Chapter Fifty

3R GUIDELINES FOR FREEWAYS

BUREAU OF DESIGN AND ENVIRONMENT MANUAL

Chapter Fifty
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Chapter Fifty
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Chapter 50 presents the Department's geometric and roadside safety design guidelines for 3R projects on existing freeways. However, these 3R freeway guidelines should not be substituted for sound engineering judgment. See Chapter 44 for the application of design criteria to new construction/ reconstruction freeway projects.

50-1 GENERAL

50-1.01 Background

The Department began construction of its freeway system in the 1950's. The system has introduced a level of mobility and safety for the traveling public that was unattainable without its special features, including full control of access, wide roadway widths, and high design speeds.

The freeway system requires repair and upgrading which exceeds the limits of normal maintenance. In general, these capital improvements are referred to as 3R freeway projects (resurfacing, restoration, rehabilitation). As with non-freeway 3R projects (Chapter 49), it is often impractical to fully apply new construction/reconstruction criteria to 3R freeway projects without some qualifications. Freeway 3R projects reflect economics and safety relative to their design until full design criteria can be applied; i.e., reconstruction.

50-1.02 Objectives

The objective of a 3R freeway project is, within practical limits, to restore the freeway to its original service or to improve it to meet current demands. This objective applies to all aspects of the freeway's serviceability, including:

- structural adequacy,
- drainage,
- slope and embankment stability,
- level of service for the traffic flow,
- geometric design,
- roadside safety, and
- traffic control.

These objectives are competing for the limited funds available for 3R projects on existing freeways. The Department's responsibility is to realize the greatest overall benefit from the available funds. This is accomplished by:

- recognizing that most 3R freeway projects are typically initiated to make a specific improvement (e.g., pavement rehabilitation) to the existing freeway (i.e., 3R freeway projects are not intended to fully upgrade or reconstruct the facility);

- defining the project scope of work to ensure that the project accomplishes the specific objective as identified at project initiation but does not expand into a full reconstruction project; and

- selectively evaluating and implementing geometric and roadside safety design improvements to the freeway which are a cost-effective expenditure of the Department's highway construction funds.

50-1.03 Approach

The Department's approach to the design of 3R freeway projects is to evaluate and selectively improve the existing geometrics. This is summarized as follows:

1. Nature of Improvement. Identify the specific improvement intended for the 3R project. For example, design improvements might include:

    - pavement rehabilitation/resurfacing/restoration,
    - upgrade roadside safety,
    - increase the length of one or more acceleration lanes at an interchange,
    - eliminate a weaving area at an interchange,
    - widen an existing bridge as part of a bridge rehabilitation project, and/or
    - improve bridge structural adequacy.

2. Selecting Design Criteria. This Chapter addresses 3R freeway projects. If reconstruction is needed to address an identified operational or safety element, the designer will use the new construction/reconstruction criteria in Chapter 44.

3. Design Considerations. Identify and evaluate any design deficiencies that may be precipitated by the freeway improvement. For example:

    - The installation of a concrete barrier may restrict horizontal sight distance.

    - A pavement overlay may require the adjustment of roadside barrier heights or reduce the vertical clearance to below the Department's allowable criteria.

4. Safety Analysis. Identify other geometric and roadside safety design deficiencies within the project limits. Conduct a crash analysis when determining any other improvements that can be practically included without exceeding the intended project scope of work. For example, if a concrete barrier is constructed, it is reasonable to correct any superelevation deficiencies to full standards at the same time, because superelevation corrections in the future may require major modifications to the wall.

5. Project Evaluation. Section 49-2.04 discusses project evaluation for 3R non-freeway projects. This includes, for example, crash data, pavement condition, geometric design consistency, and traffic control devices. As applicable, these evaluation objectives also apply to 3R freeway projects.

6. Design Exceptions. The discussion in Section 31-8 on design exceptions applies equally to the geometric design of 3R freeway projects.

50-1.04 Documentation

50-1.04(a) Phase I Report

A Phase I engineering report shall be prepared and, when required due to funding type or design exceptions, transmitted to FHWA through BDE. See Chapters 11 and 12 for a detailed discussion. The report should be brief and should contain at least the following:

1. Reasons for Project Initiation.

2. Description of Existing Conditions. Before determining the scope of the proposed 3R freeway project, an analysis of the existing conditions is necessary. Provide a fact sheet indicating project length, design and posted speed, current ADT and percentage of trucks, CRS values, etc. From as-built plans and as verified by a field survey, the following should be determined:

   - existing roadway, structure, and interchange geometrics;
   - general pavement distress or failure mode;
   - specific areas of failure;
   - presence of underdrains and pipe drain headwalls;
   - location and performance level of existing roadside safety appurtenances; and
   - locations of existing shallow roadside ditches.

3. Proposed Scope of Work. Provide a brief description of the proposed scope of work. This description must include at least the following items:

   - a Sketch Map showing the location of the proposed improvement, the limits of the proposed work, and any omissions;

   - a typical cross section showing the proposed resurfacing thickness, shoulder widths, pavement and shoulder cross slopes, side slopes, bridge widths; and

   - exceptions from policy resurfacing thicknesses. This will also include justification for the exceptions as discussed in Chapter 53.

4. Estimated Cost for the Proposed Improvement.

5. Categorical Exclusion. The applicable Group for Categorical Exclusions should be identified in the Phase I engineering report (see Chapter 23) plus any required special reports (see Chapter 26). The certification statement is not needed for Group I projects.

6. Other. The Phase I engineering report should document any other special reports such as;

   - justification for requests for exceptions from design policies,
   - discussion of Five Percent Report Locations or other over-represented crash locations and proposed countermeasures,
   - proposed geometric revisions and superelevation corrections,
   - vertical clearances,
   - condition of existing structures, and
   - environmental concerns.

50-1.04(b) Contract Provisions

In addition to providing the various contract documents needed for the 3R freeway project (see Part VII "Plan and Contracts"), the contract should contain provisions for the following items:

1. Markers. The contract should provide for the removal, storage, and replacement of all edge-of-shoulder-mounted delineators and milepost markers that will interfere with construction. When the field survey indicates missing or damaged delineators or markers, the contract should provide for a pay item for replacement. See the *Highway Standards* for placement requirements for delineators. For milepost markers, consult the Bureau of Operations.

2. Bridge Approach Shoulders. The bridge approach shoulders should be surveyed to determine the need for any corrective work if settlement has occurred. See Chapter 53.

3. Erosion. For existing foreslopes that have a history of erosion problems, consider the selective use of Shoulder Inlet and Curb. See the *Highway Standards*. However, barrier (vertical) curbs shall not be used and the placement of any curbs in front of guardrails should be avoided. See Section 50-3 and Chapter 38.

50-2 GEOMETRIC DESIGN

In general, the Department's geometric design criteria for new construction/reconstruction also apply to 3R freeway projects. See Parts IV "Roadway Design Elements" and V "Design of Highway Types." However, the designer must still make certain decisions, and there is some flexibility that can be applied. This is discussed in the following sections.

50-2.01 Design for Original Construction

A specific geometric design element on an existing freeway may not meet the Department's current criteria but did meet the criteria at the time of original construction. In these cases, the design criteria used for horizontal and vertical alignment and traveled way; shoulder and median width can remain in place if they met the AASHTO freeway design criteria in effect at the time of original construction or inclusion into the Interstate system.

50-2.02 Design Speed

The existing posted speed limit will be acceptable as the minimum design speed for the 3R freeway project. However, check with the Bureau of Operations to determine if the existing posted speed limit is likely to change after project completion. For metric projects, consider that the design speed of the project may be in metric and that the posted speed limit will be in English. Figure 50-2.A provides the conversion that will apply to 3R freeway projects.

50-2.03 Design Traffic Volumes

Some design elements on 3R freeway projects will require the selection of the DHV (e.g., level of service) or ADT (e.g., roadside clear zones). The current ADT shall be used unless geometric or structural improvements are made. Use the traffic for 20 years beyond the date of completion for these items.

Posted Speed Limit (mph)	Minimum Design Speed (km/h)	
	(mph)	(km/h)
50	50	80
55	55	90
60	60	100
65	65	110
70	70	110

DESIGN SPEED
(3R Freeway Projects)

Figure 50-2.A

50-2.04 Horizontal Curves

Mainline horizontal curves should have minimum superelevation rates equal to those allowed to remain in place as shown in Figure 50-2.B. If the required minimum superelevation rates are not met, provide additional resurfacing thickness or milling to correct the superelevation to the rate for the required comfortable operating speed. See Section 49-3 for more information on the use of Figure 50-2.B.

Where the curve occurs beneath an existing overhead structure, the additional thickness may cause the vertical clearance to become less than that required, and appropriate adjustments will be required. See Section 50-2.05.

All ramp superelevation rates should be corrected to the full superelevation rates for new construction. See Chapter 37.

50-2.05 Vertical Alignment

50-2.05(a) Vertical Curves

Analyze vertical curves to determine if they meet the criteria found in Section 33-4. If not, determine if operational or safety problems exist at the location. Where no operational or safety hazard is present, the curve may remain in place.

50-2.05(b) Vertical Clearances

For new construction and reconstruction projects in Illinois, the minimum vertical clearances are shown in Chapter 44. For 3R freeway projects, the minimum vertical clearance over the travel lanes and shoulders for new or reconstructed structures is 16 ft (4.9 m) for rural and single Interstate routing through urban areas that are served by more than one Interstate and 14 ft (4.3 m) in other urban areas. These clearances are based on Department of Defense requirements on the STRAHNET system that includes the Interstate system. Existing structures with 16 ft (4.88 m) and 14 ft (4.27 m) clearances respectively may remain in place. For Illinois, the urban Interstates for which the 14 ft (4.3 m or 4.27 m) clearance is acceptable include:

- I-74 through Peoria,
- I-55/I-70 and I-64 inside the I-270 and I-255 bypasses in the East St. Louis area, and
- those Interstates inside I-294 from I-80 to I-94 in the Chicago area.

Additionally, I-294 (from I-80 to I-94) is the current designated single routing for the Chicago area. The Department of Defense will continue the current blanket exception of 15 ft (4.6 m) on this route as long as the completion of I-355 is considered a viable alternative for a future routing for the Chicago area. Therefore, all structures on I-355 or the future I-355 corridor (e.g., I-290 and IL 53 on the north end of I-355) shall have the 16 ft (4.9 m or 4.88 m) clearance. The clearance requirements for routes between I-355 and I-294 shall be determined in cooperation with the Department of Defense through FHWA.

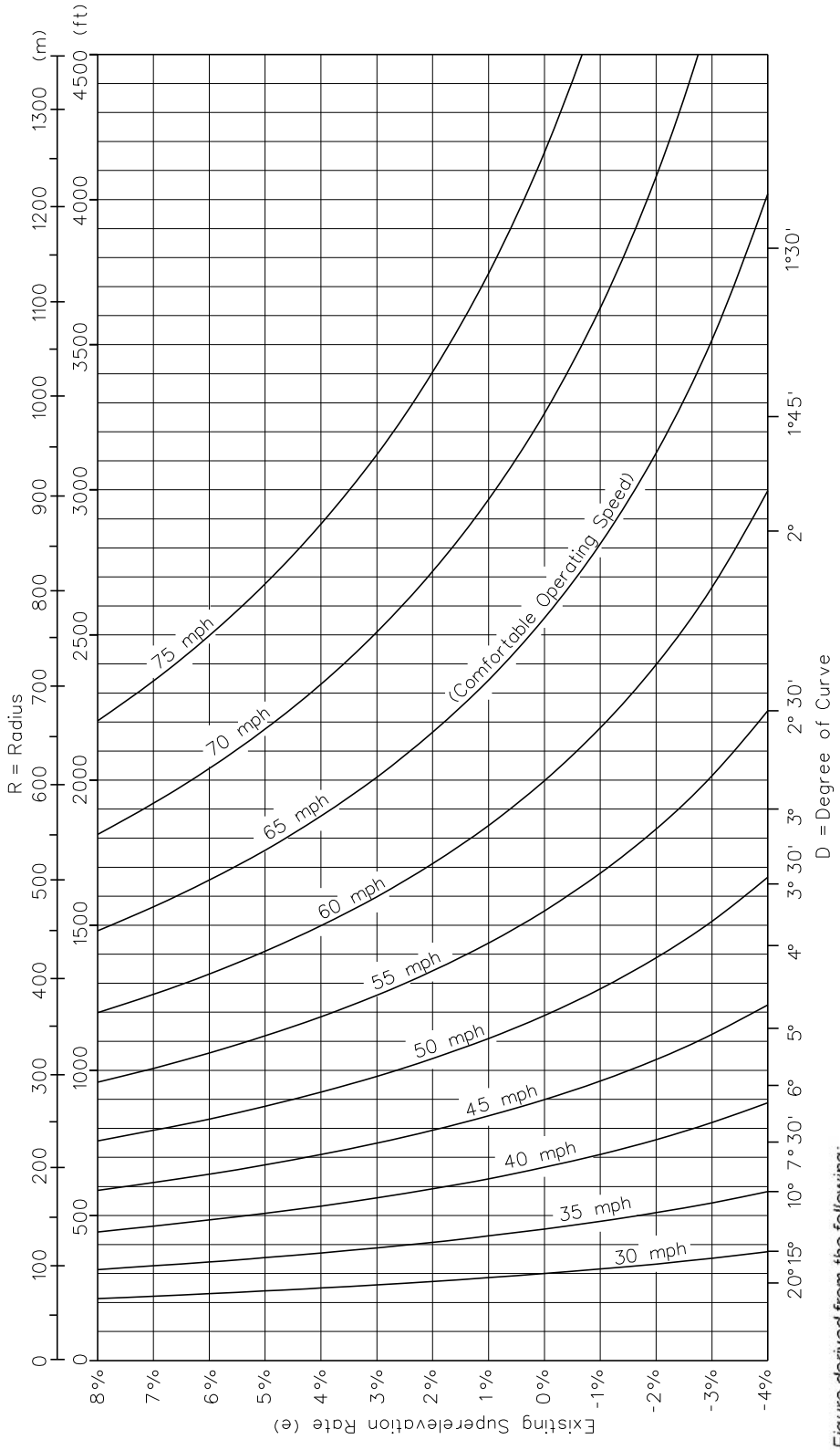


Figure derived from the following:

1. *Use AASHTO Method 2 for the distribution of superelevation and side friction.*
2. *Assume design speed and use f_{max} for selected design speed in all cases.*
3. *Assume different values of "e" and calculate values for "R" on graph for each speed.*

$$R = \frac{V^2}{15\,(e + f_{max})}$$, *where V = mph and R = ft. (US Customary)*

$$R = \frac{V^2}{127\,(e + f_{max})}$$, *where V = km/h and R = m. (Metric)*

HORIZONTAL CURVATURE ALLOWED TO REMAIN IN PLACE FOR 3R FREEWAY PROJECTS

Figure 50-2.B

Projects that do not meet the proper vertical clearances as discussed above will require coordination with the Department of Defense, Military Traffic Management Command Transportation Engineering Agency (MTMCTEA). The following summarizes the coordination process:

1. Projects such as deck replacement, deck widening, pavement resurfacing, or reconstruction that do not provide the proper clearance over the travel lanes and shoulders will require coordination with the MTMCTEA. The above clearances are not required over auxiliary lanes (other than Interstate to Interstate) and shoulders adjacent to auxiliary lanes or ramps.

2. FHWA will be the focal point for coordination with the MTMCTEA. The district shall notify the FHWA Transportation Engineer that the proposed project will not meet the required clearances and complete a Coordination Form (Figure 50-2.C) and forward it to FHWA.

3. FHWA will complete the "Date to MTMCTEA," "Response Requested by," and FHWA contact information and forward the completed form to the MTMCTEA. If the MTMCTEA does not provide comments within 10 working days, FHWA will notify the district of concurrence in the request.

Do not reduce existing clearances that are less than the 16 ft or 14 ft (4.88 m or 4.27 m) clearances during any 3R freeway project.

50-2.06 Bridges

Because of the high traffic volumes usually involved, bridges on six-lane or greater facilities must be examined on a case-by-case basis whenever 3R type work is performed. For structures on four-lane facilities, the following will apply to the geometric design criteria for bridges within the limits of 3R freeway projects.

50-2.06(a) Bridge Condition Reports/Structure Sketches

A Bridge Condition Report (BCR) and a Proposed Structure Sketch are required for every structure within a roadway section covered by a Phase I engineering report or when a bridge itself is the reason for preparing a Phase I engineering report. Before design approval can be granted, the BCR's must be approved by the Bureau of Bridges and Structures. In addition, the Bureau of Design and Environment must approve the typical section.

A Bridge Condition Report also is required for a bridge proposed to remain in place. This will ensure that the bridge meets the minimum requirements for width, safety, and structural capacity. However, the Illinois Structure Information System-Master Report (R107) may be substituted for a Bridge Condition Report.

See Section 39-3 for more information on Bridge Condition Reports and Proposed Structure Sketches.

To: Director, MTMCTEA From: Federal Highway Administration

ATTN: MTTE-SA Contact: ___
Voice: (757)599-1560 Voice: (217)492-
Fax: (757)599-1117 Fax: (217)492-4621

Response requested by: _____ **Date to MTMCTEA:** _____

—Above information to be completed by the FHWA —

Illinois Interstate Vertical Clearance Exception Coordination

1. Structure Location: Route I-___ Direction _____ Milepost _____
(Route name: _____)
___ Rural ___ Urban Single Routing
County: _____
Overpass Route: _____

2. Structure NBI number: _____

3. Project Description: _____

Estimated Total Project Cost: $ _____

4. Description and location (e.g., driving lane, passing lane, shoulder, ramp, C-D Road, etc.) **of the substandard clearance:**

	Through Lane(s)	Shoulder(s)	Aux./Ramp (I to I)
Existing:	_____ ft (m)	_____ ft (m)	_____ ft (m)
Proposed:	_____ ft (m)	_____ ft (m)	_____ ft (m)

5. Description of work required to achieve the 16 ft (4.9 m) clearance: _____

Estimated **additional cost** to obtain 16 ft (4.9 m) clearance: $ _____

6. Alternative route with 16 ft (4.9 m) vertical clearance: _____

7. Anticipated schedule for future project(s) which will correct or improve the substandard clearance:

___ Future Project (Year: Anticipated Clearance: _____ ft (m)
___ Future project not programmed

Remarks: _____

MTMCTEA COORDINATION FORM

Figure 50-2.C

50-2.06(b) Safety Analysis for Bridges

Narrow mainline, interchange, and ramp bridges within the project limits must first be analyzed to determine if widening is necessary to address a high-crash experience or other operational problems. This analysis will include a review of crash data for the previous four years and, if necessary, a field check by the district, FHWA, BDE, Bureau of Safety Engineering, and Bureau of Bridges and Structures. If it is determined that the overall safety of the roadway will be enhanced, include the widening of the bridge within the 3R project or schedule the work no later than one year following the letting of the highway project, unless an extension of time is approved by FHWA.

50-2.06(c) Bridges to Remain in Place

A 3R freeway project may be primarily intended, for example, to improve the pavement condition over several miles (kilometers). A bridge or several bridges may be within the limits of the 3R project. Desirably, the bridge widths will equal the full approach roadway width, including paved shoulders. However, this may not be the case. If the existing bridge is structurally sound and if it meets the Department's design loading structural capacity, an analysis should be performed to determine the cost effectiveness of improving the geometrics of the bridge. However, geometric deficiencies and/or adverse crash experience at the bridge may warrant widening the bridge as part of the 3R project. Design exceptions are required for bridge widths that do not meet Department criteria; see Chapter 31.

50-2.06(d) Bridge Replacement/Rehabilitation

3R freeway projects may include bridge replacements or bridge rehabilitation work and, in some cases, this may be the entire project scope of work. The following will apply to the geometric design of these projects:

1. Horizontal and Vertical Alignment. An existing bridge may have an alignment that does not meet the Department's current criteria. For bridge replacement projects, the designer should evaluate the practicality of realigning the bridge to meet the applicable alignment criteria for new construction/reconstruction (Chapters 32 and 33). For bridge rehabilitation projects, it is unlikely to be cost effective to realign the bridge to correct any alignment deficiencies.

2. Width. When the Bridge Condition Report indicates deck replacement is necessary, widen the structure to the extent possible without requiring substructure additions. Necessary repairs to or replacement of superstructure elements will be permitted. In no case shall the structure be made narrower than the existing width. The bridge width should equal the full approach roadway width, including paved shoulders, as determined by the criteria in Chapter 44. Capacity analyses could determine the need for auxiliary lanes and/or the need for wider shoulders. For example, if the predicted volume of trucks exceeds 250 DHV, the future shoulder width on the approach should be 12 ft (3.6 m). Because freeway bridges represent major economic investments with lengthy

design lives, it may be warranted to provide the wider widths as part of a bridge replacement or rehabilitation project.

As another example, a capacity analysis may indicate the need for an additional through lane to meet the level-of-service criteria for the design year. The decision may be made to widen the bridge as part of the replacement/rehabilitation project. Until the roadway approach is widened, it may be necessary to indicate with pavement markings or temporary barriers that the additional width on the bridge cannot be used by through traffic.

3. Length. The length of the freeway bridge determines the cross section of the crossroad passing beneath the freeway. Therefore, if practical, the freeway bridge should be designed to accommodate any future widening of the underpassing roadway. This may involve an assessment of the potential for further development in the general vicinity of the underpass.

4. Roadside Safety. See Section 50-3.01.

50-2.07 Interchanges

A 3R freeway project may include proposed geometric design improvements at an existing interchange. The work may be to rehabilitate the entire interchange or to make only selective improvements to the interchange geometrics. Chapter 37 will be used to design the interchange element.

50-2.08 Median Crossovers

50-2.08(a) Permanent

Close or correct all existing median crossovers that do not meet the requirements of Section 3-400 *Median Crossovers on the Fully Access Controlled Highways*, of the Bureau of Operations *Maintenance Policy Manual* or for which a variance has not been granted by the Bureau of Operations and FHWA. When the field survey indicates locations of unauthorized median crossovers, the contract should provide for the installation of 4 in x 4 in (100 mm x 100 mm) wood posts to discourage intrusions.

Use the following for bituminous surfaces for these crossovers:

1. New Crossovers. Provide an 8 in (200 mm) of BAM meeting the requirements of the *Standard Specifications for Road and Bridge Construction*.

2. Existing Crossovers. If the existing crossover has a minimum thickness of 6 in (150 mm) of aggregate surface, grade the aggregate to a uniform cross section and cover with 3 in (75 mm) of Bituminous Concrete, Superpave, or 3 in (75 mm) of BAM meeting the requirements of the *Standard Specifications for Road and Bridge Construction*. If the

minimum thickness of aggregate is less than 6 in (150 mm), reconstruct the crossover to meet the requirements for new crossovers.

See also Section 50-3.08 for guidance on slopes for permanent median crossovers.

50-2.08(b) Temporary (for Construction)

A cost savings may be realized if some construction crossovers remain in place after the project is completed. Because these crossovers are designed to carry freeway traffic, they are often constructed with a high-type pavement that adds to the cost. If the pavement is removed, it may eventually have to be rebuilt to accommodate another project. If the crossover had remained in place, it could have been reused.

The following are examples where it may be advisable to leave temporary crossovers in place:

1. At Major River Crossings. At these locations, there is usually only one location where a crossover can be placed, and any future work will require the rebuilding of the same configuration.

2. Locations Where Physical Constraints Exist. In some instances, factors such as sight distance limitations, closely spaced structures, nearby interchanges, or elevation differences between lanes limit where a crossover can be built. At times, even though the projects may be at different locations, the location of a crossover is set by these limitations.

3. When Future Work is Planned in the Same Area. If structure work is scheduled for one year and roadway work anticipated within the next five years, the same crossover may be used for both projects. Another example is a series of structures that are rehabilitated during a multi-year program.

Where these and similar situations are encountered, the designer should consider leaving the temporary crossovers in place after the project is completed. Provisions must be included in the contract to close the crossover during the time it is not in use. Discuss these provisions at a regular district coordination meeting and obtain FHWA and Central Office concurrence.

50-3 ROADSIDE SAFETY

50-3.01 General

50-3.01(a) Objective

Although ideally the roadside should be totally forgiving to those motorists who run off the roadway, geometrics, terrain, right-of-way, and economic considerations often render this impractical on existing freeways. Therefore, the objective should be to use the available highway funds to provide the most cost-effective design. This objective will require the designer to identify hazardous features and to determine:

- which hazards should be redesigned to be made traversable,
- which hazards should be removed or relocated,
- which hazards should be shielded with an appropriate barrier, and
- which hazards are not cost effective to redesign and therefore should remain untreated.

Section 50-3 provides the designer with guidelines for recognizing these hazards and provides suggested countermeasures for 3R freeway projects. Other approved countermeasures may be substituted where maintenance, operational, or other considerations are involved. Also, although some hazards may not require treatment according to these guidelines, specific circumstances may be such that treatment is necessary.

Recurring crash locations or over-represented crashes shall be identified early in the preliminary stages of plan preparation and appropriate action included in the plans to ameliorate the cause of these crashes. A recurring crash location is defined as any location that appears on the Five Percent Report Location for any two out of three-year period in the five years prior to plan preparation.

Any item identified as requiring treatment by these guidelines may remain untreated if that item is shielded by a roadside barrier required for some other hazard. In addition, some hazards may be allowed to remain just inside the clear zone when there are other similar hazards just outside the clear zone that do not require treatment and if the crash experience for the facility does not indicate a problem with the type of hazard involved.

50-3.01(b) Safety Reviews

It is not possible to include all hazards in any one set of guidelines. Therefore, a safety or plan-in-hand field review with representatives from the district, FHWA, and BDE may be required at the request of FHWA. Contact BDE for guidance on hazards not covered in Section 50-3.

50-3.01(c) Applicability

Chapter 38 presents Department criteria on roadside safety design for new construction/reconstruction. These apply to 3R freeway projects except as modified in Section 50-3.

50-3.02 Structures

50-3.02(a) Bridge Rehabilitation

If deck replacement is not necessary, treat any substandard bridge rails (which are defined as rails which were designed prior to the 1989 AASHTO *Standard Specifications for Highway Bridges*) on mainline, interchange, and ramp structures as discussed below. Rails built to the 1965 and later specifications essentially meet the 1989 specifications and may remain in place with prior approval:

1. Metal Handrails Mounted on Safety Curbs. Corrective action for handrails in this category is:

   - to remove the curb and rail and retrofit with an F-shaped parapet providing the greatest shoulder width practical without the addition of superstructure beams, or
   - to retrofit using a metal rail as shown in the *Highway Standards*.

   The decision on which type of retrofit will be employed will be based on an economic analysis combined with maintenance and performance considerations.

2. Metal Handrail Mounted on a Vertical Face Concrete Parapet (Constructed on a Concrete Safety Curb). No corrective action is recommended for handrails in this category where the concrete safety curb is less than 9 in (230 mm) wide. Where the safety curb is more than 9 in (230 mm) wide, remove the curb and rail and retrofit with an F-shaped parapet or provide a metal retrofit rail as in Item #1.

3. Concrete Parapets with General Motors Barrier Configuration. Although this configuration may not have the same optimum redirective capability as the New Jersey configuration, it is considered acceptable. Therefore, no corrective action is recommended.

4. Wide Safety Curbs. For mainline, ramp, and interchange structures with rails not considered substandard but with safety curbs greater than 9 in (230 mm) wide, remove the curb and existing rail and retrofit with an F-shaped parapet or a metal retrofit rail as in Item #1.

Bridges that have handrails that do not fit into these categories should be referred to BDE and Bureau of Bridges and Structures for analysis and remedial treatment.

If deck replacement is not necessary and the structure has previously been treated with a metal retrofit rail, no further action is required.

50-3.02(b) Piers/Abutments

Correct or shield any piers or abutment walls located within the clear zone, which are unshielded or improperly shielded, in accordance with the following criteria:

1. Piers and Abutment Walls Located 0 ft to 2 ft (0 mm to 600 mm) from the Shoulder Edge. If the pier is not shielded by any device, provide the proper length of need of guardrail and attachment with a Traffic Barrier Terminal, Type 6 or Type 6B where the pier face is solid or where the crashwall is greater than 2 ft (600 mm) high. Where the crashwall is less than 2 ft (600 mm) high, modify by filling in the gaps between the columns with concrete to a height of 2 ft (600 mm) or use precast sections of F-shape or New Jersey barrier wall with a Traffic Barrier Terminal, Type 6 or Type 6B.

   If the pier is shielded by existing guardrail that provides proper anchorage to the pier, see Section 50-3.09, provide the proper length of need guardrail for a minimum 25 ft (7.6 m) clear zone to prevent errant vehicles from becoming trapped between the beams and the slopewall.

   See Section 38-6.06 for more information on terminal treatments.

2. Piers and Abutment Walls Located 2 ft to 4 ft (600 mm to 1.2 m) from the Edge of Shoulder. If the pier or wall is unshielded, provide a proper guardrail treatment. This treatment will include Type B rail 25 ft (7.6 m) in advance of and along the front of the hazard.

   If the hazard is shielded by existing guardrail, add posts, where necessary, to provide Type B rail as above and a runout length sufficient for a 25 ft (7.6 m) clear zone as in Item #1.

3. Piers and Abutment Walls Located 4 ft (1.2 m) or More from the Shoulder Edge. Treat unshielded piers as follows:

   - If the foreslope is steeper than 1V:6H, the guardrail should be located at the shoulder line.
   - If the foreslope is between 1V:6H and 1V:10H, place the guardrail 4 ft (1.2 m) from the pier or abutment wall provided there will be at least 12 ft (3.6 m) between the shoulder hinge point and the rail. Otherwise, place the guardrail at the shoulder line.
   - If the foreslope is or can be graded to 1V:10H or flatter, place the guardrail 4 ft (1.2 m) from the structure.

- Consider other options (e.g., sand barrels or other appropriate NCHRP 350 crash TL-3 tested devices) if space permits and the placement requirements of Section 38-8.05(d) can be obtained.

If there is existing guardrail at least 4 ft (1.2 m) from the structure, provide the proper runout length. If it is less than 4 ft (1.2 m) from the structure, install additional posts to provide 25 ft (7.6 m) of Type B rail in advance of the structure and along the front of the structure.

For overhead grade separation structures with vertical face abutments 30 ft (9 m) from the edge of traveled way, no remedial treatment is warranted. However, concrete headwalls or ditch drainage pipe projecting through the bridge cone, parallel to the mainline, should be cost evaluated for remedial treatment where necessary.

50-3.02(c) Overhead Bridge Structures

Guidelines for upgrading overhead bridge structures and roadways that cross the freeway at locations other than interchanges are as follows:

1. In general, all upgrading should be in accordance with existing 3R guidelines for the roadway classification of the overhead facility. See Chapter 49 or *Bureau of Local Roads and Streets Manual*.

2. Guardrail to remain in place shall be upgraded with the addition of posts and/or blockouts to provide a minimum 6 ft 3 in (1905 mm) post spacing. Also provide a proper connection to the bridge.

3. Repair, retrofit, or replace any rails on bridges that:

   - can be easily penetrated by an “average” vehicle (usually assumed to be a full-size domestic passenger car),
   - show evidence of crash damage,
   - are in questionable condition, or
   - contain irregularities that could cause intolerable vehicular decelerations.

   If replaced, rails and their connections to the deck shall meet current AASHTO strength and functional requirements. Because of the high potential for severe crashes if a vehicle penetrates a rail and lands on the freeway, retrofit or replace all substandard rails where the current ADT is greater than 750 or 50 MUs per day.

4. Remove any curb sections that project more than 9 in (230 mm) but less than 3 ft (915 mm) from the face of the rail or install new retrofit rail elements to shield the curb where the ADT is greater than 400 or 40 MUs per day.

50-3.02(d) Overhead Bridge Cones

The following presents guidelines for upgrading safety features on existing overhead bridge cones with 1V:2H side slopes located within the clear zone of the freeway.

Examine the cones and, if needed, modify the toe of the slope to prevent bumper penetration by errant vehicles. Using the roadway foreslopes and the bridge cone slope in the severity index curve in Figure 50-3.A, a severity index greater than 1.0 indicates that remedial filling and grading at the toe of the bridge cone may be warranted.

50-3.03 Drainage Structures

50-3.03(a) Pipe Culverts

When evaluating existing cross drainage pipe structures 54 in (1400 mm) or less, use the criteria presented under the first point of Section 49-3.07(e).

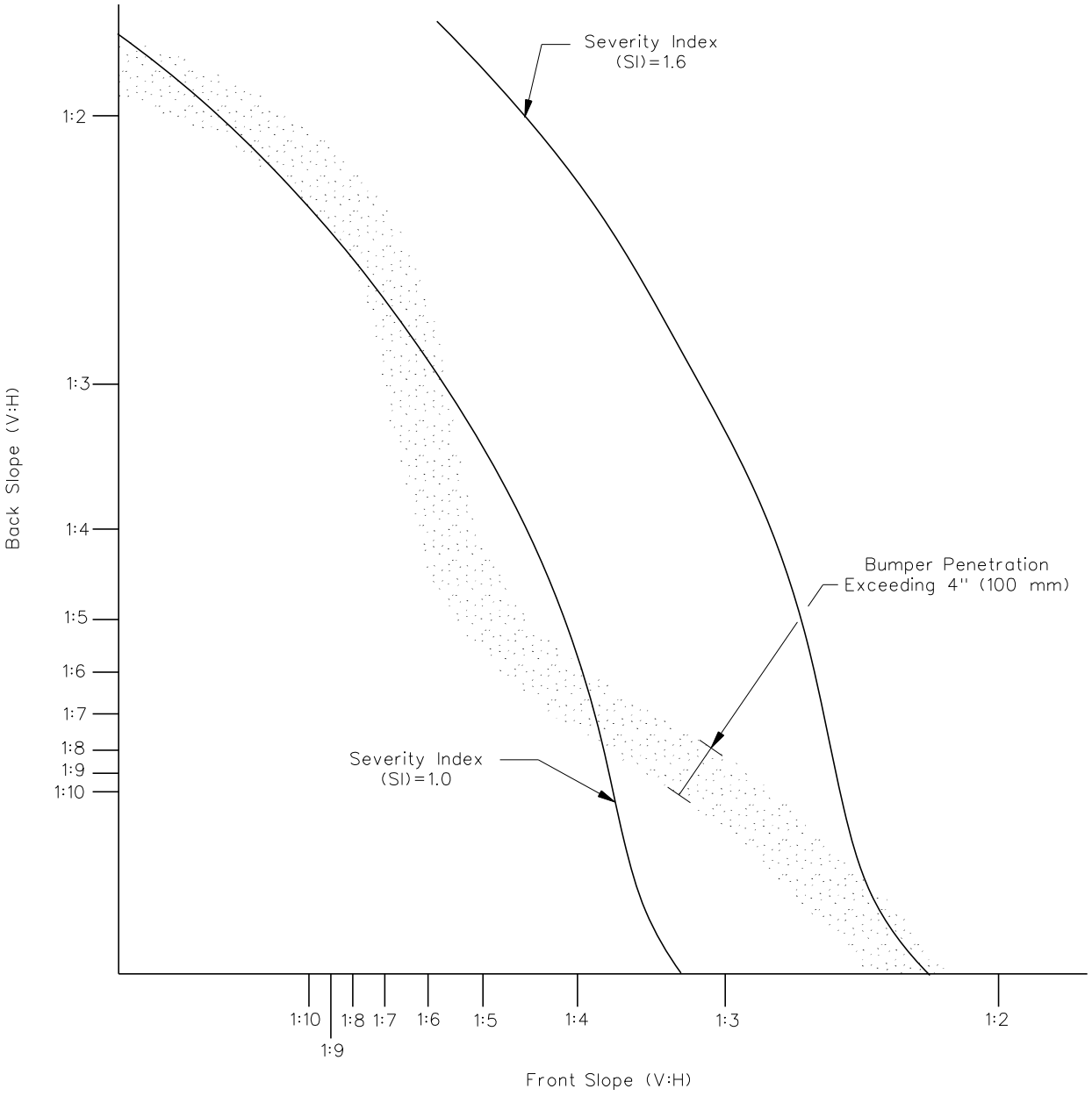
50-3.03(b) Headwalls (Small Culverts)

Treat all headwalls on box culverts 48 in x 48 in (1219 mm x 1219 mm) and less as follows:

1. If the headwall is within 8 ft (2.4 m) of the edge of the paved shoulder, extend the culvert to the embankment slope or to at least 8 ft (2.4 m) and, with the use of a cast-in-place concrete collar, add a standard end section with grate.

2. For box culverts with a drop off of 3 ft (914 mm) or less where the headwall matches the embankment slope and is more than 8 ft (2.4 m) from the edge of the paved shoulder, no further treatment is required.

3. If the dropoff is more than 3 ft (914 mm) and the headwall is more than 8 ft (2.4 m) from the edge of the stabilized shoulder, use a cast-in-place concrete collar and add a standard end section with grate.



Note: Severity Index and bumper penetration contours based on 12 in (300 mm) ditch, 60 mph (95 km/h), and 25 degree encroachment angle.

SEVERITY INDICES FOR ROADSIDE DITCHES

Figure 50-3.A

50-3.03(c) Headwalls (Large Culverts)

Treat all headwalls on pipe culverts greater than 54 in (1372 mm) in diameter and on box culverts greater than 48 in x 48 in (1220 mm x 1220 mm) which are less than 30 ft (9 m) from the edge of traveled way as follows:

1. For pipe culverts up to 66 in (1675 mm) in diameter and box culverts with a span not more than 12 ft (3.6 m) or a rise of not more than 5 ft 6 in (1.7 m), place a special grated end section using pipes for the grate. Guidelines for the design of the end section are:

    - Use a 4 in (101 mm) I.D. pipe meeting the requirements of ASTM A-53, Grade B, Schedule 40.

    - The maximum spacing for the pipes is 30 in (760 mm) on center with a preferred spacing of 15 in to 24 in (380 mm to 610 mm) on center. The minimum spacing is 12 in (300 mm) on center.

    - The slope on the end section should match the embankment slope with a maximum slope of 1V:4H.

2. For pipe culverts greater than 66 in (1675 mm) in diameter and box culverts with span or rise greater than in Item #1, shield with shoulder-mounted guardrail. Except if earth slopes between the shoulder edge and headwall offset are 10:1 or flatter within the required runout distance, install guardrail at the culvert headwall.

50-3.03(d) Cost-Effective Analyses

For all culverts greater than 36 in (915 mm) in diameter more than 30 ft (9 m) from the edge of traveled way, prepare a cost-effective analysis to determine if a safety treatment is warranted. See Section 38-4.03 for Department policies on cost-effective analyses.

50-3.03(e) Raised Median Inlets

Replace raised median inlets with flush inlets as follows:

1. If the median is less than 65 ft (19.5 m) wide, replace all raised inlets.

2. For medians 65 ft (19.5 m) wide and greater, replace raised inlets only where the ADT is greater than 20,000.

50-3.04 Sign Supports

50-3.04(a) Wood Posts

Treat all wood posts as follows:

1. Drill or notch 6 in x 6 in (150 mm x 150 mm) wood posts at a point 4 in (100 mm) above the ground to reduce the cross sectional area to that for an S4S 4 in x 6 in (100 mm x 150 mm) post. The direction of drilling must be perpendicular to the roadway and the notches must be on the backside of the post.

2. No more than two posts may be used in a 7 ft (2.1 m) wide path. If more than two posts are within a 7 ft (2.1 m) path, remove the posts or relocate the signs.

50-3.04(b) Steel Posts

Steel posts that are not breakaway shall be made breakaway unless shielded by guardrail required for other hazards. Also, all supplemental signs below the fuse plate shall be mounted such that they will not affect the breakaway action of the post.

50-3.04(c) Concrete Foundations

Concrete foundations for steel posts located within the clear zone must have no portion of the foundation or stub projection extending 4 in (100 mm) or more above the grade. Regrading, or removal and replacement, is required for all foundations where the projection exceeds 4 in (100 mm).

50-3.04(d) Sign Foundations

Treat all cantilever and sign truss foundations as follows:

1. Shield foundations located within the clear zone as in Section 50-3.02(b). Upgrade any existing guardrail used to shield foundations to current standards. An impact attenuator system may be used in lieu of a barrier.

2. Foundations located 30 ft (9 m) or more from the edge of traveled way do not require remedial treatment.

50-3.05 Light Standards

The following applies:

1. Concrete foundations for other than tower lighting must not project more than 4 in (100 mm) above the grade; otherwise, regrade or remove and replace the foundation.

2. Install breakaway bases for unshielded light poles other than tower lights. Use non-breakaway poles:

    - on urban freeways where there is a possibility that the pole may fall on an area with high pedestrian traffic, and

- in rest areas and weigh stations.

3. Treat tower lights as in Section 50-3.04(d). Impact attenuator systems may be used in lieu of barrier.

50-3.06 Trees

Remove all trees within the clear zone that, at maturity, will be 4 in (100 mm) or greater in diameter. Also, remove trees that restrict proper sight distance or trees located immediately behind breakaway devices (e.g., sign supports, light poles).

50-3.07 Gutter and Combination Curb and Gutter

Treat non-traversable gutter sections and raised barrier curbs as discussed below. Non-traversable gutters are those gutters that could snag a wheel or cause other violent vehicular reactions if traversed by an errant vehicle. Raised barrier curb for this purpose is defined as any curb which will be greater than 3 in (75 mm) in height after any resurfacing on the project is placed. Corrective work on gutters or curbs may also require revisions to existing drainage structures. If these revisions will result in excessive costs, the designer may consider rebuilding the curb or gutter as traversable.

The following applies to gutters and combination curb and gutter:

1. Remove any non-traversable gutter sections at the edge of traveled way or shoulder, or modify to make them traversable.

2. Remove any raised curb in exit gore area, and level the gore.

3. The removal of raised curb at the edge of shoulder, 1 ft (300 mm) in front of guardrail, and in entrance gore areas is not cost effective when modifications are also required to drainage structures. If no extensive regrading or modification to drainage structures is required, the designer should consider its removal.

4. Remove all curbs greater than 2 in (50 mm) high in advance of impact attenuator systems or guardrail terminals. If curb is required for drainage or delineation in advance of the impact attenuator or terminal, use a Type M-2 (M-5) curb.

50-3.08 Slopes for Earth Ditch Checks and Permanent Median Crossovers

The following applies:

1. Slopes (No Inlet Boxes). Regrade all existing earth ditch checks and median crossovers without inlet boxes to provide a 1V:10H slope. Note that regrading existing ditch checks may create a condition where motorists may use the ditch check as an illegal crossover. Place 4 in x 4 in (100 mm x 100 mm) wood posts in these areas to discourage illegal crossings. See Section 50-3.04(a) for wood post spacing.

2. Slopes (With Inlet Boxes). Treat all existing ditch checks and median crossovers with inlet boxes as follows:

    - If the median width is less than or equal to 42 ft (12.8 m) and the slope of the inlet box is 1V:4H, regrade the ditch check to 1V:10H and install a new inlet box for all ADT's over 50,000. 1V:4H ditch checks may remain if the ADT is less than 50,000.

    - If the median width is 44 ft (13.4 m) or greater, 1V:4H ditch checks may remain in place for all ADT's.

    - If the existing inlet box is 1V:6H or flatter, no treatment is necessary regardless of median width or ADT.

Remove any existing ditch checks that are not essential.

50-3.09 Guardrail

Identify and correct all guardrail deficiencies for all ADT. The designer should carefully analyze all existing guardrail installations to determine if the guardrail should be removed or upgraded in accordance with Section 38-6 and the following:

1. Guardrail Removal. An existing guardrail installation should be removed when a life-cycle benefit to cost analysis shows this is preferable to updating, and maintaining the guardrail. Roadside Safety Analysis Program (RSAP), provided by AASHTO, is one tool available for this analysis.

2. Guardrail Upgrading. Follow the analysis in Section 49-3.07(d) to determine whether existing guardrail may remain.

3. End Sections. Ensure all guardrail end sections for existing guardrail meets the approved lists of devices in force in December 2006, or subsequent versions appropriate for later *Highway Standards* for guardrail. Ensure all transitions from guardrail to bridge rails or to structures meet the *Highway Standards* in effect in December 2006, or subsequent versions appropriate for later *Highway Standards* for guardrail.

4. Insufficient Length. Use the length-of-need criteria in Section 38-6.01 to determine the sufficiency of the existing length of guardrail based on the posted speed. Upgrade existing guardrail that is deficient in length by more than 10% to provide a proper length of need. Guardrail less than 10% deficient in length may remain in place unless crash data shows that the additional length will reduce crash severity. Also, provide the proper length of need if placement of a new crashworthy terminal is required. Where practical, the designer should shorten the required length of need by tapering the barrier away from the traveled way.

5. Roadside Cable Barrier. Conduct special studies to determine the installation of new or disposition of existing cable-guard or cable barrier. If it appears desirable to use cable barrier for roadside hazards, see Section 38-6.02. Contact the Bureau of Safety Engineering regarding other possible uses on a case-by-case basis.

6. Cable Median Barrier. See Section 38-07 for guidance. For adjustment of existing cable median barrier, contact the Bureau of Safety Engineering.

7. Median Guardrail at Dual Structures. The former Highway Standard for "Traffic Barrier Terminal, Type 4" does not meet NCHRP 350 criteria. If the guardrail in the median does not meet NCHRP 350 for this or other reasons, the following corrective treatment is appropriate:

   - Use an appropriate NCHRP 350 device.

   - Remove the guardrail and treat the opening between the bridges as a non-traversable roadside obstacle with sufficient length of shoulder-mounted Steel Plate Beam Guardrail, Type A preferably, flared as shown in Figure 38-6.O. For the approach end of the guardrail, provide an appropriate crashworthy end treatment, and provide the appropriate connection to the bridge.

8. Gaps. Unless unusual circumstances dictate otherwise, remove any gaps that are less than 200 ft (60 m) in length between warranted guardrail by installing new guardrail.

9. Re-Grading. Where the remedial treatment recommendation is to add a roadside barrier or impact attenuator system, re-grade the slope of the approach to the barrier or system to be 1V:10H or flatter. This grading shall be sufficient to also provide for a 1V:10H or flatter slope in advance of the barrier or system for a vehicle leaving the roadway at a 5-degree to 10-degree angle.

50-3.10 Impact Attenuator Devices

The following applies:

1. Evaluate any existing impact attenuator devices for conformity with the criteria in Section 38-8. If the array or configuration is inappropriate for the obstacle being shielded, implement any needed modification.

2. Shield any obstacle that warrants an impact attenuator device, which presently has none, with an appropriate system. See Section 38-8.

50-3.11 Concrete Barrier Walls

Correct the approach ends of concrete barrier walls which terminate in the clear zone with the 80 ft (24.4 m) long concrete tapered transition (shown on superseded Standard 2333) by removing the taper and replacing it with an appropriate NCHRP 350 Test Level 3 end treatment.

50-3.12 Chain Link Fence

Where the ADT is greater than 30,000, modify all lengths of chain link fence located near the edge of the clear zone with a top rail which is susceptible to impact by errant vehicles (either on the mainline or adjacent roadways) by replacing the top rail with tension wire. Replace the top rail for all chain link fence located immediately adjacent to the traveled way for all ADTs.

50-3.13 Crossroads

Upgrade all crossroads, both at interchange and non-interchange locations, for safety within the limits of the original Interstate funding. The safety work will meet the 3R guidelines for the classification of roadway involved. See Chapter 49 and the Bureau of Local Roads and Streets policies. Provide special attention to ramp terminals, and consider improving the turning radii where there is evidence of the design vehicle encroaching on opposing traffic lanes or curbs. See Chapter 37.