails are not warranted, the critical slopes and clear run-out area are required to be free of fixed objects including trees. *Case-by-case:* Remove sick and diseased trees that are beyond reasonable repair, along with dead tall trees that may fall onto the roadway, 10 feet beyond the clear zone.
	North Dakota	*Rural projects:* Remove any obstructions, including trees within the clear zone on 3R (resurfacing, reconditioning and reconstructing), new or reconstruction projects. *For 3:1 slopes within the clear zone:* Remove all obstructions within the 3:1 slope and the recovery area, including trees. *Note*: If trees are removed within the agency ROW, they are not mitigated unless they are located along a riparian corridor and mitigation is requested by a resource agency such as North Dakota Game and Fish Department.
No formal policy or no guidance specific to slopes	Idaho	While the agency does not have a policy associated with non-recoverable and non-transversable slopes, Idaho state code related to the removal of traffic hazards provides requirements for the sight triangle at intersections that are more restrictive than AASHTO guidance.[2]
	Indiana	The agency does not make vegetation management distinctions based on slopes but on the basis of Vegetation Management Zones.[3]
	Nebraska	Some districts engage a contractor annually to remove trees at intersections and within 30 feet from the roadway (on most foreslopes, non-recoverable and non-traversable).
	Nevada	The agency does not have a policy or criteria requiring removal of existing trees beyond the clear zone.
	Wisconsin	The agency has no written policy, instead advising staff to keep fixed objects out of the area at the toe of the slope. Staff is also reminded to look for and review hazards beyond the clear zone and consequence of collision.[4]

1 From The Outdoor Circle's web site (https://www.outdoorcircle.org/): The Outdoor Circle is a statewide environmental nonprofit that works with branches throughout the Hawaiian Islands to

protect Hawai'I's unique natural beauty for future generations through community improvement projects, public education and advocacy.

2 Idaho Code Ann. §49-221, Removal of traffic hazards, 2017; see https://legislature.idaho.gov/statutesrules/idstat/title49/t49ch2/sect49-221/.

3 Indiana DOT's vegetation management guidelines are organized around the following Vegetation Management Zones that "have been established to define the required level of maintenance at various locations within the right of way":

> **Zone 1: Vegetation Free.** All pavement and aggregate surfaces within the right of way shall be free of all vegetation in order to facilitate drainage, visibility and aesthetics.
>
> **Zone 2: Clear Zone.** The area extending from the edge of pavement to thirty (30) feet shall be free of woody vegetation and all broadleaf weeds in order to accommodate vehicle recovery, sight distances of intersections, merging traffic, wildlife and signs, and aesthetics. Areas protected by guardrails, see Selective Zone.
>
> **Zone 3: Selective Zone.** The area extending from the edge of the Clear Zone to an additional fifty (50) feet (a total of eighty (80) feet from the edge of pavement shoulder/road surface) shall be kept free of noxious and invasive species, as well as tall-growing trees (maximum mature height of greater than 30 feet), in order to promote healthy and native vegetation and minimize maintenance costs. The area also includes sections protected by guardrail.
>
> **Zone 4: Natural Zone.** The area beyond the Selective Zone (eighty (80) feet) extending to the limits of the right of way shall be kept free of noxious or invasive species to promote healthy and native vegetation, minimize maintenance costs, improve aesthetics and provide screening of the right of way.
>
> **Zone 5: Bridge Zone.** The area adjacent to and under a bridge structure from 100 feet beyond the expansion joint and extending outward to 8 feet behind the ditch line shall be free of woody vegetation and broadleaf weeds in order to maintain the integrity of the bridge structure as well as accommodate drainage and bridge inspection.
>
> **Zone 6: Environmental Zone.** The area[s] that have special maintenance requirements due to environmental concerns. These areas will be delineated by special signage and shall require approval from INDOT's Environmental Services Division Manager or designee prior to any maintenance activity processing. Examples of special zones are retention basins, mitigated watershed, [and] native and wetland plantings.

The agency considers trees beyond the CRZ to be located in zones 3 and 4; see Attachment B for these guidelines.

4 Wisconsin DOT's Facilities Development Manual provides the following description of *consequence of a collision* (see page 13 of the PDF available at http://wisconsindot.gov/rdwy/fdm/fd-11-45-att.pdf#fd11-45-2a2.5):

> Consequence of collision deals with hazards that can generate serious crash outcomes. Many of the hazards that fall into this category are not frequently encountered along the roadway. (Overhead sign, sign bridges and light poles would be the exception to this general rule.) Consequence of a collision may not be associated with police crash reports.
>
> Some collisions, regardless of speed, will have dire consequences for vehicle occupants. Some examples are: vehicle falls off a cliff; vehicle hits a hazardous chemical tank.
>
> Some collisions may have negative consequences to others using a transportation network. Some examples are: dropping an overhead sign on to a roadway; dropping a light pole into an area of heavy pedestrian concentration.
>
> Some collisions may have negative consequences for a whole community. Some examples are: vehicle enters an electrical sub-station; vehicle hits a major gas valve.

Provide additional effort to improve roadside design in locations where consequence of collision is severe. Efforts to improve roadside design include: clear zone improvements, hazard removals, use of breakaway hardware, modifying existing barrier systems, installing a new barrier system of the same type or installing a completely different barrier system. In some cases, consequence of a collision could lead a designer to install a barrier system when normally a barrier system would not be required.

Planting Requirements for New Trees

Respondents were asked about planting requirements and limitations such as setback distances and tree trunk diameter at maturity for new trees planted at the limits of or beyond the CRZ. They described requirements and practices in these general categories:

- Same policy as for existing trees.
- New plantings limited.
- New plantings allowed.
- No formal policy.

The table below summarizes survey responses.

Planting Requirements for New Trees

Type of Requirement or Practice	State	Description of Requirement or Practice
Same policy as for existing trees	Indiana	• The agency follows the same policy used for existing trees unless protected by guardrail or reduced speed zone (thereby reducing the CRZ), which might be the case in a cloverleaf interchange or similar area. • Planting designs are reviewed prior to approval to ensure compliance.
	Maine	The agency follows the same clear zone guidelines as for existing trees: Anything with a trunk diameter exceeding 4 inches would be considered a potential deadly fixed object.
	New Jersey	The same policy is applied for new and existing trees: On non-recoverable slopes (between 4:1 and 3:1), the agency requires a clear run-out area, free of fixed objects (including trees), beyond the toe of the non-recoverable fill slope.
New plantings limited	Arkansas	Typically, the agency does not allow new tree plantings in the highway ROW. A city may be permitted to plant trees on the highway ROW within the city limits, with agency approval of the tree type and the city accepting responsibility for tree maintenance.
	Illinois	Woody plants normally should not be planted on the foreslope or in ditches even if outside the clear zone.

Planting Requirements for New Trees		
Type of Requirement or Practice	**State**	**Description of Requirement or Practice**
New plantings limited	North Dakota	• Trees are only to be planted outside the clear zone on rural highway projects. (It is rare that the agency plants trees within the ROW on a rural project.) • There is no set distance from the roadway and no limitation on trunk diameter at maturity. • If trees are planted, they are typically planted on the backslope near the ROW.
	Ohio	Excerpts from the agency's Roadside Safety Landscape Guidelines: (see page 36 of this Preliminary Investigation for the citation for these guidelines) Trees and large shrubs shall not be planted within 30 feet of the edge of the traveled way on clear zone graded sections. Low maintenance flowers, ground covers and other plants 18 inches or less in height at maturity may be located within this setback area as long as adequate sight distance is provided. Trees and other plants taller than 18 inches may be located beyond this setback distance with the following restrictions: • These plants shall not be located on foreslopes. • These plants shall not be located within a ditch or on a backslope within 10 feet of the ditch flowline.
New plantings allowed	Hawaii	All new tree plantings must be out of the clear zone regardless of the slope. When planting on steeper slopes apply industry standard to plant slope-stabilizing species (not a formal policy but standard practice).
	Louisiana	Trees may be planted or remain within the 50-foot clear distance or the 30-foot clear ramp area when protected by guardrail.
	Michigan	New trees are preferably located beyond the clear zone to the extent practicable. Agency guideline for freeway clearance is 50 feet.
	Minnesota 1	• The agency uses AASHTO guidelines for clear zones to determine the minimum setback distance for trees with a trunk diameter of 4 inches or greater. • Each situation is reviewed to determine if these areas need further consideration, based on sight lines or other potential hazards, or if they can be planted because of protections such as guardrails or J barriers to prevent cars from leaving the road.

Planting Requirements for New Trees		
Type of Requirement or Practice	**State**	**Description of Requirement or Practice**
New plantings allowed	Minnesota 2	• The agency recommends not placing new trees at or beyond the edge of the clear zone; instead, planting is recommended at a discrete distance outside the clear zone, subject to site specifics and judgment. • This recommendation applies to any tree that would grow to a 4-inch caliper diameter or greater.
	Nebraska	• The agency includes plantings on a limited number of projects, generally in urban areas. If planted, the landscape would be beyond a setback of 35 to 40 feet. • Plantings would be on back slopes or in areas that are set back from the roadway. • The agency has no policy limitations on the diameter of the trunk.
No formal policy	Idaho	While the agency does not have a policy associated with non-recoverable and non-transversable slopes, Idaho state code related to the removal of traffic hazards provides requirements for the sight triangle at intersections that are more restrictive than AASHTO guidance.[1]
	Nevada	The agency has no policy that formally restricts any planting beyond the clear zone. The agency does recognize that clear zone distances are not exact, and it develops planting plans considering clear zone, location and design speed. For example, the agency would avoid planting a large-diameter tree just outside of the clear zone on a 70 mph Interstate, but would allow planting it near interchange ramp terminals where speeds are lower.
	Wisconsin	The agency has no written policy for new plantings beyond the CRZ.

1 Idaho Code Ann. §49-221, Removal of traffic hazards, 2017; see https://legislature.idaho.gov/statutesrules/idstat/title49/t49ch2/sect49-221/.

Policy Differences

Respondents were asked whether agency practices and policies associated with new and existing trees at the limits of or beyond the CRZ differed from requirements regarding trees within the CRZ.

The table below summarizes survey responses.

Note: Most respondents reported policy differences for managing trees within the CRZ as compared to trees located on non-recoverable and non-transversable slopes. The table below that highlights agencies' clear zone requirements can be used to compare these requirements with the practices associated with non-recoverable and non-transversable slopes highlighted in the previous two tables.

Policy Differences for Trees on Non-Recoverable/Non-Transversable Slopes and Within the Clear Recovery Zone

Type of Requirement or Practice	State	Description of Requirement or Practice
Policy differences (clear zone requirements noted)	Arkansas	The agency does not allow trees within the clear zone.
	Indiana	Parts of trees extending into clear zone areas are trimmed to a minimum clear height of 17.5 feet. *Note*: This guidance is not specific to non-recoverable and non-transversable slopes. Instead, the agency uses Vegetation Management Zones; see page 9 of this Preliminary Investigation for more information about these zones.
	Michigan	• New trees are located outside the clear zone regardless of tree size. • Existing shrubs or trees with diameters of 4 inches or less at 4feet 6 inches above ground level may be retained. • Consideration is given for adverse effects to endangered species, historic value and roadside character. • Judgment is used with regard to practicable risk mitigation in the presence of continuous tree lines. Crash history is also a factor. Except as previously described, trees retained in the clear zone are shielded.
	Minnesota 1	Within the clear zone, the agency does not plant any material that will reach a trunk diameter greater than 4 inches at breast height.
	Nebraska	The agency does not "build landscape" within the fixed or horizontal clear zone.
	Nevada	Agency policy permits only small, ornamental, brush-type plants inside the clear zone.
	New Jersey	*Freeways and Interstate routes:* Trees may not be located within the clear zone. *Land service state highways:* Although providing a clear zone free of trees is desirable, in some cases, removing trees within the clear zone may not be possible.[1]

Policy Differences for Trees on Non-Recoverable/Non-Transversable Slopes and Within the Clear Recovery Zone		
Type of Requirement or Practice	**State**	**Description of Requirement or Practice**
Policy differences (clear zone requirements noted)	North Dakota	City projects have included trees within the clear zone and grass boulevard or grass median. While the agency discourages this practice when the local city street is part of the state highway system, the agency does allow the city to plant trees if requested because of the limited amount of ROW available in an urban corridor.
	Ohio	*High-volume roadways:* Large trees (greater than 4 inches in diameter) are removed.
Staff determination	Wisconsin	The agency requires staff to identify hazards within the clear zone and then determine what actions should be taken.
No policy differences	Hawaii, Illinois, Maine	N/A
No response	Idaho, Louisiana	N/A

1 See below for a representation of Table 8-2 from the NJDOT Roadway Design Manual. This table provides guidance for the location of new plantings within the clear zone on Interstate highways, freeways and land service state highways. See page 34 of this Preliminary Investigation for a citation for the publication containing this table.

Table 8-2	
Guidance for Landscape Plantings	
Interstate and Freeways	**Land Service State Highways**
No plantings in median areas except for glare screen	Plantings in median area will be limited to flowers and/or small shrubs, unless for glare screen
No plantings in clear zone except for flowers (no shrubs)	Plantings in clear zone will be limited to flowers and small shrubs
Plantings behind guide rail shall be at least: • 8’ minimum for shrubs* • 10’ minimum for shade trees* • 14’ minimum for evergreen trees*	Plantings behind guide rail shall be at least: • 6’ minimum for shrubs and shade trees* • 10’ minimum for evergreen trees*
No plantings within the roadside recovery area (see 8-3.3) except flowers	No plantings within the roadside recovery area (see 8-3.3) except flowers
No plantings within the sight triangle on curves and ramps	No plantings within the sight triangle on curves and ramps
On curves and ramps, plantings shall be placed at least 2’ from the sight triangle for shrubs and shade trees and 10’ for evergreen trees	On curves and ramps, plantings shall be placed at least 2’ from the sight triangle for shrubs and shade trees and 6’ for evergreen trees

Table 8-2	
Guidance for Landscape Plantings	
Interstate and Freeways	**Land Service State Highways**
No planting of trees above underground utility lines	No planting of trees under aerial facilities or above underground utility lines and service connections

* Measured from back of guide rail post.

Basis for Agency Requirements

Respondents were asked about the research or data used to support agency requirements with regard to new and existing trees at the limits of or beyond the CRZ. More than half of the respondents cited the AASHTO Roadside Design Guide as providing the basis for agency requirements. The Indiana DOT respondent noted that the agency's participation in an International Society of Arboriculture workshop has prompted discussion of tree risk assessment within the agency.

The table below summarizes survey responses.

Note: When a respondent reported state guidance as the basis for agency requirements or practice, the publication title is noted below. Full citations for these publications appear in Appendix A. A complete list of all publications provided by respondents appears in the next section of this Preliminary Investigation, **Guidance Documents**.

Basis for Agency Requirements	
AASHTO Roadside Design Guide	Illinois, Louisiana, Maine, Minnesota[2], Nebraska, Nevada, New Jersey, Ohio
Other guidance	Minnesota (Planning and Management of Roadside Vegetation)
Under review	Indiana (discussion of tree risk assessment)
N/A or no response	Arkansas, Hawaii, Idaho, North Dakota

1 One of the Minnesota DOT respondents noted that while the agency relies on guidance found in Chapter 10 of AASHTO's Roadside Design Guide (RDG), "our practice on urban streets is evolving and in discussion here. The RDG is not specific on [the] exact approach or on street type and design speed, so we're in the position of having to develop our own guidance to an extent."

The second Minnesota DOT respondent noted that the agency reviews each case where there are non-recoverable or non-traversable locations and evaluates the need for any of the following:

- Living snow fences for snow and ice control.
- Screening of neighborhoods.
- Habitat for different species of animals.
- Erosion control.

Guidance Documents

Respondents were asked to provide the publications that govern management of trees beyond the CRZ. A list of the publications provided by respondents is provided below; full citations for each publication are provided in Appendix A.

State Codes

- Idaho: Idaho Code Ann. § 49-221, Removal of traffic hazards.

Manuals and Other Agency Guidance

- Hawaii: Highway Manual for Sustainable Landscape Maintenance.
- Illinois: Bureau of Operations Maintenance Policy Manual; Bureau of Design and Environmental Manual.
- Indiana: Design Manual; Operation Memorandum.
- Louisiana: Policy for Roadside Vegetation Management (Vegetation Management).
- Maine: Engineering Instruction (Clear Zone).
- Michigan: Road Design Manual.
- Minnesota: Maintenance Manual; MnDOT Road Design Manual.
- Nevada: Road Design Guide.
- New Jersey: NJDOT Roadway Design Manual.
- North Dakota: Design Manual.
- Ohio: Location and Design Manual.
- Wisconsin: Facilities Development Manual.

Related Resources

The citations below are organized in three categories:

- National guidance.
- State guidance and related resources.
- Other research.

National Guidance

In addition to the AASHTO Roadside Design Guide that is cited by many survey respondents as the foundation for current management of trees beyond the CRZ, we highlight below other national guidance addressing roadside tree management. Included is a project in progress by the National Cooperative Highway Research Program (NCHRP) that will propose guidance for fixed objects; the guidance will be included as a new chapter in a future edition of the Roadside Design Guide.

Roadside Design Guide, AASHTO, 4th Edition, 2011.
https://bookstore.transportation.org/collection_detail.aspx?ID=105
From the summary:

> The *Roadside Design Guide* presents a synthesis of current information and operating practices related to roadside safety and is written in dual units—metric and U.S. Customary.
>
> The guide is intended to be used as a resource document from which individual highway agencies can develop standards and policies. It includes a synthesis of current information and operating practices related to roadside safety. It focuses on safety treatments that can minimize the likelihood of serious injuries when a motorist leaves the roadway. This guide was written for use by design engineers and professionals involved in roadside safety and is considered a significant [tool] that combines current research with practical experience.
>
> Chapter 3 discusses the clear-zone concept. It gives some relative clear-zone values from which design guidance may be derived, as well as examples of the application of the clear-zone values.

Related Resource:

> **Research in Progress: Proposed Guidance for Fixed Objects in the *Roadside Design Guide***, NCHRP Project 17-82. Project status listed as pending; the contractor has not yet been selected.
> http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4201
> From the project summary:
>
> > The objectives of this research are to develop an evaluation methodology and guidance for use by the transportation engineering practitioner to quantify the relative risk of collisions with roadside fixed objects. The research results are intended for inclusion as a new chapter or supplement in a future edition of the *Roadside Design Guide*.
> >
> > The results should address a broad range of roadside safety issues considering but not limited to: traffic volume; speed; crash severity; urban and rural land use; horizontal curvature; roadway geometrics; fixed-object type, size, and offset; and fixed-object

density. The effectiveness of various mitigation strategies in lieu of removal or relocation should also be considered or evaluated.

Noteworthy Practices: Roadside Tree and Utility Pole Management, Federal Highway Administration, 2016.
https://safety.fhwa.dot.gov/roadway_dept/countermeasures/safe_recovery/clear_zones/fhwasa16043/index.cfm#toc
From the abstract:

> Crashes involving roadside trees and utility poles are the most prevalent among fatal, run-off-road, fixed object crashes. Nevertheless, these two obstacles remain among the least-treated on the roadside. As such, comprehensive research is both needed and frequently proposed in this area. This report is intended to provide agencies with examples of successful—immediately deployable— tree and pole practices until such time as this research can be performed. These practices range from complex, multi-million dollar contract solutions to in-house efforts that can be accomplished with minimal resources, and have been drawn from every region of the United States as well as from previous research.

Clear Zone and Horizontal Clearance, Design Standards, Federal Highway Administration, November 2015.
https://www.fhwa.dot.gov/programadmin/clearzone.cfm
This web page provides high-level questions and answers about clear zones and horizontal clearances.

Crash Modification Factors Clearinghouse, Federal Highway Administration, Office of Safety Programs, undated.
http://www.cmfclearinghouse.org
This searchable web-based clearinghouse may provide useful research and practices related to this topic.

A Guide for Addressing Collisions with Trees in Hazardous Locations, NCHRP Report 500, Volume 3, 2003.
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v3.pdf
This guide provides strategies that can be employed to reduce the number of run-off-the-road crashes with trees.

Related Resource:

Appendix 6: Components of a Planting Guideline, A Guide for Addressing Collisions with Trees in Hazardous Locations, NCHRP Report 500, Volume 3, 2003.
http://safety.transportation.org/htmlguides/trees/app06.htm
From Appendix 6, “Accounting for Sideslopes”:

> The design and condition of the sideslopes have an impact on the offset to large trees. The steepness of the sideslopes determines if a slope is recoverable or not, (slopes steeper than 4:1 are non-recoverable). Exhibit 6-1 shows a schematic of a row of trees planted (or the tree line) on a non-recoverable slope. The distance of the offset is of little importance in this case because the vehicle will travel to the row of trees or the bottom of the slope. The shoulder in this schematic includes a paved and unpaved section, but the two are not wide enough to provide an adequate recovery area for the hypothetical situation. Refer to the *Roadside Design Guide* for recommended clear zone distances in these situations.

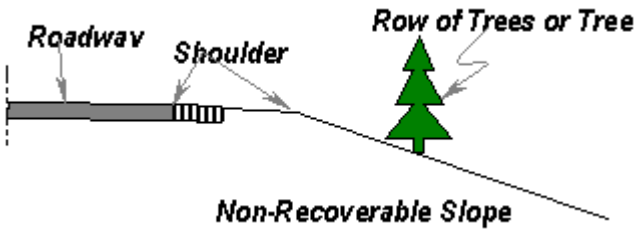

Exhibit 6-1. Non-recoverable Slopes Guide Errant Vehicles into Trees Planted on Them

State Guidance and Related Resources

To supplement the guidance documents provided by survey respondents, we highlight below publications from California, Iowa, Missouri and Wisconsin related to the clear zone and the area just beyond it.

California

Chapter 300: Geometric Cross Section, Highway Design Manual, Caltrans, December 2015.
http://www.dot.ca.gov/hq/oppd/hdm/pdf/english/chp0300.pdf
Section 309.1, Horizontal Clearances for Highway, provides minimum desirable CRZs of 30 feet for freeways and expressways and 20 feet for conventional highways. Planting of new trees is addressed in Chapter 900.

Chapter 900: Landscape Architecture, Highway Design Manual, Caltrans, December 2016.
http://www.dot.ca.gov/hq/oppd/hdm/pdf/english/chp0900.pdf
Section 902.2 addresses sight distance and CRZ standards for freeways and expressways.

Chapter 7: Traffic Safety Systems, Traffic Manual, Caltrans, January 2012.
http://www.dot.ca.gov/trafficops/safety-devices/docs/Clear-Recovery-Zone-Concept.pdf
Topic 7-02 further addresses Caltrans' CRZ concept.

Trees and Highway Safety, Preliminary Investigation, Caltrans, March 2010.
http://www.dot.ca.gov/research/researchreports/preliminary_investigations/docs/tree_safety_pi_3-18-10.pdf
This synthesis report addresses practice and research as of 2010 and includes a survey of 28 states conducted for Caltrans as well as an Ohio DOT survey regarding clear zones in urban areas.

Iowa

Clear Zones, Chapter 8: Safety Design, Design Manual, Iowa Department of Transportation, 2017.
http://www.iowadot.gov/design/dmanual/08a-02.pdf
Among other state guidance, this publication is noteworthy in two respects: its discussion of design clear zones versus provided clear zones, and its provision for vertical clear zones.

Missouri

231.2 Clear Zones, Engineering Policy Guide, Missouri Department of Transportation, last modified 2012.
http://epg.modot.mo.gov/index.php?title=231.2_Clear_Zones
From the web site:

> The clear zone width is to be applied with good judgment. If an obstacle lies just beyond the clear zone, it is to be removed or shielded if costs are reasonable. Conversely, the clear zone is not to be obtained at all costs. Limited right of way or high construction costs may lead to the installation of a barrier or possibly no protection at all.

Wisconsin

Chapter 7: Roadside Management, Highway Maintenance Manual, Wisconsin Department of Transportation, July 2015.
http://wisconsindot.gov/Documents/doing-bus/local-gov/hwy-mnt/mntc-manual/chapter07/07-10-00.pdf
Section 5.0, Shrub and Tree Removal Outside the Clear Zone, provides detailed guidance in subsection 5.2, Tree Removal:

2. Living trees shall be removed only if one or more of the following conditions exist:
    - The tree is located in the clear zone.
    - The tree obstructs vision because it is located on the inside of a curve, at an intersection, or at a private entrance.
    - The tree is located on the south side of a roadway and causes continuous shade and an icy spot on an otherwise clear roadway.
    - The tree is at or beyond maturity or is of a species likely to fall or splinter onto the roadway during storms.
    - Two or more trees are in close proximity to each other and impeding satisfactory development. In this case, selective removal of the weaker or less desirable trees may be done.

The guidance states further:

3. Unnecessary and indiscriminate tree removal shall not be permitted.

Other Research

"Tree Planting and Clearing Guidance with Consideration of Minimized Crash Risk,"
Christine E. Carrigan, T. Olaf Johnson and Malcolm H. Ray, *Transportation Research Record 2588*, pages 110-115, 2016.
Citation at http://trrjournalonline.trb.org/doi/abs/10.3141/2588-12
From the abstract:

> Improvement projects are increasingly introducing landscape elements to add aesthetic appeal to the projects. Though effective for improving aesthetics, the introduction of trees on the roadside may increase the risk of fatal or incapacitating crashes. In general, the goal of roadside design is to minimize, in so far as is practical, the chance of fatal or incapacitating injury crashes on the roadside. It may not be possible to minimize that risk to the level implied in AASHTO's *Roadside Design Guide* while capturing the benefits provided by trees,

but it is still desirable to understand the risk presented by the presence of trees and balance that risk with the aesthetic benefits. The widely adopted benefit–cost methods currently used in the *Roadside Design Guide* present a significant challenge with respect to the consideration of trees. Many purported benefits of trees have not been or cannot be quantified in dollars; this lack makes the traditional unit of measurement (i.e., dollars) in a benefit–cost analysis unavailable. This paper presents a quantitative approach for assessing the risk of fatal and incapacitating injuries presented by various tree spacing and offsets. This approach can be applied to any roadway where tree planting or removal is being considered, to quantify the risk of the current and proposed tree locations such that informed decisions can be made about the risk introduced by trees and whether the risks outweigh the benefits.

"Evaluating the Safety Risk of Roadside Features for Rural Two-Lane Roads Using Reliability Analysis," Mohammad Jalayer and Huaguo Zhou, *Accident Analysis & Prevention*, Vol. 93, pages 101-112, August 2016.
Citation at http://www.sciencedirect.com/science/article/pii/S0001457516301282
From the abstract:

The severity of roadway departure crashes mainly depends on the roadside features, including the sideslope, fixed-object density, offset from fixed objects, and shoulder width. Common engineering countermeasures to improve roadside safety include: cross section improvements, hazard removal or modification, and delineation. It is not always feasible to maintain an object-free and smooth roadside clear zone as recommended in design guidelines. Currently, clear zone width and sideslope are used to determine roadside hazard ratings (RHRs) to quantify the roadside safety of rural two-lane roadways on a seven-point pictorial scale. Since these two variables are continuous and can be treated as random, probabilistic analysis can be applied as an alternative method to address existing uncertainties. Specifically, using reliability analysis, it is possible to quantify roadside safety levels by treating the clear zone width and sideslope as two continuous, rather than discrete, variables. The objective of this manuscript is to present a new approach for defining the reliability index for measuring roadside safety on rural two-lane roads. To evaluate the proposed approach, we gathered five years (2009–2013) of Illinois run-off-road (ROR) crash data and identified the roadside features (i.e., clear zone widths and sideslopes) of 4500 300 ft roadway segments. Based on the obtained results, we confirm that reliability indices can serve as indicators to gauge safety levels, such that the greater the reliability index value, the lower the ROR crash rate.

Roadside Grading Guidance—Phase I, Kevin D. Schrum, Francisco D. B. Albuquerque, Dean L. Sicking, Ronald K. Faller and John D. Reid, Wisconsin Department of Transportation, December 2011.
http://mwrsf.unl.edu/researchhub/files/Report31/TRP-03-251-11.pdf
From the abstract:

Provisions for the design of roadside foreslopes are not readily available. As a result, engineering judgment is often employed. Unfortunately, this can lead to inconsistent designs, where, inevitably, some designs will be too costly and other designs will be too dangerous. Therefore guidance has been compiled to lend consistency to the design of these foreslopes while maintaining the most economical and safe design.

This guidance was prepared after conducting a benefit–cost analysis using the Roadside Safety Analysis Program (RSAP). A large test matrix was developed in an attempt to simulate the most possible scenarios, leaving interpolation to a minimum. However, before the analysis could be run, the severity indices associated with foreslopes needed to be

updated to accurately reflect vehicle damage and injury levels caused during an encroachment occurring at an average impact speed. Current indices are overestimated because they were based on a survey given out to highway safety officials who were most likely biased toward high-speed accidents. More data is being collected and will be added to the results of this report in phase two.

To update the severity indices, accident data from the State of Ohio was analyzed using a program called Global Mapper, which allowed the user to measure topographical features, such as foreslopes, heights, and offsets. A method to account for underreported accidents on flat slopes is presented as well. Finally, equations for determining accident cost as a function of the traffic volume are given in conjunction with examples that demonstrate the use of these equations.

Support for the Elimination of Roadside Hazards: Evaluating Roadside Collision Data and Clear Zone Requirements, J. Ogle, W. Sarasua, J. Dillon, V. Bendigieri, S. Anekar and P. Alluri, South Carolina Department of Transportation, September 2009.
https://ntl.bts.gov/lib/46000/46200/46238/SPR_667.pdf
From the abstract:

Over a three year period (2004-2006), there were more than 60,000 crashes involving fixed objects (trees, utility poles, culverts, bridge piers, etc.) located within South Carolina roadsides. These fixed object crashes accounted for 20% of all crashes in South Carolina, and nearly 50% of all fatal crashes. In comparison, only 30% of fixed-object crashes result in fatalities nationally. Responding to the growing concerns of roadside hazard involvement in crashes, SCDOT selected a research project to analyze roadside collision data, evaluate the sufficiency of current clear zones along state roadways, and assess the benefits associated with minimizing consequences of leaving the roadway by providing and maintaining adequate clear zones. Clemson University was selected to perform this work. … Using an odds ratio test for this sample, researchers determined that the odds of a site having a fixed object crash are 42 times higher if the minimum clear zone is not met. Considering the magnitude of the roadside hazard problem, and the deficiency of the clear zones in these areas, it appears that by providing recommended clear zones (or safe recovery areas) for motorists who leave the roadway, South Carolina could realize a notable decrease in roadway fatal and injury crashes. This is particularly significant realizing that many times it is for reasons other than driver error (i.e., blown tire, struck by another vehicle, avoiding an accident, avoiding deer, etc.).

"The Crash Severity Impacts of Fixed Roadside Objects," Jason M. Holdridge, Venky N. Shankar, Gudmundur F. Ulfarsson, *Journal of Safety Research*, Vol. 36, No. 2, pages 139-147, 2005.
Citation at http://www.sciencedirect.com/science/article/pii/S0022437505000186
From the abstract:

This study analyzes the in-service performance of roadside hardware on the entire urban State Route system in Washington State by developing multivariate statistical models of injury severity in fixed-object crashes using discrete outcome theory. The objective is to provide deeper insight into significant factors that affect crash severities involving fixed roadside objects, through improved statistical efficiency along with disaggregate and multivariate analysis. *Method:* The developed models are multivariate nested logit models of injury severity and they are estimated with statistical efficiency using the method of full information maximum likelihood. *Results:* The results show that leading ends of guardrails and bridge rails, along with large wooden poles (e.g. trees and utility poles) increase the

probability of fatal injury. The face of guardrails is associated with a reduction in the probability of evident injury, and concrete barriers are shown to be associated with a higher probability of lower severities. Other variables included driver characteristics, which showed expected results, validating the model. For example, driving over the speed limit and driving under the influence of alcohol increase the probability of fatal accidents. Drivers that do not use seatbelts are associated with an increase in the probability of more severe injuries, even when an airbag is activated. *Impact on industry:* The presented models show the contribution of guardrail leading ends toward fatal injuries. It is therefore important to use well-designed leading ends and to upgrade badly performing leading ends on guardrails and bridges. The models also indicate the importance of protecting vehicles from crashes with rigid poles and tree stumps, as these are linked with greater severities and fatalities.

Appendix A: Survey Results

The full text of each survey response is provided below. For reference, an abbreviated version of each question is included before the response; the full question text is available on page 5 of this Preliminary Investigation.

Arkansas

Contact: Trinity Smith, Division Head, Roadway Design Division, Arkansas State Highway and Transportation Department, 501-569-2336, trinity.smith@ahtd.ar.gov.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** Existing trees inside the right of way but outside the clear zone are dealt with on a case-by-case basis. If the tree does not cause a problem with sight distance or maintenance, the district engineer may allow it to stay. However, if the tree causes a problem, then it should be removed. This decision is typically left to the discretion of the district engineer.
2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** Typically AHTD [Arkansas State Highway and Transportation Department] does not allow new trees planted on the right of way. In some cases, a city is allowed to have a permit to plant trees on the highway right of way within the city limits. When this is allowed, the city must specify which type of tree they intend to plant, and the tree type must be approved by AHTD. The city must handle all maintenance associated with the trees.
3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** Yes, AHTD does not allow trees within the clear zone.
4. **Guidance documents:** N/A.
5. **Data, calculations and citations for state policy:** N/A.

Hawaii

Contact: Ross Hironaka, Design Branch, Highway Design Section, Hawaii Department of Transportation, 808-692-7575, ross.hironaka@hawaii.gov.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** We do not have any set removal or mitigation requirements. We do, however, consult with the Outdoor Circle for mitigation or disposition plans on all tree remov[als] regardless of slopes. The Outdoor Circle typically requires a 1:1 mitigation plan which includes location, size and species for replacement trees. [From the Outdoor Circle's web site at https://www.outdoorcircle.org/: The Outdoor Circle is a statewide environmental non-profit that works with branches throughout the Hawaiian Islands to protect Hawai'i's unique natural beauty for future generations through community improvement projects, public education, and advocacy.]
2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** All new tree plantings must be out of the clear zone regardless of the slope. When planting on steeper slopes it's industry standard to plant slope-stabilizing species (i.e., Callistemon sp., Bottle Brush Tree); this is not DOT policy, but it is a standard that we practice. In addition, all tree work must be in accord with ASIA A300 and ASIA Z133.1. [The respondent appears to be referring to ANSI A300, which has been described as the generally accepted industry standard for tree care practices, and ANSI Z133.1, safety

standards for arborists. American National Standards Institute (ANSI) "oversees the creation, promulgation and use of thousands of norms and guidelines that directly impact businesses in nearly every sector …."]

3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** Not to my knowledge.

4. **Guidance documents: Highway Manual for Sustainable Landscape Maintenance**, Hawaii Department of Transportation, 2011; see http://hidot.hawaii.gov/highways/landscape-architecture-program/. [Scroll down the page to see links to each section of the manual.]

5. **Data, calculations and citations for state policy:** N/A.

Idaho

Contact: Ted Mason, Technical Engineer, Design/Traffic Services, Idaho Transportation Department, 208-334-8500, ted.mason@itd.idaho.gov.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** The Idaho Transportation Department (ITD) does not have any formal policy for tree[s] outside the clear zone to the roadway. We do have a state policy associated with the sight triangle at intersections (see **Guidance documents** below) that is often more restrictive than AASHTO guidance resulting in addressing trees at intersections.

2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** (See reply to Question 1.)

3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** [No response.]

4. **Guidance documents: Idaho Code Ann. § 49-221, Removal of traffic hazards**, 2017; see https://legislature.idaho.gov/statutesrules/idstat/title49/t49ch2/sect49-221/.

5. **Data, calculations and citations for state policy:** [No response.]

Illinois

Contact: Michael Brand, Acting Policy and Procedures Engineer, Bureau of Design and Environment, Illinois Department of Transportation, 217-782-7651, michael.brand@illinois.gov.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** Existing trees are covered in our Maintenance Policy Manual (see Section 5-600 of the manual attached). The guidance is not specific to type of front slope, just specific to the tree being "undesirable" due to being within the clear zone. Our Design Manual describes clear zones and that a clear zone should be increased for a non-recoverable front slope. [See **Guidance documents** below for links to the publications referenced above.]

2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** Planting trees is covered in Chapter 59 of our Design Manual (see Section 59-7.01(g); link below). [*From the manual*:] Do not locate woody plants with diameters at maturity greater than 4 in (100 mm) in the clear zone, as defined for new construction. Also, such plants normally should not be planted on the foreslope or in ditches even if outside the clear zone.

The design of clear zones is covered in Chapter 38 of the same manual (see Section 38-3.03(b)).

3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** No.

4. **Guidance documents:**

   - **Bureau of Operations Maintenance Policy Manual**, Illinois Department of Transportation, June 2013; see Attachment A.

   - **Chapter 59, Landscape Design**, Bureau of Design and Environmental Manual, Illinois Department of Transportation, July 2015; see http://www.idot.illinois.gov/Assets/uploads/files/Doing-Business/Manuals-Guides-&-Handbooks/Highways/Design-and-Environment/Illinois%20BDE%20Manual.pdf.

5. **Data, calculations and citations for state policy.** AASHTO Roadside Design Guide [see https://bookstore.transportation.org/item_details.aspx?id=1802].

Indiana

Contact: Matt Kraushar, Roadside Services Coordinator, Indiana Department of Transportation, 317-232-5509, mkraushar@indot.in.gov.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** We do not make distinctions based on slopes, but rather by Vegetation Management Zones.

   Tree — Woody vegetation larger than three inches (3") at diameter breast height [DBH].

   For trees beyond the CRZ [clear recovery zone] (we define that as Zones 3 and 4, i.e., Selective Zone and Natural Zone, respectively):

   > **Zone 3: Selective Zone** (30-80 feet from the road edge): The area extending from the edge of the Clear Zone to an additional fifty (50) feet (a total of eighty (80) feet from the edge of pavement shoulder/road surface) shall be kept free of noxious and invasive species, as well as tall-growing trees (maximum mature height of greater than 30'), in order to promote healthy and native vegetation and minimize maintenance costs. The area also includes sections protected by guardrail.

   Additionally:

   > **Zone 3: Tree Removal** — Large trees that are diseased, dead or in the safety clear zone as indicated by Federal Regulations. If large trees are already growing in this area and out of the clear zone design for the particular road segment, they may remain until they become a safety issue.
   >
   > **Zone 4: Tree Removal** — Remove only trees that are in danger of falling off of right of way and damaging adjacent property. Fallen tree should be left on site to decompose and enrich soil.
   >
   > A. **Tree Removal General Guidelines**
   >
   > > I. All Federal and State rules and laws for removal of trees to protect endangered species shall be followed for compliance. It is the responsibility of every manager to keep informed on current regulations and requirements which will include Federal, State and Local quarantines in regard to tree removal.

II. The following locations shall be removed:

a. Trees that block any official signage or interfere with safe sight distances.

b. Trees for removal known to be hazards based on reports from law enforcement agencies or observed to be damaged by collision with a vehicle.

III. Trees observed or reported to be deteriorating and of potential hazard to the public, such as within the designed safety clear zone and trees located in ditch bottoms that would direct a vehicle to impact it.

IV. Trees around bridges that are above bridge deck.

V. It may be generally desirable to schedule tree and brush work in conjunction with resurface work or reconstruction contracts. Critical trees may be more readily removed if considered as a part of safety upgrading of the facility.

VI. There are several areas in the state where particular trees have unique historic value. There are also designated scenic routes controlled by the Department of Natural Resources (DNR). Before work is performed on trees in these areas, special coordination with local historical societies or the DNR shall be done. INDOT should work closely with these agencies while maintaining the safety of the roadway.

VII. Prior to cutting trees where right of way lines are not clearly defined, permission from the adjacent property owners should be obtained. Particular care must be given to trees which may be owned by adjacent property owners under retained timber rights.

VIII. INDOT shall not normally maintain trees where property owners retained timber rights. Where such trees are known to exist that are hazardous to persons using the highway, INDOT shall advise the owner of their responsibility to remedy the situation with a certified letter. If the owner fails to take action within a reasonable period of time, INDOT may remedy the situation in the least costly method available.

IX. INDOT will not maintain, remove, or trim trees inside incorporated municipalities which are located in grassy strips between the edge of pavement and sidewalk.

IC 8-23-6-3, Chapter 6. State Highways in Municipalities – Upon the completion of a street, the department shall maintain the roadway of the street, including the curbs and gutters, catch basins, and inlets within the limits of the street or highway that form integral parts of the street or highway. The city or town shall maintain the sidewalks, grass plats, and the connecting drainage facilities.

Exceptions; trimming or removal may be done if:

A hazard exists that must be remedied and the city is unable to fulfill their obligation in a timely manner

B. **Tree Removal — Zone 1: Vegetation Free Zone**

I. None Required.

C. **Tree Removal — Zone 2: Clear Zone**

I. Trees that are within the right of way clear zone shall be removed if in danger of a vehicle/tree collision. The exception is reduced speed limits, curbs and others. For detailed information refer to the current INDOT design manual at 49-2.0 Roadside Clear Zone.

II. All trees within 30 feet of the travel lanes on high speed limited access highways shall be removed, unless protected by guardrail or terrain.

D. **Tree Removal — Zone 3: Selective Zone**

I. Trees leaning heavily toward the travel portion of the highway should be removed.

II. Trees that are in danger of falling off of the right of way and damaging private property shall be removed.

E. **Tree Removal — Zone 4: Natural Zone**

I. Trees that are in danger of falling off of the right of way and damaging private property shall be removed.

F. **Tree Removal — Zone 5: Bridge Zone**

I. All trees that will interfere with bridge inspection equipment shall be removed.

II. Trees that are growing within the right of way, that may strike the super structure of the bridge if the tree falls, shall be removed.

2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** We follow the same policy as listed above unless protected by guardrail or reduced speed zone (thereby reducing CRZ) as might be the case in a cloverleaf or similar area. Planting designs are reviewed prior to approval to ensure compliance.

3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** See part "C" above in answer for #1. Parts of trees extending into these areas are to be trimmed to a minimum clear height of 17.5 feet.

4. **Guidance documents:**

   - **Chapter 49, Roadside Safety**, Design Manual, Indiana Department of Transportation, 2013; see http://www.in.gov/indot/design_manual/files/Ch49_2013.pdf.
   - **Vegetation Management: Operation Memorandum 14-05 Maintenance**, Indiana Department of Transportation, July 2014; see Attachment B.

5. **Data, calculations and citations for state policy:** [Tree risk] assessment is a topic of discussion currently within our maintenance division after attending a workshop put on by [the] International Society of Arboriculture. [See http://www.isa-arbor.com/certification/becomequalified/traqevents.aspx for a description of the International Society of Arboriculture's Tree Risk Assessment Qualification Courses.]

Louisiana

Contact: Chad Winchester, Project Development Division Chief, Louisiana Department of Transportation and Development, 225-379-1048, chad.winchester@la.gov.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** We do not have a program for tree removal nor a specific policy. We would remove trees or provide positive protection if there is a performance issue or, on a case-by-case basis, [we] would address concerns, by removal or by protection, within preservation (overlay) projects.
2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** Our guidance:

   > For central business districts and local streets with barrier curbs, a minimum distance of 1.5 feet should be provided beyond the face of the curb to the anticipated outside diameter of the tree trunk when mature. On urban arterials and collectors with similar curbs and usually higher speeds, the offset distances should be increased.
   >
   > The clear distance from the edge of the traveled way to the face of the tree line shall be a minimum of 50 feet on the mainline and 30 feet for ramps. Trees may be planted or remain within the 50 foot clear distance or the 30 foot clear ramp area when they are protected by guardrail.

3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** [No response.]
4. **Guidance documents: Policy for Roadside Vegetation Management**, Louisiana Department of Transportation and Development, undated; see http://wwwsp.dotd.la.gov/Inside_LaDOTD/Divisions/Engineering/Misc%20Documents/Policy%20For%20Roadside%20Vegetation%20Management.pdf.
5. **Data, calculations and citations for state policy:** We follow AASHTO guidance for roadside safety (Roadside Design Guide).

Maine

Contact: Bradford Foley, Highway Program Manager, Maine Department of Transportation, 207-624-3459, brad.foley@maine.gov.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** MaineDOT does not include non-recoverable slopes as part of the clear zone. We require a clear “run-out area” beyond the toe of these slopes and would normally remove trees from these slopes and the run-out area beyond.
2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** MaineDOT would normally follow the same clear zone guidelines as for existing trees. Anything with a trunk diameter exceeding 4" would be considered a potential deadly fixed object.
3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** No, we do not normally allow new or existing trees within the clear zone.
4. **Guidance documents: Clear Zone**, Engineering Instruction C2.1, Maine Department of Transportation, February 2015; see

http://www.maine.gov/mdot/edi/docs/Clear_Zone_Engineering_Instructionreworked1-8-15b.pdf.

5. **Data, calculations and citations for state policy:** Our requirements are based on Section 3.3.2, Non-Recoverable Foreslopes, in the 4th edition of the AASHTO Roadside Design Guide.

Michigan

Contact: Carlos Libiran, Design Standards Engineer, Michigan Department of Transportation, 517-335-1904, libiranc@michigan.gov.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** With considerations for crash history and context sensitive design, we recommend removal of existing isolated trees generously beyond the clear zone of non-recoverable slopes. Our freeway guidelines call for 50 [ft.] min[imum] clearance from traveled way. Clear runout is provided where feasible for non-recoverable slopes. Strong consideration is given for removing or relocating trees that are located at or near the toe of a non-recoverable slope despite being beyond the clear zone. For barn roof slopes, the clear zone is extended to include the non-recoverable portion to a minimum 10 ft. past the recoverable slope.

2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** New trees are preferably located beyond the clear zone to the extent practicable. Our guideline for freeway clearance is 50 ft.

3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** Yes. New trees are located outside the clear zone regardless of tree size. Existing shrubs or trees with diameters 4" or less at 4'-6" above ground level may be retained. Consideration is given for adverse effects to endangered species, historic value, roadside character, etc. Judgement is used with regard to practicable risk mitigation in the presence of continuous tree lines. Crash history is also a factor. Except as previously described, trees retained in the clear zone are shielded.

4. **Guidance documents: Chapter 7, Appurtenances**, Road Design Manual, Michigan Department of Transportation, undated; see http://mdotcf.state.mi.us/public/design/files/englishroadmanual/erdm07.pdf. See Sections 7.01.11 A and B.

5. **Data, calculations and citations for state policy:** The guidance in the MDOT Road Design Manual was a collaboration of the MDOT Barrier Advisory Committee and the author of Guide to Management of Roadside Trees, 1986. [This December 1986 FHWA publication is available at https://www.naturewithin.info/Roadside/Zeigler_FHWA.pdf.]

Minnesota 1

Contact: David Larson, Unit Supervisor, Office of Environmental Stewardship, Minnesota Department of Transportation, 651-366-4637, david.larson@state.mn.us.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** We remove vegetation if a tree is structurally deficient and could cause harm to a vehicle or pedestrian. We mitigate for vegetation in the above-defined area based on EPA [U.S. Environmental Protection Agency] regulation or if there are endangered species that require mitigation of plant material.

2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** At MnDOT, we use the AASHTO guidelines for clear zones to determine the minimum setback distance for trees with a trunk diameter of 4" or greater. We also look at each situation to determine if these areas need further consideration, based on sight lines or other potential hazards or if they can be planted because we have protections such as guardrails or J barriers to prevent cars from leaving the road.

3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** Yes, within the clear zone we do not plant any material that will reach trunk diameter size greater than 4" DBH.

4. **Guidance documents:**

   - **Chapter 5, Debris and Roadsides**, Maintenance Manual, Minnesota Department of Transportation, September 2016; see http://www.dot.state.mn.us/maintenance/pdf/manual/chapter-5-debris-and-roadsides.pdf.

   - **Chapter 4, Cross Sections**, MnDOT Road Design Manual, Minnesota Department of Transportation April 2012; see http://dotapp7.dot.state.mn.us/edms/download?docId=1062357. (See Tables 4-6.04A-K; discussion of these tables begins on page 38 of the PDF.)

5. **Data, calculations and citations for state policy:** Planning and Management of Roadside Vegetation: An Analysis of Principles, Highway Research Board Special Report, 1956; see https://books.google.com/books?id=ujUFAAAAMAAJ&q.

Additional Comments: At MnDOT, we look at each case where there are non-recoverable or non-traversable locations, and evaluate whether there is a need for any of the following:

- Living snow fences for snow and ice control.
- Screening of neighborhoods.
- Provide habitat for varying species of animals.
- Erosion control.

Minnesota 2

Contact: James Rosenow, Office of Project Management and Technical Support, Minnesota Department of Transportation, 651-366-4673, james.rosenow@state.mn.us.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** It depends on the situation (maintenance, preservation project, reconstruction project). All those situations are subject to the same roadside design guidance (essentially the AASHTO RDG [Roadside Design Guide] as re-stated in our Road Design Manual, subject to judgment), but action would depend on project scope, purpose/need and, of course, the significance of the tree.

2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** We advise not placing new trees right at the edge or right beyond the edge of the clear zone; instead they should be planted a discrete distance outside the clear zone, subject to site specifics and judgment. This would apply to any tree that would grow to a 4" caliper diameter or greater.

3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** Not sure I understand the question.

4. **Guidance documents:**

   - **Chapter 4, Cross Sections**, MnDOT Road Design Manual, Minnesota Department of Transportation, April 2012; see http://dotapp7.dot.state.mn.us/edms/download?docId=1062357. (See Tables 4-6.04A-K; discussion of these tables begins on page 38 of the PDF.)

   - **Chapter 10, Traffic Control Devices and Traffic Barriers**, MnDOT Road Design Manual, Minnesota Department of Transportation, May 2012; see http://dotapp7.dot.state.mn.us/edms/download?docId=1062363.

5. **Data, calculations and citations for state policy:** AASHTO Roadside Design Guide.

Additional Comments: In light of the guidance in the new RDG Chapter 10, our practice on urban streets is evolving and in discussion here. The RDG is not specific on exact approach or on street type and design speed, so we're in the position of having to develop our own guidance to an extent. Please don't hesitate to contact me if you'd like to discuss things in greater detail than is practical in this survey format.

Nebraska

Contact: Michael Owen, Planning and Project Development Engineer, Nebraska Department of Transportation, 402-479-4601, mike.owen@nebraska.gov.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** Several of our districts contract an annual tree removal contract. The contract would remove trees at intersections and within 30 feet from the traveled way (on most foreslopes, non-recoverable and non-traversable). This is not a policy but has been a practice of several district engineers.

2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** We only build plantings on a limited number of projects. The projects with plantings are generally in urban areas with a commitment to the NEPA [National Environmental Policy Act] or public involvement responses. If planted, landscape would be beyond a setback of 35 to 40 feet. Plantings would be on backslopes or in areas that are set back from the traveled way, e.g., wetland mitigation, on-site. We do not have a policy that limits the trunk size diameter or other.

3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** No. We would not build landscape within the fixed or horizontal clear zone.

4. **Guidance documents:** We have limited guidance on maintenance policies related to tree removal on non-recoverable and non-traversable slopes.

5. **Data, calculations and citations for state policy:** [AASHTO] Roadside Design Guide would be authoritative document guiding our decisions.

Nevada

Contact: Paul M. Frost, Design Division, Nevada Department of Transportation, 775-888-7797, pfrost@dot.nv.gov.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** NDOT does not have any policy or criteria requiring removal of existing trees beyond clear zone.
2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** NDOT does not have policy that formally restricts any planting beyond clear zone. However, we do recognize that clear zone distances are not exact, and we develop our planting plans considering clear zone, location, design speed, etc. For example, we would avoid planting a large-diameter tree just outside of clear zone on a 70-mph Interstate, but would allow it near interchange ramp termini where speeds are lower.
3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** NDOT policy would not allow any large plantings inside of clear zone. Only small, ornamental, brush-type plants.
4. **Guidance documents:**
   - AASHTO Green Book [see https://www.fhwa.dot.gov/design/standards/151112.cfm].
   - AASHTO Roadside Design Guide.
   - **Road Design Guide**, Nevada Department of Transportation, 2010; see https://www.nevadadot.com/home/showdocument?id=1535.
5. **Data, calculations and citations for state policy:** See response to Question 4.

New Jersey

Contact: Sowatta Eap, Bureau of Design Standards, Roadway Standards Unit, New Jersey Department of Transportation, 609-530-2888, sowatta.eap@dot.nj.gov.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** On non-recoverable slopes (between 4:1 and 3:1), we require a clear runout area, free of fixed objects (including trees), beyond the toe of the non-recoverable fill slope. The extent of this clear runout area is determined by first finding the available distance between the edge of the traveled way and the breakpoint of the recoverable fill slope (1:4 or flatter) to the non-recoverable fill slope. This distance then is subtracted from the suggested clear zone distance. The result is the desirable clear runout area that should be at least 10 feet. Refer to the bottom of Figure 8-B for an example [see **Guidance documents** below].

   Slopes greater than 3:1 are critical slopes. For critical slopes, guide rail might be warranted depending of the height of the slopes. Guide rail warrants for critical slopes are shown in Table 8-1 of the NJDOT Roadway Design Manual [see **Guidance documents** below]. Where guide rail[s] are not warranted based on Table 8-1, we require that the critical slopes and clear runout area be free of fixed objects including trees.

In certain cases, we thin the forest 10 feet beyond the clear zone of sick and diseased trees that are beyond reasonable repair, along with dead tall trees that may fall into the roadway.

2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** Table 8-2 of the NJDOT Roadway Design Manual provides guidance for the location of new plantings within the clear zone on Interstate highways, freeways and land service highways.

   For new trees at the limits of or beyond the clear zone, see our responses to question #1.

3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** The following guidance is provided for the treatment of existing trees within the clear zone:

   a. On freeways and Interstate routes, trees shall not be located within the clear zone.

   b. Although it is desirable to provide a clear zone free of trees on land service roads, it is likely that situations will be encountered where removal of trees within the clear zone cannot be accomplished. For instance, the aesthetic appeal of the trees may cause local opposition to their removal, the trees may not be within the right-of-way, or removal of the trees may not be environmentally acceptable.

      In some cases it may be appropriate to plant replacement trees outside the clear zone so that the removal of trees in close proximity to the roadway may be accomplished without public criticism.

      Factors such as crash experience, traffic volume, speed, clearance from the traveled way and roadway geometry should be evaluated when determining whether it is appropriate to leave trees within the clear zone.

      Sick and diseased trees that are beyond reasonable repair, along with dead trees, trees that cause sight distance problems and trees with a significant crash history shall be removed regardless of public criticism. Also, trees that will be harmed beyond reasonable repair due to construction shall be removed (i.e. new curb that destroys the main root system). The Office of Landscape Architecture should be consulted for the tree's physical assessment.

4. **Guidance documents:**

   - **Section 8, Guide Rail Design and Median Barriers**, NJDOT Roadway Design Manual, New Jersey Department of Transportation, 2015; see page 170 of the PDF available at http://www.state.nj.us/transportation/eng/documents/RDM/documents/2015RoadwayDesignManual.pdf.

   - **Figure 8-B: Clear Zone Examples**, NJDOT Roadway Design Manual, New Jersey Department of Transportation, 2015; see page 173 of the PDF available at http://www.state.nj.us/transportation/eng/documents/RDM/documents/2015RoadwayDesignManual.pdf.

5. **Data, calculations and citations for state policy:** Our guide rail and clear zone standards come from AASHTO Roadside Design Guide, 2011.

North Dakota

Contact: Chad Frisinger, North Dakota Department of Transportation, 701-328-2558, cfrising@nd.gov.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** On rural projects, we would remove any obstructions, including trees within the clear zone on 3R [resurfacing, reconditioning and reconstruction] projects or new or reconstruction projects. If there is a 3:1 [slope] within the clear zone, then all obstructions would be removed within the 3:1 slope and the recovery area. This would include trees. If trees are removed within NDDOT right of way (ROW), they are not mitigated unless they are located along a riparian corridor and mitigation is requested by a resource agency such as ND Game and Fish [Department].
2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** Trees are only to be planted outside the clear zone on a rural highway project. It is rare that the NDDOT plants trees within the ROW on a rural project. There is no set distance from the roadway and no limitation on trunk diameter at maturity. If trees are planted, they are typically planted on the backslope near the ROW. The typical ROW is 100 feet from centerline for two-lane highways and 200' from centerline on the Interstate.
3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** City projects have included trees within the clear zone and have planted trees within the grass boulevard or grass medians. This practice is discouraged by the NDDOT when the local city street is part of the NDDOT highway system. But the NDDOT allows trees to be planted if requested by the city. This practice is allowed due to limited amount of ROW available in a[n] urban corridor.
4. **Guidance documents: Section II-02.05.02, Tree Impacts**, Chapter II, Environmental and Public Involvement, Design Manual, North Dakota Department of Transportation, November 2013; see https://www.dot.nd.gov/manuals/design/designmanual/Chapter%202.pdf (begins on page 28 of the PDF).
5. **Data, calculations and citations for state policy:** No research or data is available.

Ohio

Contact: Rick Bruce, Section Administrator, Office of Roadway Engineering, Ohio Department of Transportation, 614-995-5519, rick.bruce@dot.ohio.gov.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** We do not have a policy governing trees beyond the clear zone unless they are a safety concern, dead and within the fall zone of the roadway, or if they are restricting sight distance.
2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** New trees would follow Section 900, Roadside Safety Landscape Guidelines of our Location and Design Manual, Volume 1 [see **Guidance documents** below].
3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** On high-volume roadways any large trees (>4" diameter) should be removed.

4. **Guidance documents: Section 900, Roadside Safety Landscape Guidelines**, Location and Design Manual, Volume 1, Ohio Department of Transportation, July 2017; see http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Location%20and%20Design%20Manual/Section_900_July_2017.pdf

5. **Data, calculations and citations for state policy:** Our roadside design is based on the AASHTO Roadside Design Guide.

Wisconsin

Contact: Erik Emerson, Standards Development Engineer, Wisconsin Department of Transportation, 608-266-2842, erik.emerson@wi.gov.

1. **Requirements for *existing* trees on non-recoverable/non-traversable slopes?** We have no written policy on this specific topic. We do tell staff to keep fixed objects out of the area at the toe of slope. Staff is also reminded to look and review hazards beyond clear zone and consequence of collision.

   [Wisconsin DOT defines consequence of collision, in part, as follows:

   > Consequence of collision deals with hazards that can generate serious crash outcomes. Many of the hazards that fall into this category are not frequently encountered along the roadway. (Overhead sign, sign bridges and light poles would be the exception to this general rule.) Consequence of a collision may not be associated with police crash reports.

   See page 13 of the PDF available at http://wisconsindot.gov/rdwy/fdm/fd-11-45-att.pdf#fd11-45-2a2.5 for a complete definition.]

2. **Requirements for *new* trees on non-recoverable/non-traversable slopes?** We have no written policy on this topic.

3. **Policy differences between non-recoverable/non-traversable slopes and the clear recovery zone?** We require staff to identify hazards within the desirable clear zone. Then staff has to make determination on what actions to take.

4. **Guidance documents: Section 45, Other Elements Affecting Geometric Design**, Chapter 11, Design, Facilities Development Manual, Wisconsin Department of Transportation, December 2014; see http://wisconsindot.gov/rdwy/fdm/fd-11-45.pdf.

   Guidance on clear zones for:

   - Rural roads can be found at **Section 15, Cross Section Elements for Rural Highways and Freeways**, Chapter 11, Design, Facilities Development Manual, Wisconsin Department of Transportation, March 2017; see http://wisconsindot.gov/rdwy/fdm/fd-11-15.pdf#fd11-15.

   - Urban roads can be found at **Section 20, Cross Section Elements for Urban Highways**, Chapter 11 Design, Facilities Development Manual, Wisconsin Department of Transportation, June 2017; see http://wisconsindot.gov/rdwy/fdm/fd-11-20.pdf#fd11-20.

Note that certain project types have some adjustments to roadside designing. For example, 3R projects have some different clear zone requirements.

5. **Data, calculations and citations for state policy:** Our Facilities Development Manual (FDM) chapters 11-45-2 and 11-45-3 have references within them.