

TRAFFIC SAFETY SYSTEMS GUIDANCE



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FOREWORD

This guidance was prepared by the Division of Traffic Operations to establish uniform practices and guidance for the traffic safety systems of the Department. This guidance does not constitute a standard, specification or regulation. Field and economic conditions may call for variation from this guidance's requirements and may be subject to approval by designated levels of management in the district or at Headquarters.

This guidance is neither a textbook nor a substitute for engineering knowledge, experience or judgment. It includes techniques as well as graphs and tables not ordinarily found in textbooks. These techniques are intended as aids in the solution of field conditions.

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Topic 1 – General Information and Standards

1.1 Introduction

Traffic safety systems are highway features designed primarily to reduce the severity of run-off-road collisions, prevent errant vehicles from crossing the median, and decelerate errant vehicles. These features include, but are not limited to, guardrail, crash cushions, median barrier, end treatments, breakaway supports for signs and light standards, and truck escape ramps. (For more information about the design of truck escape ramp facilities, see Traffic Bulletin No. 24 and NCHRP Report 178.)

1.2 Roles and Responsibilities

The District Traffic Safety Office or District Traffic Operations Office is the primary district functional unit responsible for the application of standards and policies for use of traffic safety systems on State highways. The Headquarters Office of Traffic Engineering ensures quality control of those standards and policies, and the Headquarters Traffic Safety Systems Branch, Chief has authority over certain standards. The Division of Maintenance ensures the most efficient use of personnel and materials resources for those applications. The Project Engineer signs and stamps the project plans and is responsible for the selection and placement of traffic safety systems used in the project.

The following establishes the role and responsibility of Headquarters or district personnel involved in decisions regarding installation or upgrade of traffic safety systems.

1. *Project Engineer*: The Project Engineer specifies traffic safety systems and shows their placement on the project plans. The engineer coordinates with the District Traffic Safety Office/Branch to complete the *Exceptions to Traffic Safety System Standards* form, see Appendix A.
2. *District Traffic Safety Systems Coordinator*: The District Traffic Safety Systems Coordinator is the primary contact for inquiries about traffic safety systems in the respective districts. The coordinator provides guidance for use of traffic safety systems and makes recommendations for exceptions to Traffic Safety System Standards that require District and Headquarters approval.
3. *District Traffic Safety Engineer*: The District Traffic Safety Engineer, or their designee, ensures compliance with the traffic safety systems policies in this guidance. The engineer recommends exceptions to traffic safety system standards that require Headquarters approval, and approves exceptions to the traffic safety system standards that require district approval.
4. *Deputy District Director of Traffic Operations*: The Deputy District Director of Traffic Operations, or their designee, along with the Deputy District Director of Maintenance, approves the use of cable guardrail and cable median barrier.
5. *Deputy District Director of Maintenance*: The Deputy District Director of Maintenance, or their designee, along with the Deputy District Director of Traffic Operations approves the use of cable guardrail and cable median barrier.
6. *Headquarters Traffic Safety Systems Branch, Chief*: The Headquarters Traffic Safety Systems Branch Chief, or their designee, advises on the use of traffic safety systems and is the first contact in Headquarters Division of Traffic Operations for inquiries from district personnel. The Headquarters Traffic Safety Systems Branch Chief approves exceptions to the traffic safety system standards that require Headquarters approval. Also, approves the exceptions for the use of concrete guardrail where the criteria in Topic 3.2(2) are not met.
7. *District Maintenance Engineer*: The District Maintenance Engineer is consulted regarding use of thrie beam barrier as outlined in Table 7.
8. *Construction Engineer*: The Construction Engineer inspects and oversees the placement of traffic safety systems within a construction project and ensures that they are in compliance with the project plans, the Standard Plans, non-standard special provisions, and the policies contained within traffic safety systems guidance. The construction engineer coordinates with the District Traffic Safety Systems Branch and the project engineer on the placement of these systems and the need for field changes to the plans concerning changes and installation of traffic safety systems.

1.3 Traffic Safety System Standards

This section identifies the traffic safety system standards which are defined and implemented as follows:

Headquarters Approval Required: Statements of required practice that are considered the most essential are traffic safety system standards that use the word “shall” and are printed in **boldface** type. Deviations from those standards are approved by the Headquarters Traffic Safety Systems Branch Chief, documentation requirements for the approval process for exceptions to traffic safety system standards requiring Headquarters approval is in the appendix, and the editable format is posted on the Division of Traffic Operations, Office of Traffic Engineering, Traffic Safety Systems Branch web site. See [Table 2](#) for the list of Traffic Safety System Standards that require Headquarters approval for exceptions.

District Approval Required: Statements of recommended, but not essential practice in typical situations, with deviations allowed if engineering judgment or engineering study indicates the deviation to be appropriate, are Traffic Safety System Standards that appear in underlined type. The verb “should” is typically used. Deviations from those standards are approved by the District Traffic Safety Engineer. The documentation requirements for the approval process for exceptions to Traffic Safety System Standards requiring District approval is in the appendix, and the editable format is posted on the Division of Traffic Operations, Office of Traffic Engineering, Traffic Safety Systems Branch web site. See [Table 3](#) for the list of traffic safety system standards that require District approval for exceptions.

Procedural Traffic Safety System Requirements: Procedures required for the use of traffic safety systems are indicated by the word “must” and are enclosed with boxes in the text. The procedures may involve actions by the Headquarters Traffic Safety Systems Branch Chief and/or the District Traffic Safety Engineer, along with the District Maintenance Engineer, or the Deputy District Directors for Traffic Operations and Maintenance.

Where documentation in the project files is required, the district may determine its type. Guidance for documentation requirements in 3 and 6, except Topics [3.2](#), [3.6\(2\)](#) and [3.6\(6\)](#), is provided below.

- *Topic 3.4:* A statement of concurrence that addresses all locations in the Project Plans, as indicated in the Typical Cross Sections

and Summary of Quantities, and may address applicable Layout Sheets.

- *Topic 3.5:* A statement of concurrence that addresses all locations in the Project Plans, as indicated in the Summary of Quantities, and may address applicable Layout Sheets.
- *Topic 3.6:* A statement of concurrence that addresses all locations in the Project Plans, as indicated in the Typical Cross Sections and Summary of Quantities, and may address applicable Layout Sheets.
- *Topic 6.3:* A statement of concurrence that addresses all locations in the Summary of Quantities, and may address applicable Layout Sheets.

For the above topics, copies of the identified Project Plans Sheets may supplement the documented statements of concurrence inserted in the project files. See [Table 4](#) for the list of procedural traffic safety system requirements.

Permissive Traffic Safety System Standards: Permissive Traffic Safety System Standards are statements of practice that are permissive conditions and carry no requirements or recommendations. Permissive statements texts appear in normal type. The verb “may” is typically used for permissive Traffic Safety System Standards.

1.4 Traffic Safety System Designs and National Traffic Safety System Crash Testing Guidelines

This topic discusses the use of Caltrans approved traffic safety system designs and provides an overview of the national traffic safety systems crash testing guidelines that are the basis for the designs. These designs are based on full-scale crash test and are conducted under controlled conditions generally associated with typical highway features. It also addresses upgrading traffic safety systems in projects other than projects programmed in the Collision Reduction Category of the State Highway Operation and Protection Program (SHOPP).

1. *Standard Designs:* The Standard Plans contain design details for the construction of some non-proprietary traffic safety systems. Standard Plans cannot always be directly applied to all situations on existing roadways, and some design modifications may be needed. Modified or unique non-proprietary traffic safety system

designs require review and approval of a Headquarters Traffic Safety Systems Branch Chief. All approved traffic safety systems are listed on the Department's Pre-Qualified Products List (Authorized Materials List) for Highway Safety Features and available from the Traffic Safety Systems Coordinator.

2. *Overview of Crash Testing Guidelines:* The Department has adopted the Manual for Assessing Safety Hardware (MASH), which was published by the American Association of State Highway and Transportation Officials (AASHTO). The MASH Implementation memo, dated December 23, 2016, lists the sequence of dates that MASH safety devices will take effect. Full MASH compliance will be achieved by October 31, 2019. In MASH, procedures are presented for conducting vehicle crash tests and in-service evaluation of roadside safety features or appurtenances. The procedures are directed toward the safety performance of roadside safety features; other service requirements such as economics and aesthetics are not considered.

The crash testing procedures are devised to subject roadside safety features to severe vehicle impact conditions rather than to typical or average highway situations. For vehicle crash testing, specific impact conditions are presented for vehicle mass, speed, approach angle and critical impact point on the safety feature. The crash test results are based on frontal impacts of vehicles; the crash testing criteria do not include side or rear impacts by vehicles. Three primary appraisal factors are presented for evaluating the crash test performance: structural adequacy, occupant risk and after-collision vehicle trajectory.

MASH updates the guidelines for in-service evaluations provided in NCHRP Report 350, which became effective October 1, 1998. MASH recognizes the complex nature of vehicular collisions and the limited resources of agencies responsible for monitoring the performance of

new or modified safety features. (See [Table 1](#), Crash Test Levels). In accordance with the MASH Implementation memo, once a large enough section of the existing system is damaged and requires a project to replace the system, only Caltrans approved MASH safety systems will be allowed on California State Highways.

3. *Upgrading Traffic Safety Systems:* Standards for traffic safety systems have evolved over time and continue to change in response to changing technology, research findings, and changes in the design and speed of vehicles. Consequently, some existing traffic safety systems may not comply with the latest adopted crash testing guidelines. It is often neither economically feasible nor practical to upgrade existing installations when revisions are made to current crash testing guidelines.

When major work is done in a project, which is funded by STIP, Local Agencies, Propositions, Federal Government, SHOPP Resurfacing, Restoration & Rehabilitation (2R), or Assets Management (Multi Assets Projects), traffic safety systems must be upgraded to current standards. With other SHOPP programs, upgrading to current standards should be done provided that SHOPP program guidelines allow it.

Table 1: Crash Test Levels

TEST LEVEL	TEST VEHICLE DESIGNATION AND TYPE		TEST CONDITIONS	
	MASH	NCHRP Report 350	SPEED (MPH)	ANGLE (degrees)
2	1100C (Passenger Car)	820C (Passenger Car)	44	25
	2270P (Pickup Truck)	700C (Passenger Car)	44	25
		2000P (Passenger Car)	44	25
3	1100C (Passenger Car)	820C (Passenger Car)	62	25
	2270P (Pickup Truck)	700C (Passenger Car)	62	25
		2000P (Passenger Car)	62	25
4	1100C (Passenger Car)	820C (Passenger Car)	62	25
	2270P (Pickup Truck)	700C (Passenger Car)	62	25
	10000S (Single Unit Truck)	2000P (Passenger Car)	56	15
		8000S (Single Unit Truck)	56	15

**Table 2
Standards Requiring Headquarters Approval for Exceptions**

Topic 3 Guardrail	3.6(10)(l) Curb and Dike in front of Guardrail
Index 3.2(2) Concrete Guardrail Offset	3.6(11) Offsetting and Overlapping Guard-rail
3.5 Strengthened Guardrail	
3.5 Guardrail at Fixed Objects	Topic 04 Median Barrier
3.6(1) Breakaway Anchors	Index 4.5(1) Concrete Barrier
3.6(3) Mountable Dike	4.5(2) Thrie Beam Barrier
3.6(3) Curb and Dike with MGS with 8-inch Blockouts or MBGR	4.5(2) Thrie Beam Barrier Maintenance Offset
3.6(4) Cross Slopes 10:1 or Flatter	4.6(2) Thrie Beam Barrier Saw-Toothed Median Section
3.6(7) Guardrail in Cut Slops	4.7(1) Longitudinal Median Dikes
3.6(8) Anchored to Pavement	4.7(6) Planted Medians
3.6(8) Anchored to Structures	4.7(11) Pavement Overlays
3.6(8)(c) Transitions to Structures	4.8(3) Access Opening Intervals
3.6(10)(b) Consecutive Post	Topic 5 Outer Separation Barrier
3.6(10)(c) Special Post Footing	Index 5.2 Outer Separation Barrier Criteria
3.6(10)(d) Adjusting Rail Height	
3.6(10)(g) Weathered W-Beam Treatment	

Table 3
Standards Requiring District Approval for Exceptions

<p>Topic 2 Clear Recovery Zone Concept</p> <p>Index 2.3 United States Postal Service Mailboxes</p>	<p>3.6(10)(b) Multiple blocks Long Span Nested Guardrail (add fig back in)</p>
<p>Topic 3 Guardrail</p> <p>Index 3.2(1) MGS Guardrail Selection Mixing Guardrail Post Types</p> <p>3.2(2) Pavement Beyond Concrete Guardrail</p> <p>3.5 Continued Strengthened Railing Section at Columns Shielding of Trees Shielding Median Structure Columns Guardrail on Two-Lane Highways Guardrail on Two-Way, Multi-Lane Highways</p> <p>3.6(1) Guardrail Minimum Length of Need Guardrail Length of Need</p> <p>3.6(2) Transition Railing at structure approaches or concrete barrier</p> <p>3.6(2)(a) Two-Way Conventional Highway</p> <p>3.6(2)(b) Multi-Lane Highway with Separate Structures</p> <p>3.6(2)(c) Multi-Lane Freeways or Expressways with Decked Medians Bridge with Wide Clear Width</p> <p>3.6(3) Dike Flush with MGS</p> <p>3.6(6) W-Beam in Rock</p> <p>3.6(8) Concrete Guardrail Support Pad Intermediate Guardrail Anchorages Guardrail Anchorages Side Slope</p> <p>3.6(9) Gaps Between Guardrail Installations</p> <p>3.6(10)(a) Restricted Horizontal Clearance to Hinge Point</p>	<p>3.6(10)(f) Guardrail Delineation</p> <p>3.6(10)(h) Guardrail in Fire Prone Areas</p> <p>3.6(10)(l) Pullouts</p> <p>3.6(11) Offsetting and Overlapping Guardrail</p> <p>Topic 4 Median Barrier</p> <p>Index 4.4 Freeway Traffic Volume/Width Study Warrant</p> <p>4.4(1) Building New or Widening Freeways</p> <p>4.4(5) Incremental Improvements</p> <p>4.7(2) Median Ditches</p> <p>4.7(3) Scuppers</p> <p>4.7(4) Median Barriers on Raised Medians</p> <p>4.7(5) Paving Flat Medians with Barriers</p> <p>4.7(7) Future Construction with Concrete Median Barriers</p> <p>4.10 Delineation of Median Barriers</p> <p>Topic 5 Outer Separation Barrier</p> <p>Index 5.1 Outer Separation Barrier Considered</p> <p>Topic 6 Crash Cushions</p> <p>Index 6.2 Crash Cushion Evaluated</p> <p>6.3 Crash Cushion Height</p>

Table 4
Procedural Standards

Prohibited Procedural Standards

Topic 3 Guardrail

- Index 3.2(1) Guardrail Post in Pavement
- 3.2(2) Concrete Guardrail on Soil
- 5 Concrete Guardrail Use

Topic 4 Median Barrier

- Index 4.5(1) Concrete Barrier as Retaining Walls or on Soil

Documentation in Project Files Required

Topic 3 Guardrail

- Index 3.6(4) Vehicle Trajectory and Guardrail

Headquarters Traffic Safety Systems Branch Approval Required

Topic 3 Guardrail

- Index 3.6(10)(a) MBGR use of Cast-In-Drilled-Hole Piles MGS use of 8-foot wood or 9-foot steel post
- 3.6(10)(b) Special Post Footing

Topic 4 Median Barrier

- 4.5 Modification of Barrier Type Selection Criteria
- 4.5(4) Portable Concrete Barrier
- 4.6(2) Sawtooth Thrie Beam Barrier

District Traffic Safety Engineer Concur/Approval and Documentation in the Project Files Required

Topic 3 Guardrail

- Index 3.2(1) Vegetation Control
- 3.2(2) Attachments on Concrete Guardrail
- 3.4 Guardrail at Embankment Slopes
- 3.5 Guardrail at Fixed Object
- 3.6(1) Guardrail Length of Need
- 3.6(12) Deviation from Typical Layouts

Topic 4 Median Barrier

- Index 4(1) Freeway Median Barrier
- 4.4(2) Expressway Median Barrier
- 4.5(1) Aesthetic Treatments
- 4.5(1) Attachments on Concrete Barrier
- 4.7(3) Scuppers in Median Barrier
- 4.7(8) Median Barrier and Cross Slope
- 4.7(12) Wildlife Passageways
- 4.8 Barrier Openings
- 4.9 Glare Screens

Topic 6 Crash Cushions

- Index 6.3 Crash Cushion Placement

Deputy District Directors of Traffic Operations and Maintenance Approvals Required

Topic 3 Guardrail

- Index 3.2(3) Cable Guardrail

Topic 4 Median Barrier

- Index 4.5(3) Cable Barrier

District Traffic Safety Engineer Approval Required

Topic 3 Guardrail

- Index 3.2(2) Concrete Guardrail

Topic 2 – Clear Recovery Zone Concept

2.1 Introduction

An area clear of fixed objects adjacent to the traveled way is desirable to provide a clear recovery zone (CRZ) for vehicles that leave the traveled way. Thirty feet should be considered the minimum clear recovery zone where possible for freeways and high-speed expressways. In accordance with MASH, high-speed is defined as operating speeds greater than 45 mph.

On most conventional highways, a 30-foot CRZ may be difficult to justify for engineering, environmental or economic reasons. For these reasons, a minimum CRZ of 20 feet on conventional highways is advised.

Site-specific conditions such as volume, speed, alignment, side slope, weather, and environmental conditions need to be considered when determining the CRZ. Guidance can be found in the *Caltrans Highway Design Manual*, Topic 309.1, and the *Roadside Design Guide*, Chapter 3, published by AASHTO for more information on the CRZ and how it can vary depending upon the roadway alignment, side slope, and traffic volumes.

The installation of new fixed objects within the CRZ is to be avoided whenever practical on all projects. Fixed objects located in the CRZ, in order of preference, should be:

1. Removed/relocated, or
2. Made breakaway, or
3. Shielded
4. Delineate the obstacle

2.2 Remove/Relocate the Fixed Object

The options available to remove or relocate a fixed object are as follows:

1. Remove the fixed object if practicable.
2. Move the fixed object to a location that is less likely to be hit, such as up a slope or behind guardrail or wall required for other reasons. A fixed object placed at least 5 feet up a cut slope (measured vertically from the toe of slope at a minimum 3:1 although 2:1 is preferred) is considered outside of the CRZ. See the *California MUTCD*, Section 2A.19.

3. Relocate the fixed object as far as possible from the traveled way to minimize its chances of being struck. Non-traversable ditches, drainage structures, columns, utility poles, and overhead sign structures may be handled by this method.
4. Relocate a fixed object in the median or gore to a location beyond the right CRZ, thereby reducing the risk of exposure to at least one direction of travel.

2.3 Make the Fixed Object Breakaway

Fixed objects that cannot be moved out of the CRZ should be considered for breakaway treatment. These include but are not limited to the following:

- light standards
- ground-mounted sign supports
- mailbox supports
- call boxes
- chain control signs

Light standards are used with a three-point triangular slip-base where breakaway treatment is needed. The Standard Plans contain details for this feature. All light standards located within the CRZ are to have a slip-base except where there is high potential for pedestrians to be struck by the falling light standard, or when there are conflicts with traffic.

The laminated wood box beam is the standard breakaway support system for large ground-mounted signs. Intermediate size ground-mounted signs may be mounted on dimensioned wood posts. Any sign post 4 inches x 6 inches or larger is to be drilled to make it breakaway. Details for the size and location of the holes are contained in the Standard Plans.

Small ground-mounted signs may be supported on dimensioned wood posts or approved commercially available yielding steel supports. Contact your District Traffic Safety Systems Coordinator for information regarding commercially available yielding steel supports.

If non-proprietary supports are used, mailboxes are to be mounted either on wood posts no larger than a nominal 4 inches x 4 inches, considered the maximum breakaway size, or a steel pipe no larger than a nominal 2 inches in diameter. Spacing between mailbox posts shall be at least $\frac{3}{4}$ the height of the post. Multiple mailboxes are not to be mounted on a longitudinal rail within the CRZ.

There is an approved commercially available yielding mailbox support system that will accommodate up to four mailboxes. The steel mailboxes installed by the U.S. Postal Service should not be installed in the CRZ. For more information about mailbox support design and placement, see the *Roadside Design Guide*, Chapter 11, “Erecting Mailboxes on Streets and Highways.”

Call boxes and chain control signs on steel posts should be mounted on slip-bases, unless otherwise shielded. Other features in the vicinity are not to impede the function of the breakaway device or adversely influence the vehicle response.

Breakaway objects are not to be placed behind guardrail or bridge rail. For more information about breakaway electrical devices and slip bases see the *Traffic Manual*, Chapter 9.

At the time of publications, October 31, 2019, when all bridge rails will be to MASH standard.

2.4 Shield the Fixed Object

If it is not practical to eliminate, relocate, or make a fixed object breakaway, it should be considered for shielding. All traffic safety systems used to shield fixed objects are also fixed objects. Traffic safety systems do not prevent collisions but are intended to reduce the severity by shielding a fixed object. See also [Topic 3.5](#), Guardrail at Fixed Objects, for more information.

Longitudinal railings or barriers such as guardrail, median barrier, and bridge railing are designed to redirect a vehicle, and can be used to shield fixed objects. Fixed objects within the CRZ should only be shielded when the consequences of impacting the obstacle are considered to be significantly more serious than striking the barrier.

Crash cushions can be used to shield fixed objects or the ends of barriers, and are designed to safely decelerate passenger vehicles to a stop in head-on impacts. See [Topic 6](#) for more information about crash cushions.

See [Table 5](#) of commonly placed fixed objects and if they are considered for shielding if within the CRZ and cannot be removed/relocated or made break away.

2.5 Delineate the Fixed Object

When an obstacle cannot be removed, relocated, made break away or shielded, the object at a minimum should be delineated with an approved object marker.

OBSTACLES WITHIN THE DESIGN CRZ AS NOTED	TRAFFIC BARRIER
Embankments, critical and traversable, non-recoverable embankments without run-out area.	Typically YES, consult with District Traffic Safety Engineer.
Bridge Piers, Parapets, etc.	Typically YES, consult with District Traffic Safety Engineer.
Signs/Lighting standards which cannot be made breakaway.	Consult with District Traffic Safety Engineer.
Streams or other permanent bodies of water more than 2-ft. in depth.	Typically YES, consult with District Traffic Safety Engineer.
Drainage Features – ditches, headwalls, etc.	Typically YES, consult with District Traffic Safety Engineer.
Trees	Engineering judgment based on severity of obstacle and site specific circumstances.
Controller and other Cabinets	Typically YES, consult with District Traffic Safety Engineer.

Table 5
Commonly Placed Fixed Objects

Topic – Guardrail

3.1 Introduction

Guardrail, installed to reduce the severity of run-off-road collisions, is the most common traffic safety system found on California State Highways. Guardrail may redirect an errant vehicle and dissipate energy from the collision in some, but not for all cases depending on the sequence of events during the collision. Although guardrail is itself a fixed object, it may reduce collision severity in situations where it is determined that striking the guardrail is less severe than striking fixed objects or slopes behind the guardrail.

1. *Definition of Use:* Guardrail is used as a longitudinal rail off of the edge of pavement to shield areas of concern. It is typically installed to the right of approaching traffic, but may be installed to the left (e.g., one-way traffic roadbeds on separate alignments, ramps, or at fixed objects).
2. *MASH Implementation:* With the full implementation of MASH the minimum height of guardrail is 30 inches.
3. *CRZ Treatment:* Consideration should first be given to eliminating or minimizing conditions requiring guardrail. This may be done by flattening the embankment slope or by removing/relocating fixed objects out of the CRZ.

Projects should eliminate or relocate solitary fixed objects found in the CRZ that cannot be made breakaway or yielding. The Length of Need (LON) for guardrail at solitary fixed object increases the exposure to the guardrail and may increase the number of collisions.

Where guardrail is to be installed on an existing highway or in conjunction with existing roadside features, the conditions relating to the roadside feature should be verified, such as slopes, clearances, dimensions, underground utilities, and material. This is especially important where connections to existing structures are proposed. Details for constructing guardrail are shown on the Standard Plans

or Construction Details of Contract Plans. The layout of new guardrail shall be shown on the Contract Plans to conform to embankment and fixed object criteria.

3.2 Guardrail Types

The approved types of guardrail are metal (W-beam), concrete and cable.

1. The W-beam type Midwest Guardrail System (MGS) is the current standard and should be used when W-beam is to be constructed. W-beam is typical for embankment and fixed object shielding. It is made up of “W” shaped metal beam rail elements mounted on wood or plastic blocks fastened to wood or galvanized steel posts. The metal beam guardrail (MBGR) at a height of 27 ¾ or 29 inches, was the standard metal guardrail for many years. It has been replaced by the MGS, with a height of 31 inches to the top of rail, and meets current MASH standards. MBGR can be maintained and reconstructed as referenced within Table 6.

All wood components of MGS and MBGR are pressure treated to resist decay.

Line post must not be installed in structural pavements that would restrict movement of the post during impact.

Only one type of post, either wood or steel, should be used in a run of guardrail. Also, only one size of block, either 12-inch or 8-inch should be used in a run of guardrail.

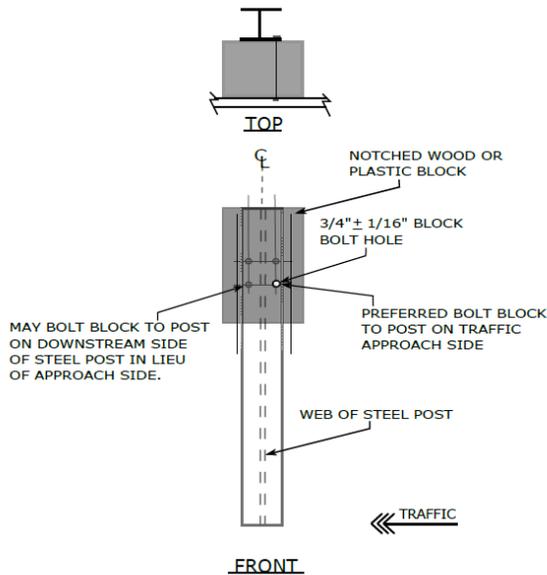
Vegetation control may be considered for use around guardrail at the request of Maintenance and concurred by the District Traffic Safety Engineer. This needs to be done at the Project Initiation Document (PID) phase. If not requested at the PID phase it will not be considered.

Details for vegetation control beneath guardrail are in the Standard Plans.

Typically rail elements for guardrail are available in two lengths: 12.5 feet and 25 feet. A 15-foot, 7½-inch rail element, or a 9-foot, 4½-inch rail element is used for a proprietary terminal system connection to the MGS. The longer rail elements may be problematic for maintenance to transport.

When steel posts are used, blocks cannot be bolted to the center of the post, as the web is in the middle. This means the hole in the block and post must be offset from center (See Figure 1). When installed, the bolt should be located on the traffic approach side of the post.

FIGURE 1
Block-out with Steel Post



This provides a better connection to the block and minimizes the amount the block will rotate around the post in a typical collision. The Standard Plans require the block to be attached to steel posts on the traffic approach side of the post yet show holes on both sides of the post so they can be placed on either side of the roadway.

2. *Concrete Barrier* is generally damage-resistant and can be used in place of W-beam guardrail to decrease maintenance worker exposure. Criteria for this use are when the guardrail is within 14 feet of the traveled way and it has been struck three or more times in any 12 consecutive months during the most recent three-year period that data or records are available.

The approved types of concrete barrier best suited for permanent guardrail installations on the outside of the roadbed are the Type 732B, Type 736B, Type 742B and the Type 60MS series. The approved types of concrete barrier best suited for permanent guardrail installations when integrated with the top of a structure, like on a bridge or on top of a retaining wall, then bridge barriers are used (see Standard Plans).

At the time of publication the only bridge barrier that is MASH complainant is concrete barrier 732SW which is TL2. At the time of publication, October 31, 2019, is when all bridge rails will be to MASH standard. For temporary or short-term installations, approved portable concrete barriers may be used, such as Temporary Railing (Type K and Type 60K). See [Topic 3.6 \(8\)](#) for requirements on the use of Temporary Railing (Type K and Type 60K) as temporary guardrail.

Justification for use of concrete barrier as guardrail that does not meet the above criteria, or is for new construction, must be based on the recommendation from the District Traffic Safety Engineer. Documentation for this decision must be placed in the project files.

Concrete guardrail shall be placed a distance of 17 feet or less from the edge of traveled way (measured from the base of the barrier).

Concrete guardrail must be on pavement or a well compacted base.

Concrete guardrail must be Type 60MS.

The pavement should extend a minimum of 1 foot beyond the concrete guardrail (see [Figure 8](#)).

Chain link fence may be attached on top of concrete barriers or guardrail if installed per the Standard Plans. Other appurtenances, such as steel sign posts or electroliers, but excluding structure columns or sign pedestals, may be placed on top of concrete guardrail based on the following restrictions to prevent snagging:

- a. The top of the barrier is tapered up to 48 inches, at a minimum 4:1 slope, for a maximum 4 inch diameter post or,
- b. The top of the concrete barrier (up to 36 inches) on the approach side shall have a minimum 15 inch setback from the appurtenance for TL-3.
- c. The top of the concrete barrier (up to 36 inches) on the approach side shall have a minimum 8 inch setback from the appurtenance for TL-2.

See the Standard Plans for details for installing steel sign posts on top of Type 60MP, Type 60PR, and Type 60AP concrete barrier

used as guardrail, and details of structure columns and sign pedestals enclosed by Type 60MF and Type 60MGF. With the adoption of the MASH standards the use of Type 60S series is no longer allowed and must not be used.

See the Structures XS Sheets for additional details for structure columns and sign pedestals enclosed by Type 60R and Type 60SD series barriers. For more information about these details go to the Structures XS Sheet site at:

<http://www.dot.ca.gov/hq/esc/tech-pubs/manual/bridgemanuals/bridge-standard-detail-sheets/>

Note that the details on the Structures XS Sheets are non-standard and require an exception to be used (See [Appendix A](#)).

Proposed appurtenances on concrete guardrail, except Standard Plans details, must be approved by the District Traffic Safety Engineer and documented in the project files.

3. *Cable Guardrail* is a high-tension three or four-strand flexible barrier. It may be recommended by the District Traffic Safety Systems Coordinator for locations that can accommodate cable deflections up to 9.5 feet. See [Topic 4.6\(3\)](#) for details on cable barrier.

Cable guardrail must be approved by the Deputy District Directors for Traffic Operations and Maintenance. Documentation of the approval must be placed in the project files.

3.3 Guardrail Installation Criteria

When considering installation of guardrail at an embankment or a fixed object the following criteria, although not an all-inclusive list, may be used as a guide:

1. *Collision History*: Based upon the run-off-road collision history, statistical experience or analysis can be used to evaluate if guardrail is needed.
2. *Roadway Alignment*: Isolated curves on relatively straight roadway alignment may increase the risk of running off road. Also, on roads with curving alignment, curves that are sharper than expected may increase the probability for run-off-road collisions.

3. *Operating Conditions*: The location's traffic characteristics can also affect the potential for a vehicle to leave the traveled way:
 - a. *Volume*: The higher the volume of traffic, the greater the potential for run-off-road collisions.
 - b. *Speed of Traffic*: Higher operating speed can increase the potential for run-off-road collisions, and will affect the distance that a vehicle will traverse before the driver can regain control or bring the vehicle to a stop.
 - c. *Merge and Weave Areas*: The potential for run-off-road or lane departure collisions may increase in the vicinity of ramp merge and diverge areas, especially those without auxiliary lanes where stopped or slowing traffic can cause abrupt lane changing and collision avoidance maneuvers.
4. *Climate Conditions*: Frequent dense fog, rain, or snow and ice conditions increase the risk of run-off-road collisions.
5. *Roadside Recovery Area*: The risk of a run-off-road vehicle colliding with an embankment or a fixed object is greater as the recovery area decreases.

The highway facility type, whether a freeway, expressway, or a conventional highway, has an impact on the analysis for installing guardrail due to the differing characteristics of these facilities. For example, the presence of driveways may prevent the installation of guardrail to shield an object within the CRZ. Funding limitations and differing operating conditions preclude firm rules for installing guardrail.

3.4 Guardrail at Embankment Slopes

Installing guardrail to shield embankment slopes is largely a result of analyzing the above criteria on a case by case basis and determining whether a vehicle hitting guardrail is more severe than going over an embankment slope. A tool developed for evaluating this severity, the "Equal Severity Curve" (see [Figure 2](#)), developed in the 1960s and updated in the early 1980s, is still applicable.

The line in [Figure 2](#) represents collisions at combinations of embankment height and slope that resulted in severities generally equal to the severity of an average guardrail collision. If combinations of embankment height and slope plot close to the line, the severity of an errant vehicle going over an embankment may be greater or less than the severity

of striking the guardrail, so the shaded areas of the line should be regarded as a band. When the site specific embankment height and slope conditions plot above the equal severity band, the severity of colliding with the guardrail should be less than the severity of a run-off-road vehicle going over the embankment. Therefore, guardrail can be installed when the embankment height and slope plot above the band, and the criteria in [Topic 3.3](#) are considered.

Although an embankment slope may not qualify for installation of guardrail based on application of [Figure 2](#), the presence of fixed objects along the slope or bodies of water, school grounds, or other fixed objects at the toe of slope or beyond the CRZ, can justify guardrail at such locations. For this reason local site conditions need to be considered in conjunction with [Figure 2](#).

Guardrail placed to shield an embankment slope should shield both directions when the embankment is within the CRZ for each direction of travel. See [Figure 3](#). For more information on clear recovery zones on conventional highways see Topic 2.

The District Traffic Safety Engineer must concur with the decision to install or not to install guardrail and the type of end treatment at an embankment slope that meets the “Guardrail Less Severe” conditions of [Figure 2](#). The statement of concurrence must be documented in the project files (see [Topic 1.3](#) for guidance).

Copies of the Typical Cross Sections, Summary of Quantities and applicable Layout sheets from the Project Plans may supplement the documented statement of concurrence inserted in the project files.

3.5 Guardrail at Fixed Objects

Guardrail should be considered at all fixed objects that are accessible to traffic and within the CRZ, whether to the left or right of traffic. Guardrail may also be considered at fixed objects located

beyond the CRZ when such objects occupy an otherwise clear recovery area.

MGS with standard post size and spacing will be placed as far as possible from the edge of pavement, where the slope is 10:1 or flatter, but no closer than 36 inches from the back of the post to the face of the fixed object. This clearance between the guardrail and the fixed object is necessary since guardrail deflects up to 36 inches during impact. **Guardrail that is to be installed less than 36 inches from back of post to the face of a fixed object but not less than 12 inches from back of post to face of fixed object shall be constructed according to “Strengthened Railing Sections for Fixed Object” detail of the Standard Plans.** See Topic 3.6(10)(c) for discussion of this detail.

If guardrail is to be installed less than 12 inches from the back of post to face of fixed object, concrete barrier must be used.

See [Topic 3.2](#) for allowable types of concrete barrier to be used as guardrail. Where there is a row of structure columns with less than 26 feet in-between each column, the strengthened railing section detail should be continued between the columns. Where the column spacing exceeds 26 feet, a new detail may be started.

Placement of guardrail, itself a fixed object, may also increase the probability of a vehicle colliding with the guardrail. For this reason, fixed objects such as individual signal poles, lighting standards, utility poles, trees, or traffic control cabinets are typically not shielded by guardrail.

Guardrail shall be placed at the following fixed objects within the CRZ that are not shielded by other traffic safety systems:

1. Overhead sign posts,
2. Structure piers, columns, and abutments, and
3. Exposed ends of walls.

See Standard Plans for additional details where walls are above the height of guardrail.

Figure 2: Equal Severity Curve

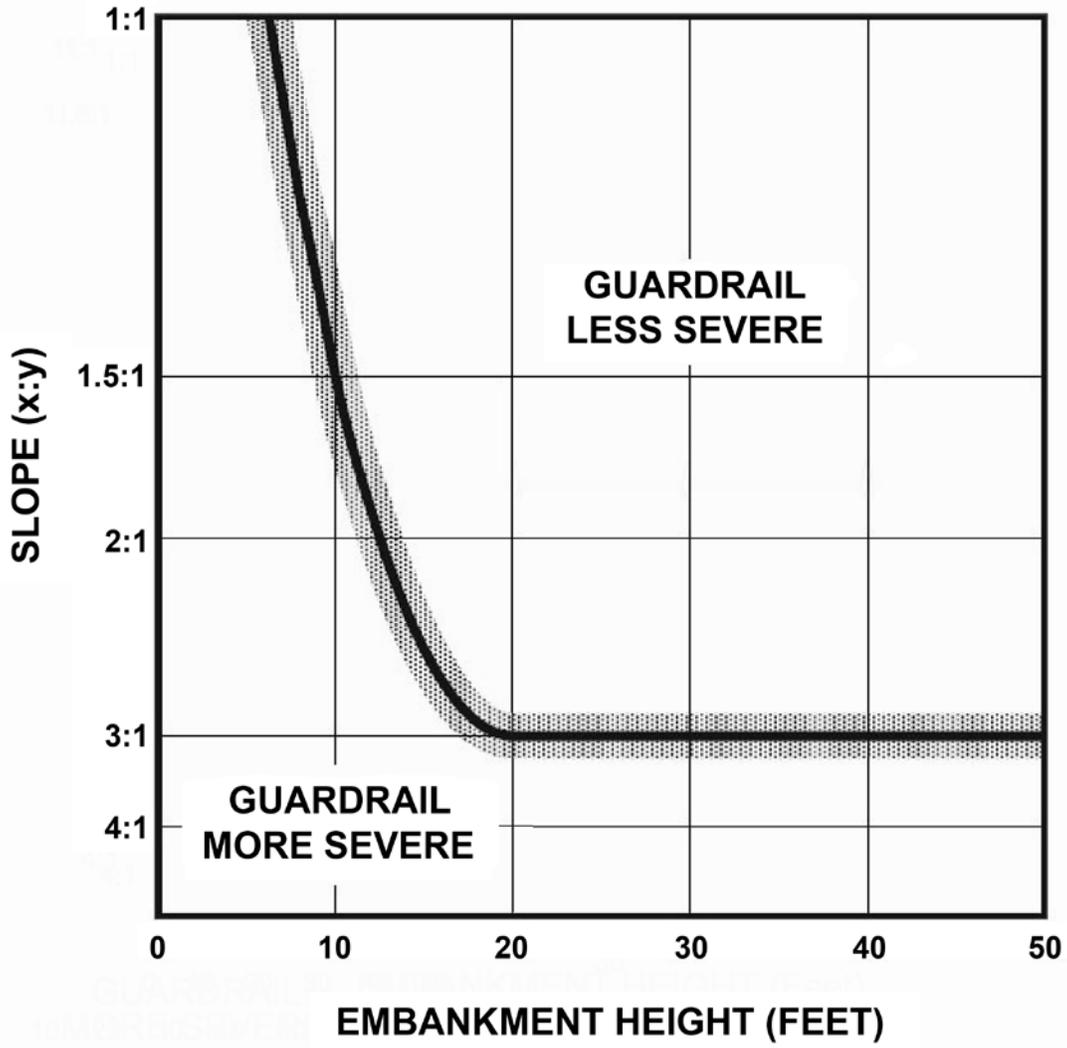
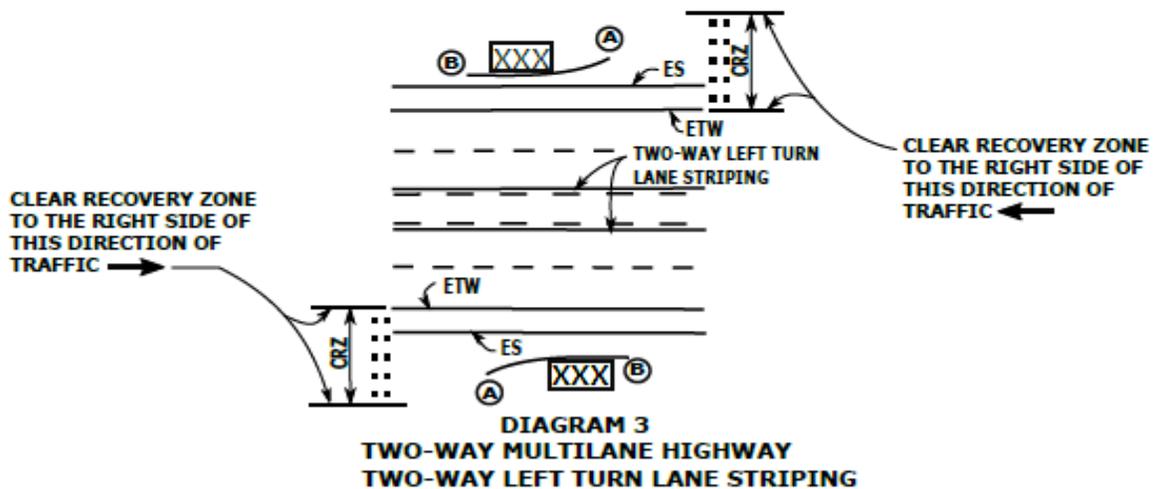
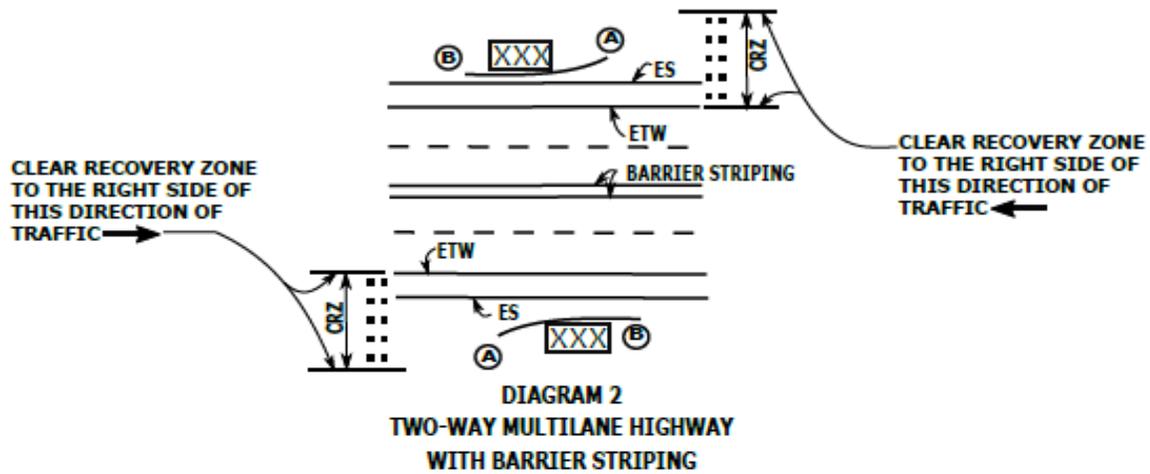
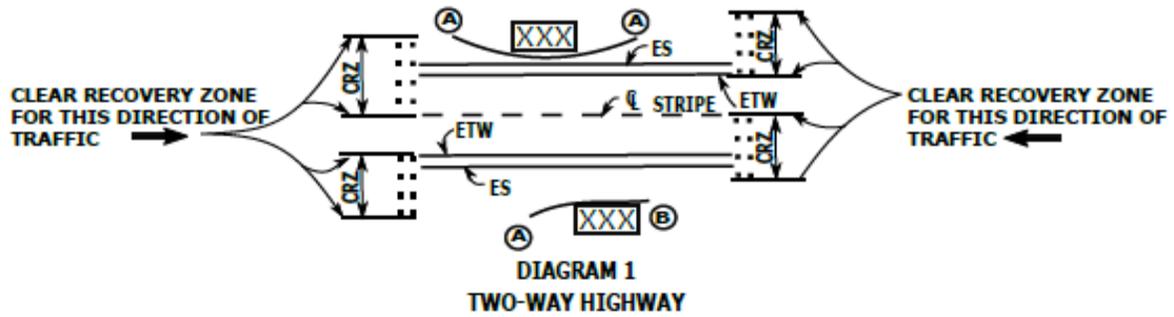


Figure 3: Railing at Fixed Objects or Embankment Installations



LEGEND

(A) CALTRANS APPROVED END TREATMENT, BURIED POST END ANCHOR, OR CRASH CUSHION. IF LOCATED OUTSIDE THE CRZ, A RAILING END ANCHOR ASSEMBLY SUCH AS A SOIL FOUNDATION TUBE (Type SFT) ANCHOR OR OTHER FIXED ANCHOR MAY BE APPROPRIATE AT ENGINEER'S DISCRETION.

(B) RAILING END ANCHOR ASSEMBLY

XXX FIXED OBJECT(S) OR NON-RECOVERABLE EMBANKMENT SLOPE

When evaluating placement of guardrail to shield rows of trees within the CRZ that have trunks 4 inches or greater in diameter, consult with the District Traffic Safety Engineer. More emphasis should be given to those trees spaced 100 feet apart or less.

In medians or roadway separations that are less than 100 feet wide and traversable by vehicles, structure piers or columns should be shielded with guardrail with appropriate end terminals and/or crash cushions if not otherwise shielded.

Guardrail placed to shield a fixed object on a two-way highway should shield both directions when the object is within the CRZ for each direction of travel. See [Figure 4](#): Railing at Structures, Diagram 6, for illustration of CRZ on multilane highway structure with asymmetrical roadway layout. For more information on clear zones on conventional highways see [Topic 2](#).

Guardrail placed to shield a fixed object on a two-way multilane highway with a two-way, left turn lane, should protect adjacent traffic if the fixed object is within the CRZ.

The District Traffic Safety Engineer must concur with the decision to install or not to install guardrail and the type of end treatment at a fixed object. The statement of concurrence must be documented in the project files (see [Topic 1.3](#) for guidance).

Copies of the Summary of Quantities and applicable Layout Sheets from the Project Plans may supplement the documented statement of concurrence inserted in the project files.

3.6 Guardrail

Design Considerations

This topic addresses site-specific considerations involved in designing a guardrail layout. It discusses the length of guardrail needed to shield an area of concern, as well as the lateral placement relative to the area of concern. It also covers uses of guardrail at structures and drainage features, and addresses appropriate cross slopes. It discusses end treatments and transitions to structures, gaps in guardrail installations, and concludes with various other design details.

1. *Guardrail Length of Need*: LON is the total length of guardrail and portion of the end termi-

nal needed to shield an area of concern by containing or redirecting an errant vehicle. The LON is defined as that point on the terminal or longitudinal barrier downstream from which it will contain and redirect an impacting vehicle along the face of the terminal or barrier, shielding it from impact with a fixed object (See Roadside Design Guide for Length of Need calculations).

The LON generally includes some portion of the end treatment: for gating end treatments, all except the last 12 ½ feet of the end treatment is effective barrier (contributing to the LON requirement). Non-gating end treatments are capable of redirecting a vehicle impacting the nose or the side of the system along the systems entire length.

Gating end treatments allow a vehicle impacting the nose or the side of the system near the nose to pass through the device. For gating end treatments, the LON will usually start 12 feet-6 inches from the impact head or at post 3. Because gating terminals will allow a vehicle to pass through the system on a side angle impact within the first 12 feet-6 inches, additional length of rail should be considered to account for the run out distance of the vehicle.

The majority of run-off-road collisions occur at departure angles between 10 and 15 degrees, with 12.5 degrees typically used to determine if guardrail shields an object.

The minimum LON should be 150 feet for all guardrail installations. Additional length may be required depending on the location of other fixed objects or features being protected that may exist behind a guardrail run. This length is inclusive of the WB-31 transition, standard MGS line rail and any approved end terminal up to its LON point, which is typically starting at post 3 of the terminal system.

The LON will vary depending upon site conditions and the guardrail layout. As the setback to a fixed object increases, so will the LON required to shield that object. Likewise, for locations with multiple objects within the CRZ, such as a bridge approach rail on an embankment with trees, the LON to be considered should be sufficient to shield the approach rail, embankment, and the other fixed objects.

[Figure 5a](#), Position of Guardrail at Fixed Objects, illustrates how additional guardrail is needed to shield an area extending back from the edge of the roadbed on a one-way road. [Figure 5b](#) also illustrates how the length of a

guardrail installation may be reduced where there is a wider clear recovery area between the edge of the shoulder and the fixed object.

Where fixed objects are added behind existing guardrail, care should be taken that all fixed objects are within the area shielded by the guardrail. **Fixed objects shall not be allowed behind, or in front of, breakaway anchors, end treatments, or where posts are removed in a run of guardrail**

The District Traffic Safety Engineer or their designee must concur with the LON for embankment and fixed object guardrail for all installations. The statement of concurrence must be documented in the project files.

Copies of the Typical Cross Sections, Summary of Quantities and applicable Layout Sheets from the Project Plans may supplement the documented statement of concurrence inserted in the project files.

2. *Guardrail Placement and Position:* For illustrations of guardrail at structure approaches in the following applications, see [Figure 4](#). Structure approaches apply to the ends of bridge railings, parapets exposed to approaching traffic, curb, sidewalk and dike. Where guardrail is needed at structure approaches or concrete barrier, transition railing of the Standard Plans should be used unless site conditions support use of a crash cushion system. Refer to [Topic 6](#) for more information on crash cushions. If curb or bridge barrier without a vertical face is present, refer to Structures XS Sheets (Barriers and Railings) for non-standard connection details. The use of these non-standard details will require that the Exception to Traffic Safety System Standards be filled out. Where a curb or sidewalk is present, traffic is one-way and approach speeds are 45 mph or less, the connection details in [Figures 6a](#) and [6b](#) may be used. See Note 1 of [Figure 8](#) for design requirement from Headquarters Geotechnical Services.
 - a. *Two-Way Conventional Highway:* Guardrail should be placed at bridge approaches if the bridge rail is within the CRZ. The CRZ should be considered in both directions of travel. Guardrail should be placed on both sides of the roadway if the distance from the centerline to the bridge rail is 20 feet or less. If more than 20 feet, guardrail may be placed only to the right of approaching traffic, however it may be considered based on site specific geometry and the nature of the adjacent terrain. See [Figure 3](#).
 - b. *Multi-Lane Highways with Separate Structures:* Guardrail should be placed to the right and left of approaching traffic. Railings, guardrail, and bridge railing should not be placed transversely across the median or separation openings between adjacent or parallel structures. Protection should be provided by bridge approach guardrail with adequate length and an appropriate typical layout. Details regarding guardrail typical layouts are contained in the Standard Plans.
 - c. *Multi-Lane Freeways or Expressways with Decked Medians:* Guardrail should be placed if the bridge rail is within the CRZ. The CRZ should be considered in both directions of travel. If the distance from the lane line to the bridge rail is more than 30 feet, guardrail is not required, but may be considered based on site specific conditions. See [Figure 4](#). When the bridge clear width is 60 feet or more, guardrail should be placed only to the right of approaching traffic.
3. *Curb and Dike:* Placement of dike near W-beam guardrail requires special consideration to prevent vehicles from vaulting over the rail. Vaulting may occur when W-beam guardrail deflects enough for the wheels to mount the dike, lowering the effective height of the w-beam and allowing the vehicle to vault over it.

Mountable dike shall not be placed under W-beam guardrail. The increased height of MGS compared with MBGR allows for the placement of up to a 6 inch height curb or (TYPE A) dike under the rail if 12" blockouts are used. 6 inch curb or (Type A) dike must not be used with 8" blockouts. Dike should typically be constructed with the base of dike being flush with the face of rail (A Construction Detail may be required). Dike up to 6 inches may be placed with MGS if 12-inch blockouts are used, so that the base of the dike extends up to 7 inches from the face of rail. Dike placed more than 7 inches in front of the face of rail with MGS shall be 2 inch (TYPE C) dike as shown in the Standard Plans.

When installing MGS with dike in snow areas, it may not be desirable to place dike protruding from the face of rail, as it may interfere with snow removal and other operations. In these cases a construction detail may

be needed to construct dike so that the base of dike is placed flush with the face of rail.

To prevent a vehicle from vaulting over MGS with 8-inch blockouts, or MBGR, when they are used in conjunction with a 4-inch high curb or dike (Type F), the guardrail face will be on a vertical line with the curb face or on a line no more 2 inches behind the flow line of the dike. **A curb or dike greater than 2 inches in height, ditches or drainage structures shall not be placed in front of MGS with 8-inch or 12-inch blockouts or where MBGR is used.** Where placement of dike is required in front of MGS with 8-inch or 12-inch blockouts or MBGR, Type C dike may be used.

It can be difficult to construct dike completely under MBGR rail, due to space constraints. In snow areas, 12 inch blockouts may be considered so that the base of the dike may be placed flush with the face of rail. Dike placement for MBGR is no longer shown in the Standard Plans, therefore a construction detail is needed when dike is used in combination with MBGR.

Only 2 inch (Type C) dike is allowed in front of end terminal systems and within 25 feet in advance of the end terminal system as shown in the Standard Plans.

4. **Cross Slopes: The cross slope from the edge of shoulder to the w-beam guardrail shall be 10:1 or flatter, except when conforming**

to the cross slope of the roadway. When w-beam guardrail is considered for installation where the cross slope is not on the same plane as the adjacent pavement slope, but not greater than 6:1, it is necessary to determine whether the trajectory of the impacting vehicle has stabilized back to the ground prior to impact. A discussion of calculating vehicle trajectory is outlined in Traffic Bulletin No 15, "Method for Checking the Integrity of Cable and Beam Barriers" and in the Roadside Design Guide Section 5.6.6.2.

Possible vehicle trajectory must be checked, and documented in the project files, when guardrail placement is proposed behind a slope steeper than 10:1.

The trajectory of a vehicle should also be evaluated on the high side of a superelevation even if the shoulder slope is 10:1 or flatter because of the grade break between the two slopes. The height of the rail may need to be raised above the standard height to minimize the chance of a vehicle vaulting over the rail. As the rail height is increased, longer posts may be needed to maintain post embedment and rub rail may be needed to keep vehicles from going under the rail.

5. **W-Beam Installed in Paved Areas:** Line posts must not be installed in structural pavements as it restricts the movement of the posts during impact.

Figure 4: Railing at Structures

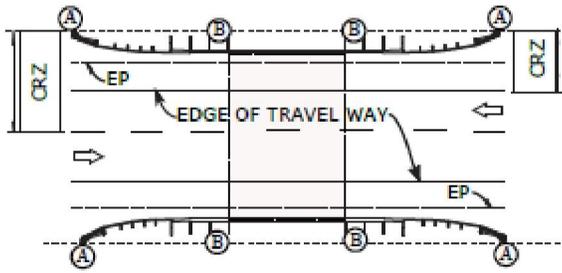


DIAGRAM 4
UNDIVIDED ROADWAY
TWO WAY HIGHWAY STRUCTURE
ROADBED LESS THAN 40 FEET

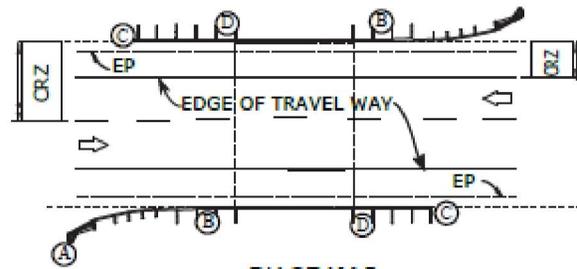


DIAGRAM 5
UNDIVIDED ROADWAY
TWO WAY HIGHWAY STRUCTURE
ROADBED EQUAL TO OR GREATER THAN 40 FEET

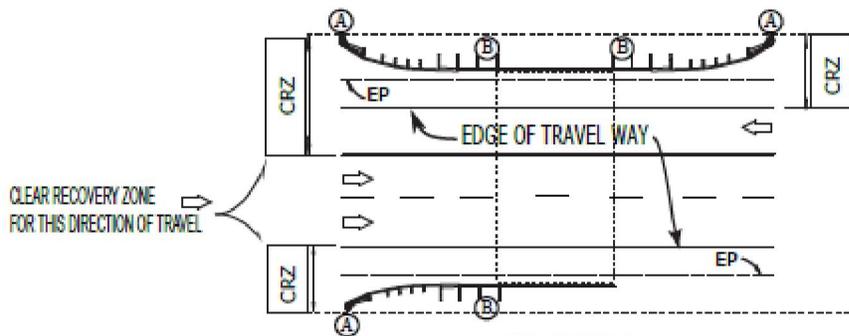


DIAGRAM 6
MULTILANE HIGHWAY WITH
ASYMMETRICAL ROADWAY LAYOUT

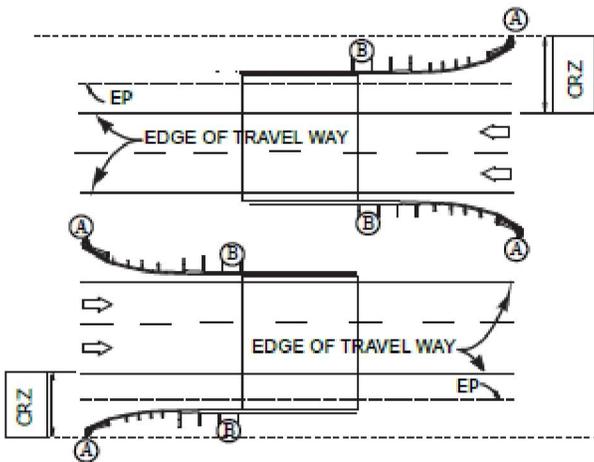


DIAGRAM 7
MULTILANE HIGHWAY WITH SEPARATE
STRUCTURE FOR EACH DIRECTION OF TRAVEL

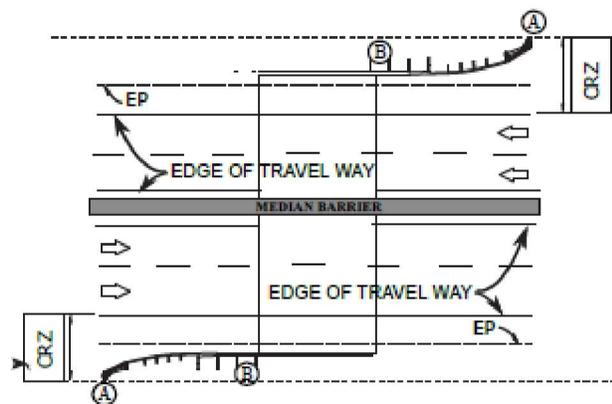


DIAGRAM 8
MULTILANE HIGHWAY WITH
DECKED MEDIAN STRUCTURE

LEGEND

- (A) Caltrans approved end treatment (flared shown), buried post end anchor, or crash cushion.
- (B) Transition Railing with anchorage to structure.
- (C) Railing end anchor assembly.
- (D) Positive anchorage to structure.
- Structure

Figure 5a: Position of Guardrail at Fixed Objects

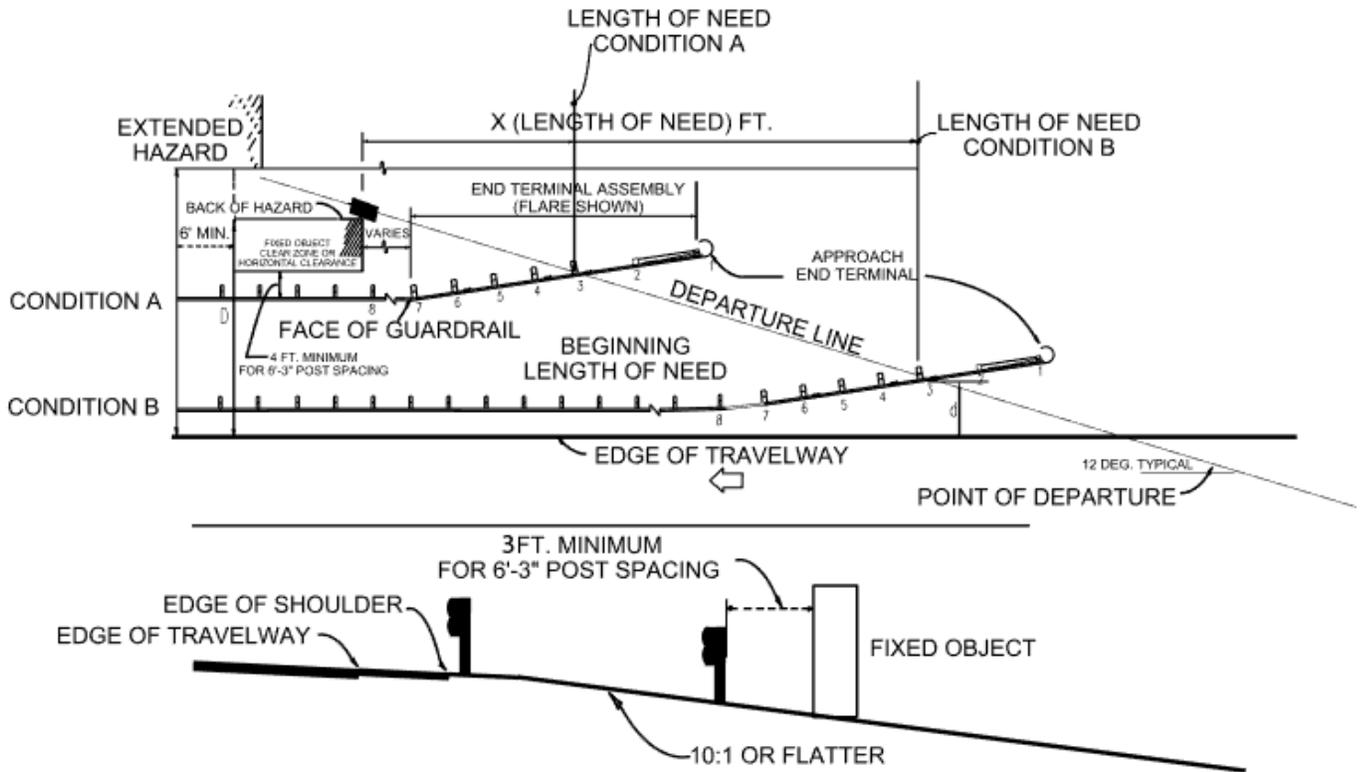
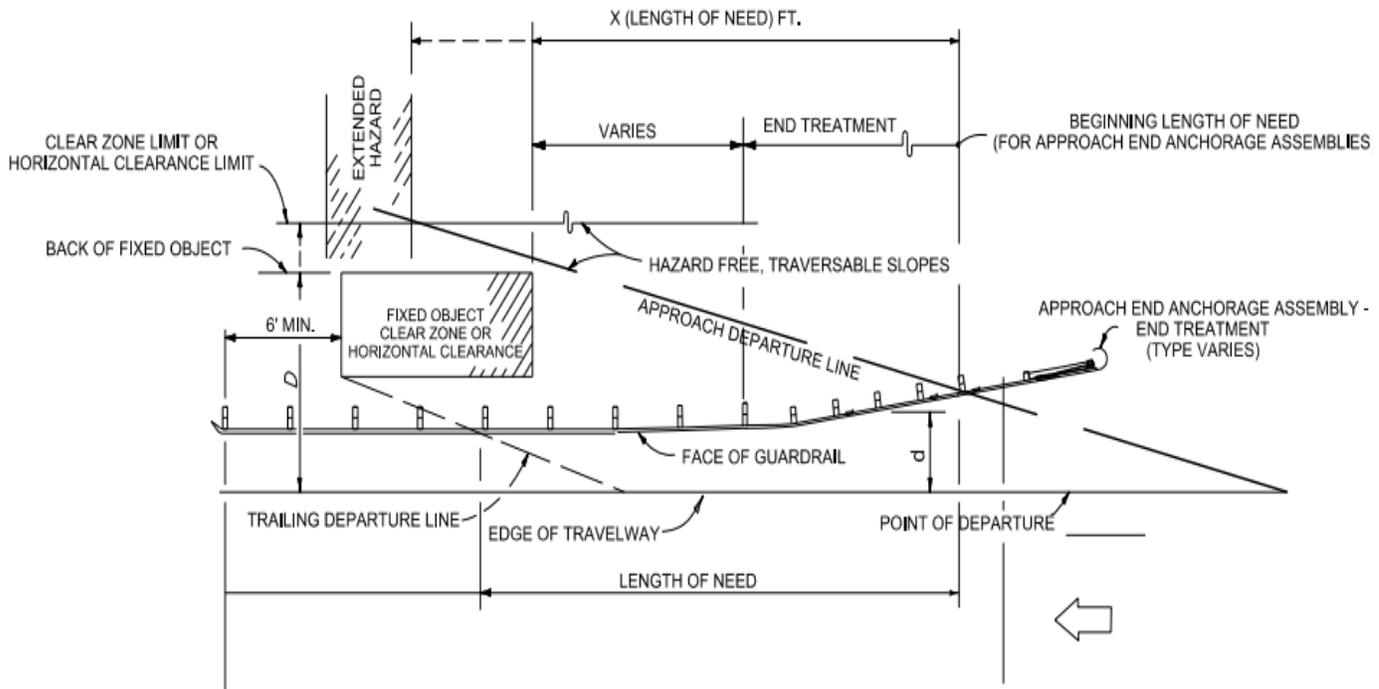
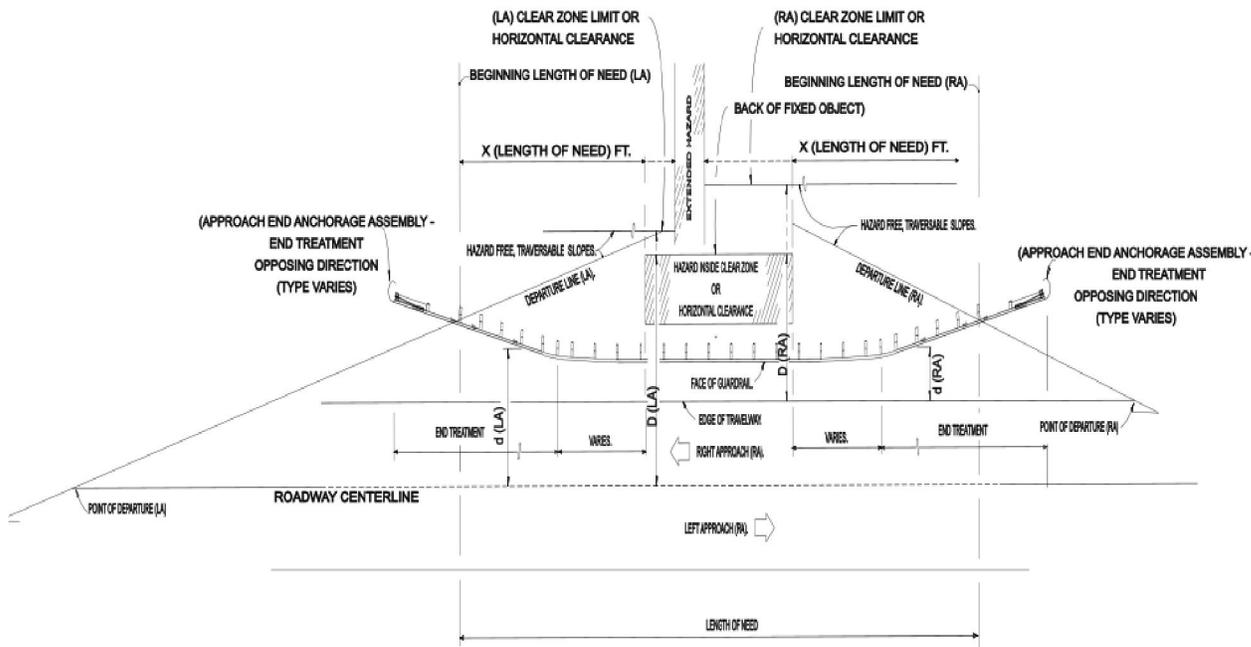


Figure 5b: Length of Need Determination



(LEFT SIDE OPPOSITE HAND)
ONE-WAY TRAFFIC
NOT TO SCALE



TWO_LANE TWO-WAY TRAFFIC
NOT TO SCALE

Figure 6a: Connection to Bridge Curbs

Note: Only use where traffic is one-way and approach speeds are 45 mph or less

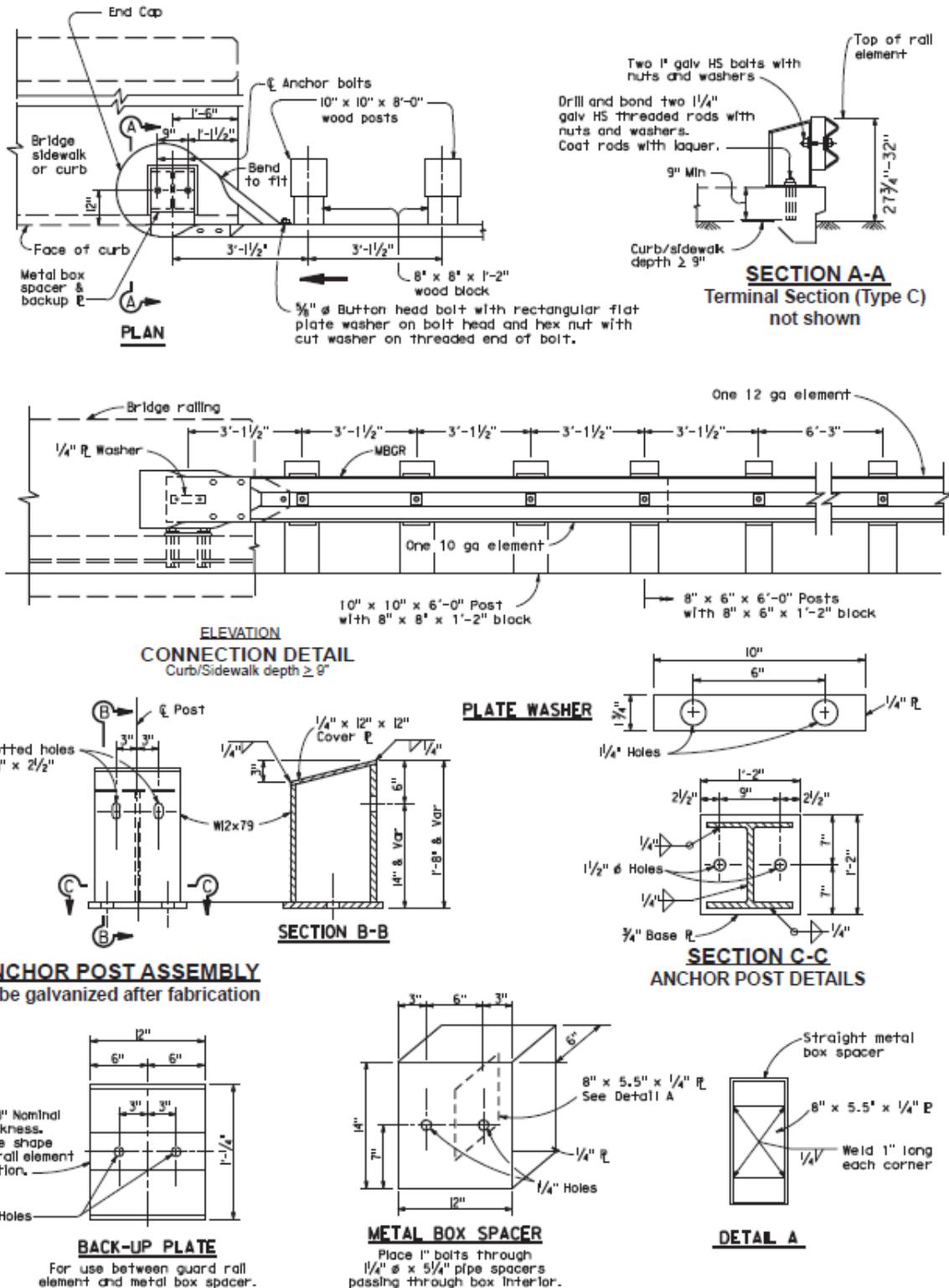


Figure 6b: Guardrail Connections to Anchor Posts

Note: Only use where traffic is one way and approach speeds are 45 mph or less

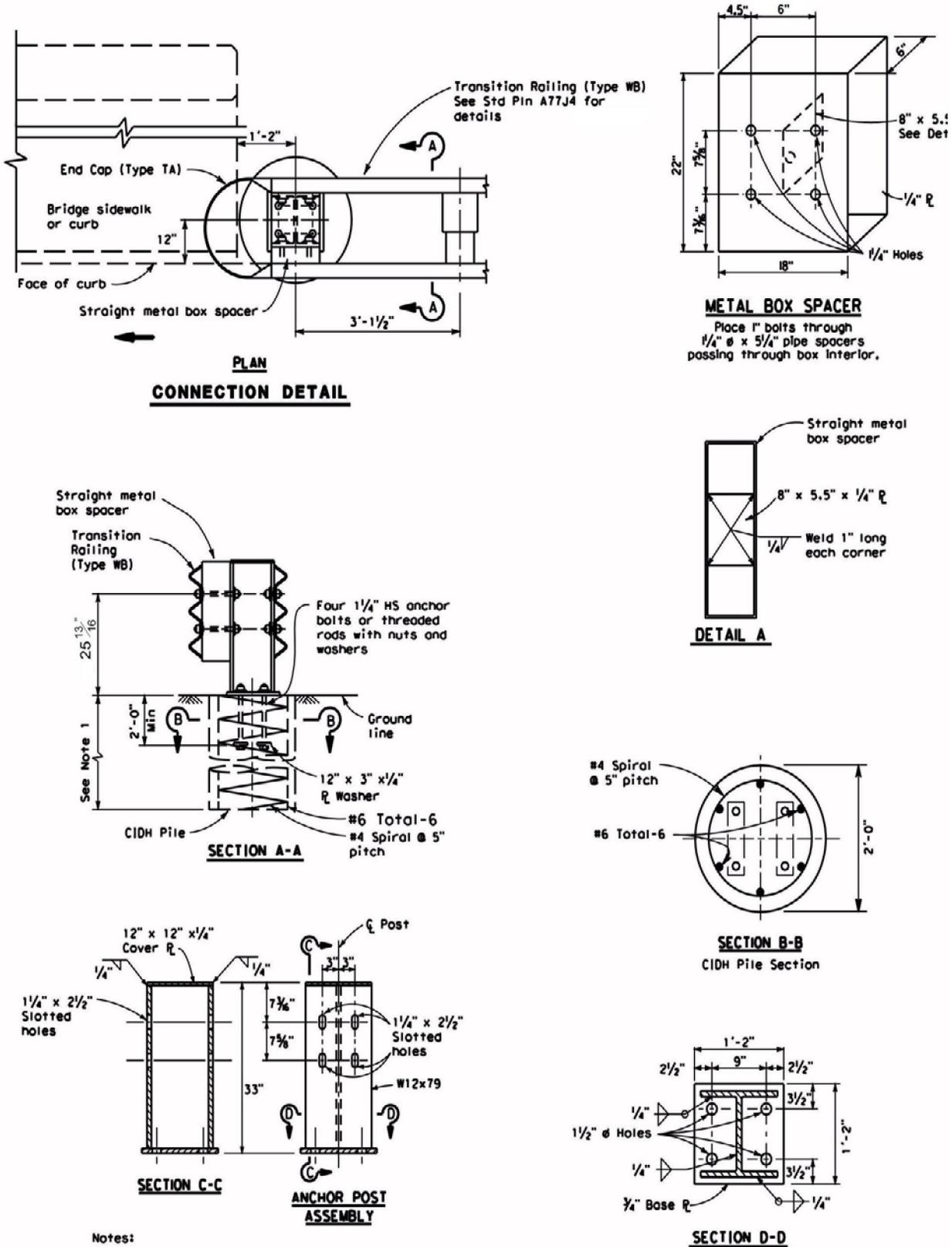


Figure 7: Post Embedment in Rock

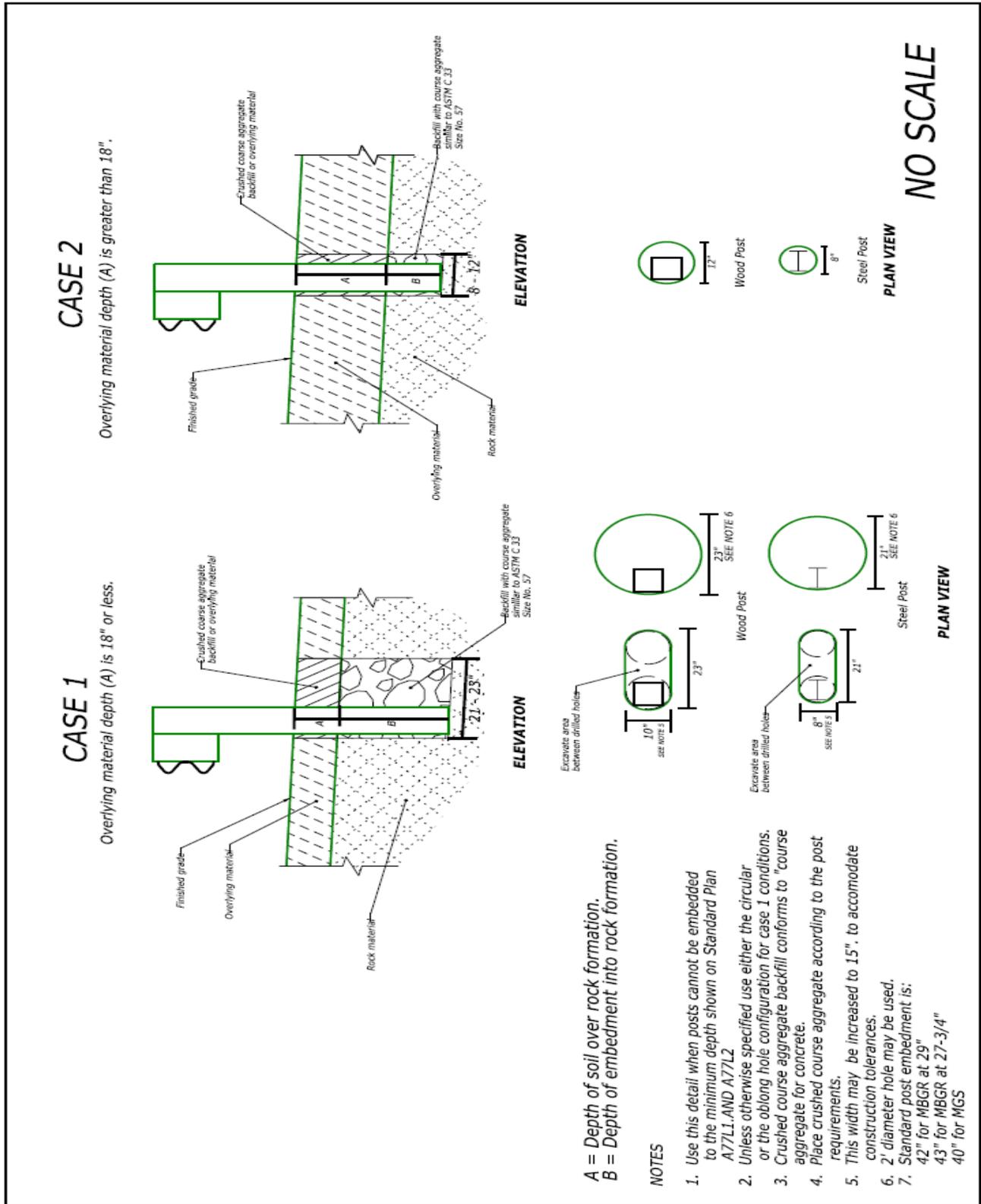


Figure 8: Concrete Guardrail

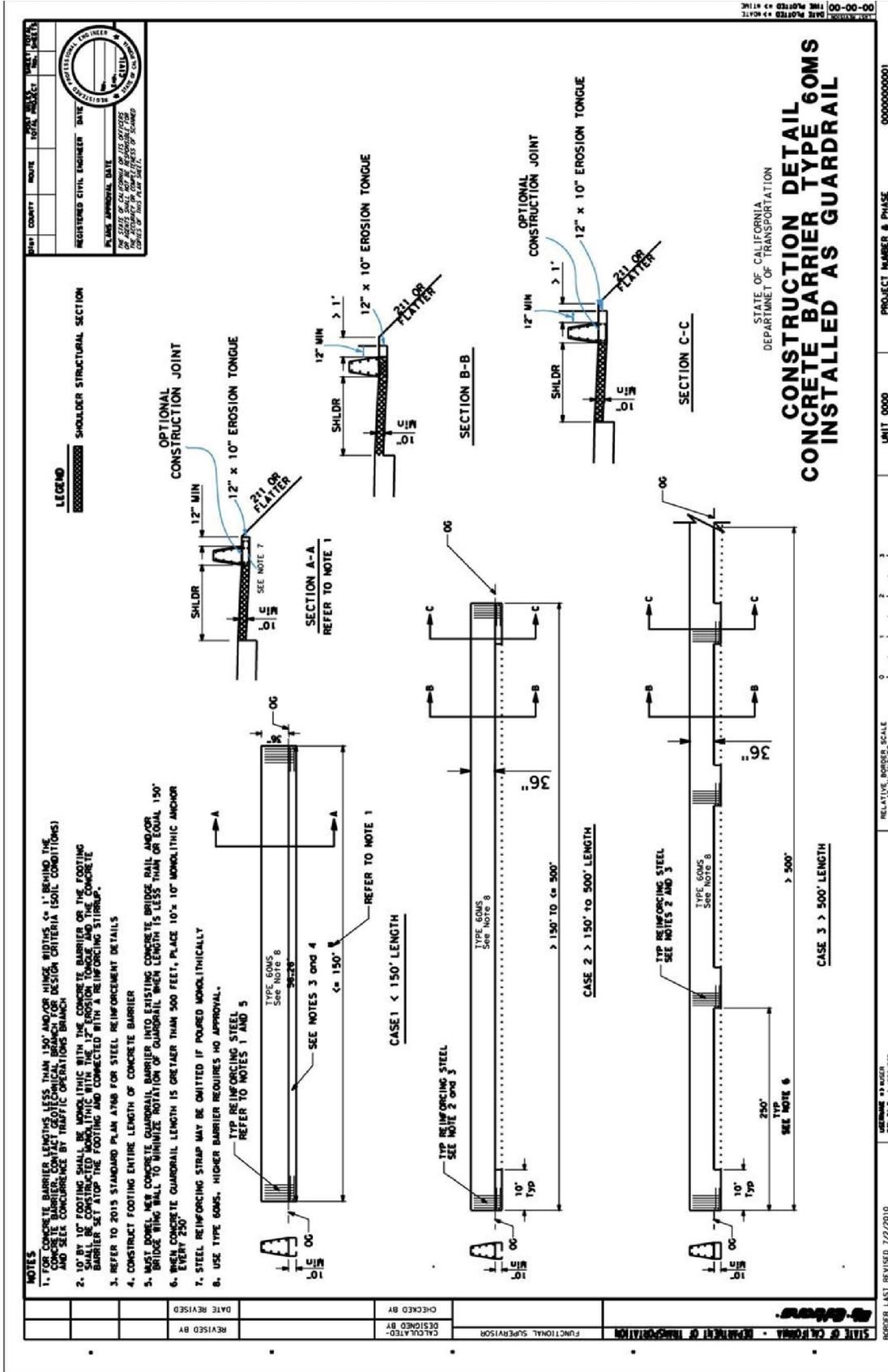
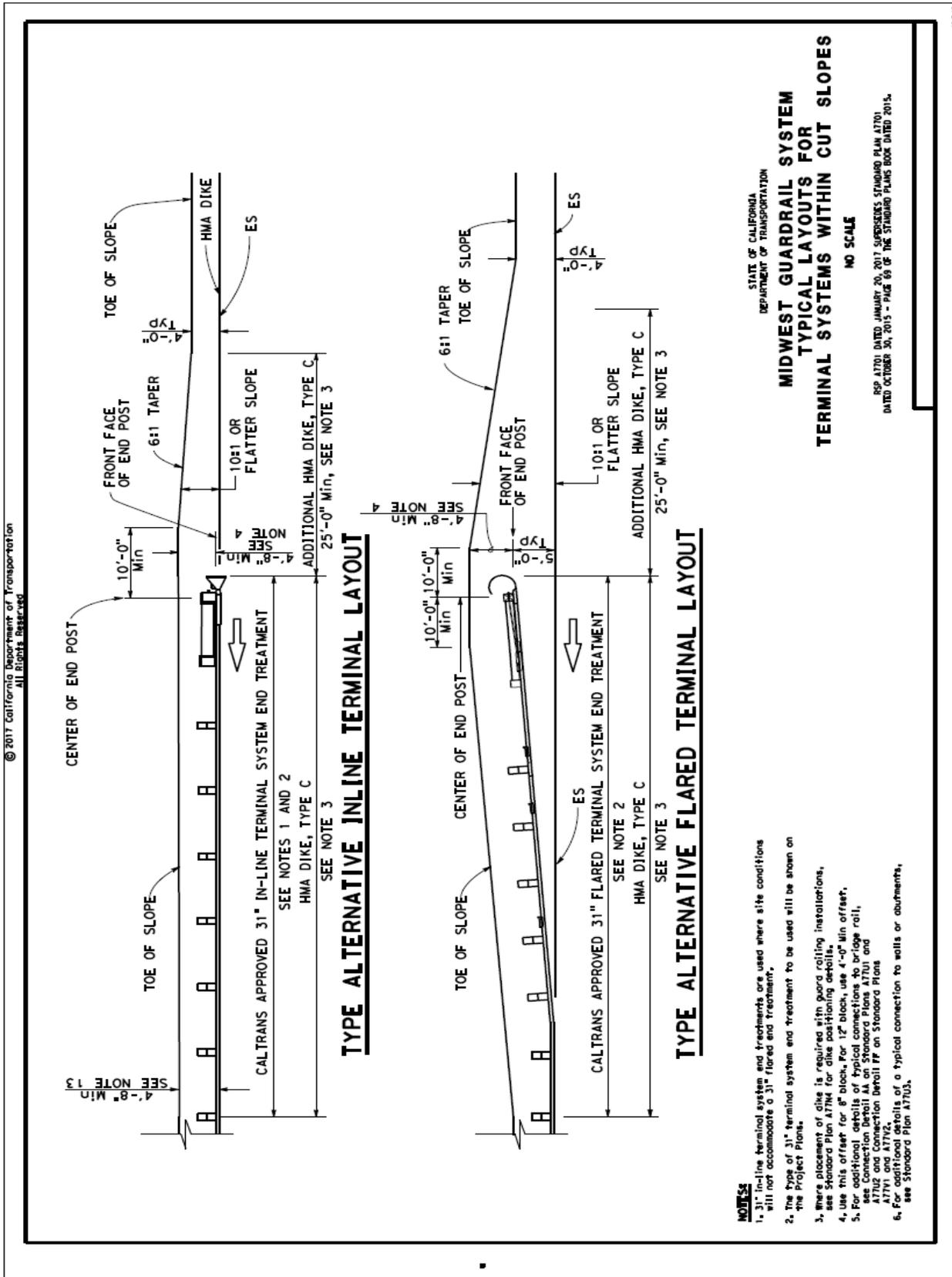
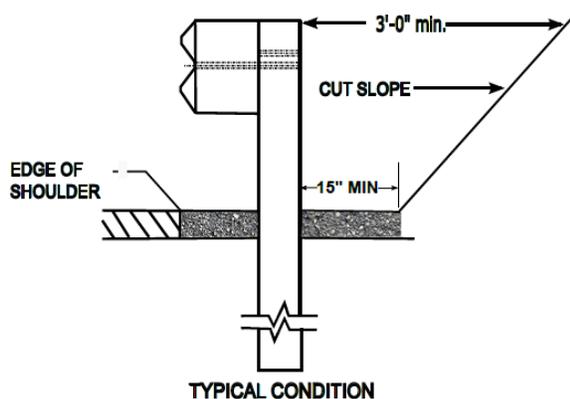


Figure 9a MGS Typical Layout for Cut Slopes and Terminal System End



6. *W-Beam Installed in Rock:* If posts need be installed in rock then the following procedures should be used. When installing posts in rock the hole size required will depend on the amount of soil over the rock (See [Figure 7](#)). When there are 18 inches or less of soil above the rock, 15 inches of clearance behind the post will be provided for the entire embedment depth. If there is more than 18 inches of soil above the rock, a 12 - inch diameter hole will be drilled into the rock far enough to allow full post embedment. Backfill in the same manner as a post installed in a paved area (See [Figure 7](#)). Further guidance may be found in the Roadside Design Guide, Sec.5.6.7.
7. *Cut and Fill Slopes:* **When guardrail is placed in a cut slope, there shall be a minimum clearance of 15-inches from the back of post, at the base, to the toe of slope. There shall also be a minimum clearance of 3 feet from the back of post, at the top, to the face of slope.** This is to allow the guardrail to deflect as it would on a fill or level plane, See [Figure 9b](#). The 15-inches from back of post to toe of slope does not apply to the buried end anchor from the beginning of parabola point to the buried anchor. A 3- foot minimum clearance from back of post to fixed objects should be maintained with guardrail. End treatments, except for buried ends, shall laid out as shown in [Figure 9a](#) and the Standard Plans for placement on fill. Additional area will be required for both the in-line and flared end treatments when placed near cut slopes for these systems to perform as they were designed.

FIGURE 9b
W-Beam near Cut Slopes



8. *Guardrail Anchorage, Transitions and Approach End Treatment:* Guardrail functions as

a tension member, much like a bowstring, redirecting the errant vehicle away from the obstacle. Thus it is necessary that both ends of all guardrail installations be anchored. **Concrete guardrail shall be anchored to prevent movement.** Type 732B, 736B and 742B are anchored by continuous footings; Type 60MS series requires a 10-foot long footing at each end. On runs of Type 60MS barrier that are used as guardrail and are 150 feet or less, the footing is added over the entire length. For runs of Type 60MS barrier that are used as guardrail and are 500 feet in length or less, a footing is added at each end. For runs greater than 1000 feet in length, a footing is added every 250 feet. Footings added on runs of concrete guardrail are to minimize movement of the barrier upon impact. Concrete guardrail footings must be in pavement or a well compacted base. The pavement must extend a minimum of 1 foot beyond the concrete guardrail footing or if placed on a well compacted base must have a monolithic tongue constructed with the concrete guardrail that extends 1 foot beyond the backside of barrier. (see [Figure 8](#)). Temporary Railing (Type K) is anchored by 1-inch diameter dowels for temporary and long-term use while Portable Concrete Barrier (Type 60 K) is not staked. See the Standard Plans for staking details for Temporary Railing (Type K).

(repeat of what is stated above) Type 60MS series and Temporary Railing (Type K and Type 60 K) should be supported by a 4-inch thick asphalt or concrete pad that begins from the edge of the pavement and extends 12 inches beyond the back edge of the concrete guardrail. If the pad cannot be extended 12 inches beyond the back edge of concrete guardrail, other measures should be used to prevent soil erosion. Pavement should extend to the footing of the Type 732B, 736B and 742B barriers.

Type CA Cable Anchor Assembly (non-breakaway) shown in the Standard Plans can be used only where the end of a guardrail installation cannot be impacted by an approaching vehicle. A non-breakaway anchor should be used to add intermediate anchorage where there is an abrupt change in the alignment of the guardrail, such as when the guardrail is continued down an intersecting road or if there is an area of concern on the side slope that would cause a more severe collision than impacting the guardrail. **Standard Plan A77T1 shall be used for a non-breakaway anchor.** If there is no area of

concern on the side slope, then a breakaway anchor with drilled posts set in a foundation should be used for intermediate anchorage.

Guardrail approaching structures is anchored to, or near the structure. In general, guardrail may be anchored to structure railings that are designated barrier railings.

Guardrail shall not be anchored to structure columns or abutments unless detailed in the Standard Plans, as holes drilled for anchor bolts can compromise the integrity of earthquake reinforcement. Where existing masonry and lightly reinforced concrete walls are involved, an independent anchor shall be used. Connections may be made to new installations of concrete barrier.

a. *Approach End Treatments:* The order of preference for approach end treatments is as follows:

- i. Bury the end of the guardrail in a non-traversable slope. It may be necessary to extend a guardrail installation a reasonable distance to reach a cut section where a buried end anchor can be used. A minimum height of 30 inches to the top of guardrail is to be maintained to minimize vaulting.
- ii. Extend the end of the guardrail at a 20:1 or flatter flare for concrete, or a 15:1 or flatter flare for W-Beam, to a point outside the CRZ.
- iii. Install an approved end treatment at the approach end of the guardrail.

For more information on which end treatments are approved for use on California State highways and for assistance in choosing an appropriate system, contact your District Traffic Safety Systems Coordinator.

All in-line end treatments are to meet MASH standards and be Caltrans approved. As of April 30, 2018, all flared end treatments will have to meet MASH standards, and be Caltrans approved.

- b. *Trailing End Anchorage:* The End Anchor Assembly (Type SFT-31) is intended for use on the trailing end of guardrail installations that are outside the CRZ of opposing traffic. See [Figure 3](#).
- c. *Transitions to Structures:* Transitions are required for guardrail approaching connections to structures. MGS is a semi-rigid barrier and must be gradually stiffened as it approaches connections to, or at rigid objects

such as bridge railings, retaining walls, abutment walls, sound walls or other structure supports. **Stiffening smoothly redirects an impacting vehicle away from the rigid object and shall be accomplished by using the Transition Railing and Connection Details of the Standard Plans.**

9. *Gaps Between Guardrail Installations:* Gaps of less than 200 feet between guardrail installations, or between the end of cut slopes and the beginning of guardrail, should be avoided. Where such a gap is essential for maintenance purposes, removable rail elements can be installed. For additional information on rail panels, consult the District Safety Systems Coordinator.

A gap for maintenance use may be left at the departing end of embankment guardrail on one way roadbeds, or two-way roadbeds where the departure end is outside of the CRZ. Where there is recovery area between the edge of the traveled way and the edge of an embankment, the guardrail should be installed near the edge of the embankment, preserving the recovery opportunity.

10. *Design Details:* There are a number of factors that must be taken into consideration when installing guardrail.

a. *Restricted Horizontal Clearance to Hinge Point:* Where embankment width between the edge of shoulder and hinge point is less than 4 feet, there is not sufficient soil to support a standard length W-beam guardrail post. If there is at least 2½ feet of this embankment width but less than 4 feet, and standard MGS is to be installed, a 7-foot long, 8-inch x 8-inch wood post or an 8-foot long steel post should be used. See [Figure 10](#), Midwest Guardrail System on Standard and Narrow Embankments. This design may also be used where embankment material is non-cohesive. If there is less than 2½ feet between the hinge point and the edge of shoulder, the concrete beam detail in Figure 11 may be used. Another potential option where there is less than 1½ feet between the hinge point and the edge of shoulder is use of a 2-foot diameter cast-in-drilled-hole pile (CIDH) to support a W6x8.5 or 9 steel post for MBGR. Under the same conditions CIDH piles cannot be used for MGS. Instead either wood post of 8-feet in length or steel post of 9-feet in length will need to be used. For MBGR use

of the CIDH detail should be limited to no more than six consecutive posts for MBGR. Details for these alternate designs are shown in [Figure 10](#).

Use of CIDH piles for MBGR and the use of 8-foot wood or 9-foot steel post for MGS, on very narrow embankments, must be approved by the Headquarters Traffic Safety Systems Branch.

- b. *Restricted W-beam Post Embedment Depth or Placement:* When it is necessary to continue a roadside guardrail across an, underground obstruction full embedment of the guardrail post(s) may not be possible due to the shallow soil cover. Posts located in an overside drain are undesirable and are therefore often set back behind the drain with multiple blocks. The use of more than two blocks can cause guardrail rotational problems and should be avoided.

One, two or three posts located directly over the culvert or drain may be eliminated. The three consecutive posts adjacent to both ends of the gap shall be controlled releasing terminal posts. Design details are shown in [Figure 12a](#), Long Span MGS. Long Span MGS should not be used in transition areas, or where a fixed object is closer than 12-feet due to increased rail deflection.

An alternative design to [Figure 12b](#) is the special post footing shown in [Figure 13](#). [Figure 12a](#) and [Figure 12b](#) are for MGS and MBGR. Show details for removing up to 3 posts with MGS and up to 2 posts with MBGR. This detail may be used only where standard embedment of railing post is restricted by underground facilities, such as drainage structures, utilities, footing of walls, columns, etc., **No more than three consecutive posts with this design shall be used for MGS and 100 feet of unaltered rail shall be placed between any skip post detail.**

Use of [Figure 13](#) must be approved by the Headquarters Traffic Safety Systems Branch.

- c. *Strengthened MGS Rail Sections:* [Topic 3.5](#) discusses application of the strengthened railing sections detail where W-beam guardrail is installed less than 4 feet from a

fixed object. This detail uses reduced post spacing of 37½ inches and larger posts and blocks to transition from the standard post spacing and size. The wood posts are 10-inches x 10-inches x 8 feet long with 8-inch x 12-inch blocks. The alternate steel posts are a W6x15 section and the blockouts are 8-inch x 12-inch wood or plastic blocks. All steel parts are to be galvanized. Details of the “Strengthened Railing Section for Fixed Objects” are shown in the Standard Plans.

- d. *Adjusting Rail Height:* All W-beam guardrail posts have holes for adjusting the rail-height for an overlay to be placed on the shoulder. The adjustable post had three predrilled holes per the 1995, 1997 and 1999 Standard Plans and has two holes per the 2004, 2006, 2010 and the 2015 Standard Plans, which allow the rail element and block to be raised when an overlay is placed on the shoulder. Details of the components are shown in the Standard Plans. See [Figures 14a](#) and [14b](#) for installation details. **Pavement overlays that impact the effective height of rail elements shall include the required action from [Table 6](#) for MBGR and MGS. Concrete guardrail cannot be capped to increase its height. Instead it must be removed and replaced with new barrier as outlined in [Table 6](#).**
- e. *W-beam Rail Curvature:* W-Beam Guardrail can be installed on curving alignment without special fabrication where the radius of curvature is more than 150 feet. Where the radius of curvature is 150 feet or less, down to a minimum radius of 5 feet, the rail elements require shop rolling to the required radius. Installations of guardrail with specially fabricated components should be held to a minimum to reduce the need to stockpile special components for maintenance. Also, where special components are not stockpiled, the delay in ordering and receiving replacements unnecessarily extends the exposure for traffic.
- f. *W-Beam Guardrail Delineation:* Galvanized steel guardrail provides some supplemental value as a delineation device. Where necessary, this delineation ability can be enhanced with reflective delineation devices as described in the California MUTCD. Reflective delineation devices

used on guardrail installations should provide optimum visibility. Guardrail located more than 12 feet from the roadbed should not have reflective delineation devices installed. Guardrail intruding on the roadbed, such as at approaches to narrow bridges, warrants additional delineation treatment as described in the California MUTCD.

- g. *Aesthetic W-beam Guardrail Treatment:* **Weathered steel or ungalvanized steel is allowed only where rainfall is less than 8 inches per year and there is no salt in the area. Additionally, all new and existing installations of weathering steel or ungalvanized steel guardrail or median barrier shall be examined annually to determine their conditions. Those installations showing signs of advanced deterioration shall be replaced as soon as possible. Advanced deterioration is defined as visible tubercular rust signs. Replacement parts shall be galvanized.** For more on Aesthetic Metal Guardrail Treatments, and the options, refer to Landscape Architecture, Highway Metal Guardrail Aesthetics, see Landscape Architectures or at: http://www.dot.ca.gov/hq/Land-Arch/16_la_design/research/aesthetics.htm
- h. *Use of Steel Posts in Fire Prone Areas:* All new and replacement W-beam guardrail should be specified with steel posts if the surrounding environment contains potential fuel for wildfires. This restriction does not apply to transitions to bridge rails or concrete barriers. Guardrail in roadside areas with no proximate fuel sources may use wood or steel posts. However, guardrail post and block type should be consistent in a single installation or run. Consult with

the District Maintenance Engineer or review the State of California FIRE HAZARD SEVERITY MAP published by CAL FIRE at http://www.fire.ca.gov/fire_prevention/fire prevention wildland statewide to determine if a project site is in an area containing flammable vegetation that requires use of steel posts for guardrail.

- i. *The use of Steel Post in Environmentally Sensitive Areas:* Steel post may be preferred as they are driven and not augured thereby minimizing soil disturbance.
- j. *Thrie Beam Barrier Used as Guardrail:* Thrie Beam Barrier may be used as guardrail only in special situations where additional height of rail is needed. Refer to [Topic 4.6\(2\)](#) for more information about the design of thrie beam barrier.
- k. *Curb and Dike in front of Guardrail:* The following are restrictions exist on the placement of curb or dike in front of guardrail.
 - Midwest Guardrail System: Refer to [Topic 3.6\(3\)](#).
 - Concrete Guardrail: **Curb or dike shall not be placed in front of concrete guardrail.**
 - Cable Guardrail: **Cable Guardrails are proprietary systems. If curb or dike are needed then curb or dike shall be installed per manufactures recommendations**
- l. *Pullouts:* At pullouts, guardrail may be routed around the perimeter of the pullout but should maintain the 15:1 for W-Beam and 20:1 for Concrete, or flatter, flare in the departing end from the back of the pullout.

Table 6: Railing and Barrier Restoration Practice*

Existing Railing or Barrier	Height (in)	Overlay Tolerance (in)	Required Action
Metal Beam Guardrail (MBGR)	29	+1	- Replace with MGS if top of rail is below 29” or above 30” - 8 inch blockouts must be used.
Midwest Guardrail System (MGS)	31	+1 -2	Raise block and rail using additional hole(s) in post. If out of tolerance: - Add rub rail if top of rail is above 32” - Reconstruct if top of rail is below 29”
Metal Beam Barrier	30	N/A	Should be upgraded per policy to current standards. If not, contact the Headquarters Traffic Safety Systems Branch
Thrie Beam	32	0	Reconstruct if top rail is below 32”
Type 50	32	0	Remove and install Type 60M Barrier even if height is not reduced and shoulder cross slope is not greater than 10:1.
Type 60MS	36	0	Remove and install new Type 60M or Type 60MG Barrier.
Type 60M	42	-6	Remove and install new Type 60M or Type 60MG Barrier.
All Other Barriers	N/A	N/A	Consult The District Traffic Safety Engineer and the Bridge Barrier & Railing Specialist – Division of Engineering Services.
Crash Cushions	N/A	N/A	Remove, raise pad to grade and replace cushion all per manufacturer.

*Check with the District Traffic Safety Engineer and the District Safety Systems Coordinator before proceeding with these practices.

11. *Offsetting and Overlapping Guardrail:* Guardrail is meant to prevent collisions with fixed objects or non-traversable/non-recoverable slopes when these events are more severe than impacting the guardrail itself. As such, guardrail is limited to when it is actually needed. Overlapping one guardrail system in front of another defeats this. If an issue exist with an existing system it should be removed and replaced with a current system. The only time offsetting and overlapping is advisable is when a gap is needed like at a MVP. **Therefore, except at the end of guardrail system where overlapping will eliminate the need for an end treatment, or is for Maintenance openings, guardrail systems shall not overlap.**

12. *Typical Layouts:* W-beam guardrail typical layouts are designed to place the ends of guardrail installations away from approaching traffic and provide a smooth transition. Placement is controlled by such factors as embankment width, distance between roadbeds, clear roadside width, and the design of the guardrail itself. The layouts shown in the Standard Plans are both general and typical. They are most applicable to new construction; however, any installation may require some modification to fit special circumstances.

Deviations from guardrail typical layouts must be approved by the District Traffic Safety Engineer and documented in the project files.

a. *Embankment Layouts:*

The Type 11 Layout series are used to shield embankment slopes where guardrail is recommended.

Layout Types 11A, 11B and 11C are used where guardrail is recommended to shield embankment slopes only for adjacent traffic, using an allowable end treatment. See [Topic 3.6\(8\)](#) for information about allowable guardrail end treatments.

Layout Types 11D through 11L illustrate combinations of allowable end

treatments used at the approach and trailing ends of guardrail to shield embankment slopes.

b. *Structure Approach and Departure Layouts:*

The Type 12 Layout series are used to shield the approach or departure ends of structures with an allowable end treatment.

Layout Types 12A, 12B and 12C illustrate allowable end treatments used at structure approaches, to the right or left of traffic.

Layout Type 12D is used where continuous guardrail is installed between structures. Layout Type 12E is used to the left of approaching traffic at the end of each structure on multilane freeways or expressways.

Layout Type 12E is used where guardrail is installed in the median to shield both the approach structure and the structure on the opposite side of the median if it is less than 50 feet from the edge of traveled way.

Layout Types 12AA, 12BB and 12CC illustrate allowable end treatments used at structure departures.

Layout Type 12DD is used where guardrail is recommended to shield embankment slopes only for adjacent traffic.

c. *Fixed Object Layouts:*

The Type 14, 15 and 16 Layout series are used to shield fixed objects.

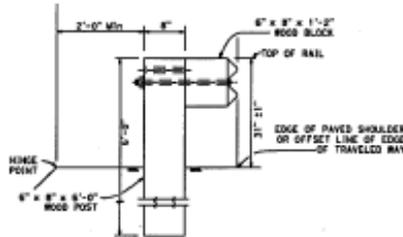
Layout Type 14A is used to shield fixed objects between separated roadbeds in two-way traffic and Layout Type 15A is used to shield objects between separated roadbeds in one-way traffic, using allowable end treatments.

Layout Types 16A, 16B and 16C are used to shield fixed objects only for adjacent traffic, using allowable end treatments.

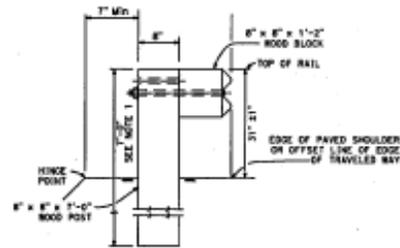
Layout Types 16D through 16L illustrate combinations of allowable end treatments used at the approach and trailing ends of guardrail to shield fixed objects.

Figure 10: Guardrail on Standard and Narrow Embankments

MIDWEST GUARDRAIL SYSTEM (MGS)

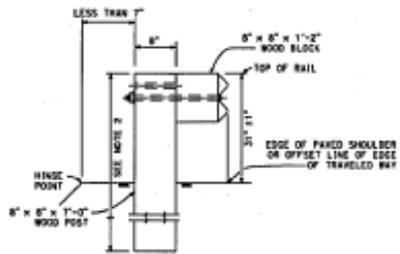


TYPICAL ROADWAY
INSTALLATION



NARROW ROADWAY
INSTALLATION

POST EMBEDMENT



VERY NARROW ROADWAY
INSTALLATION

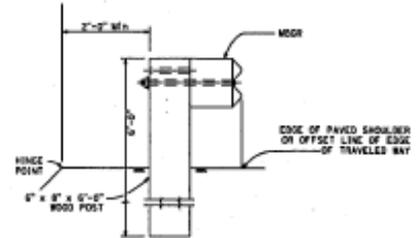
SEE NOTE 4

POST EMBEDMENT

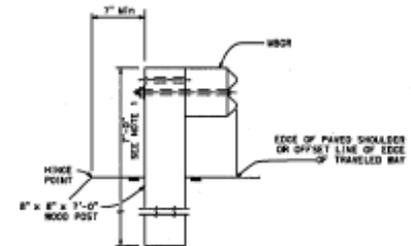
NOTES:

1. USE 8'-0" Wx8 (or W6x8.5) STEEL POST.
2. 2'-0" Wx8 (or W6x8.5) STEEL POST, 2" X 8" WOOD POST AND 6" X 8" WOOD OR PLASTIC BLOCK-OUT.
3. FOR DIKE POSITIONING OR USE OF A DIKE WITH MGS INSTALLATIONS, SEE STANDARD PLAN A71M.
4. USE THIS DETAIL ONLY WITH AN APPROVED TRAFFIC SAFETY SYSTEM EXCEPTION.

METAL BEAM GUARDRAIL (MBGR)

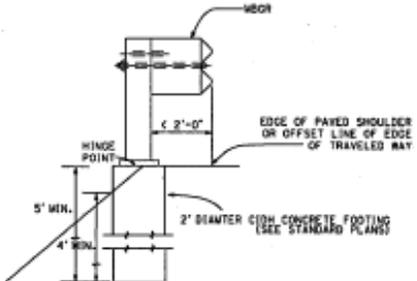


TYPICAL ROADWAY
INSTALLATION



NARROW ROADWAY
INSTALLATION

POST EMBEDMENT



VERY NARROW ROADWAY
INSTALLATION

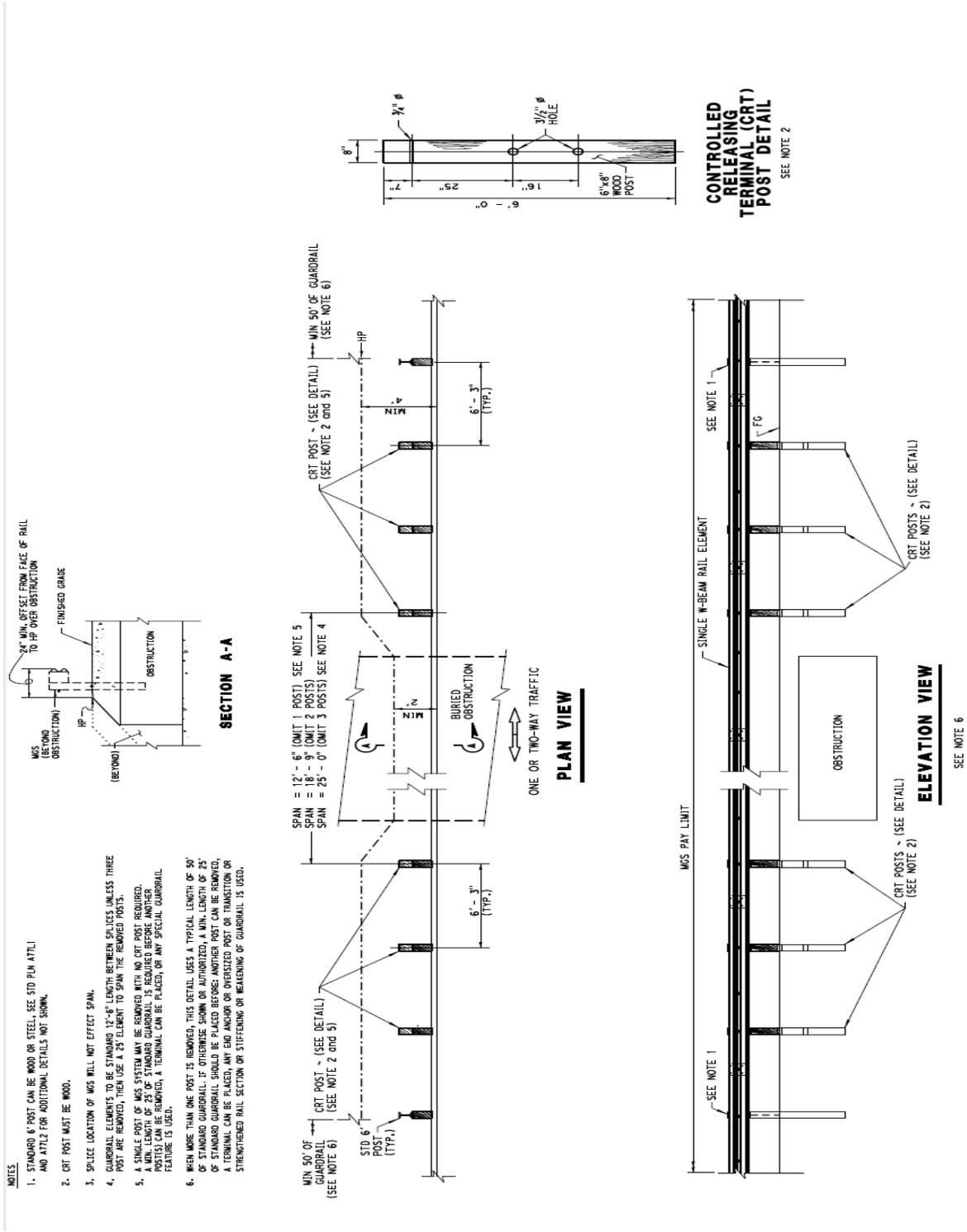
SEE NOTE 2

POST EMBEDMENT

NOTES:

1. USE 8'-0" Wx8 (or W6x8.5) STEEL POST
2. USE THIS DETAIL ONLY WITH AN APPROVED TRAFFIC SAFETY SYSTEM EXCEPTION.

Figure 12a: Long Span Midwest Guardrail System



MIDWEST GUARDRAIL SYSTEM
 OMIT 1 TO 3 POSTS
 NO SCALE

Figure 12b: Long Span Nested MBGR

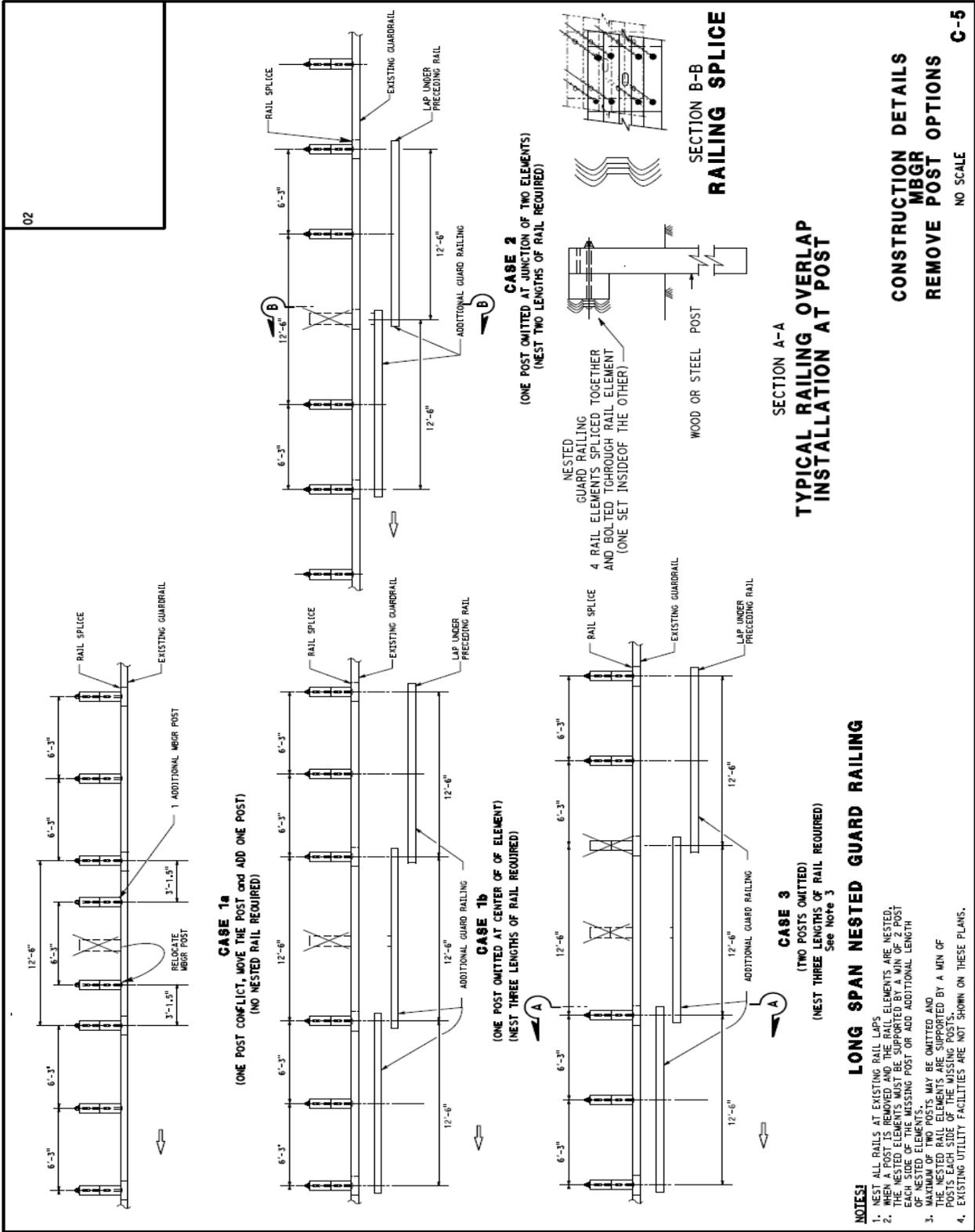
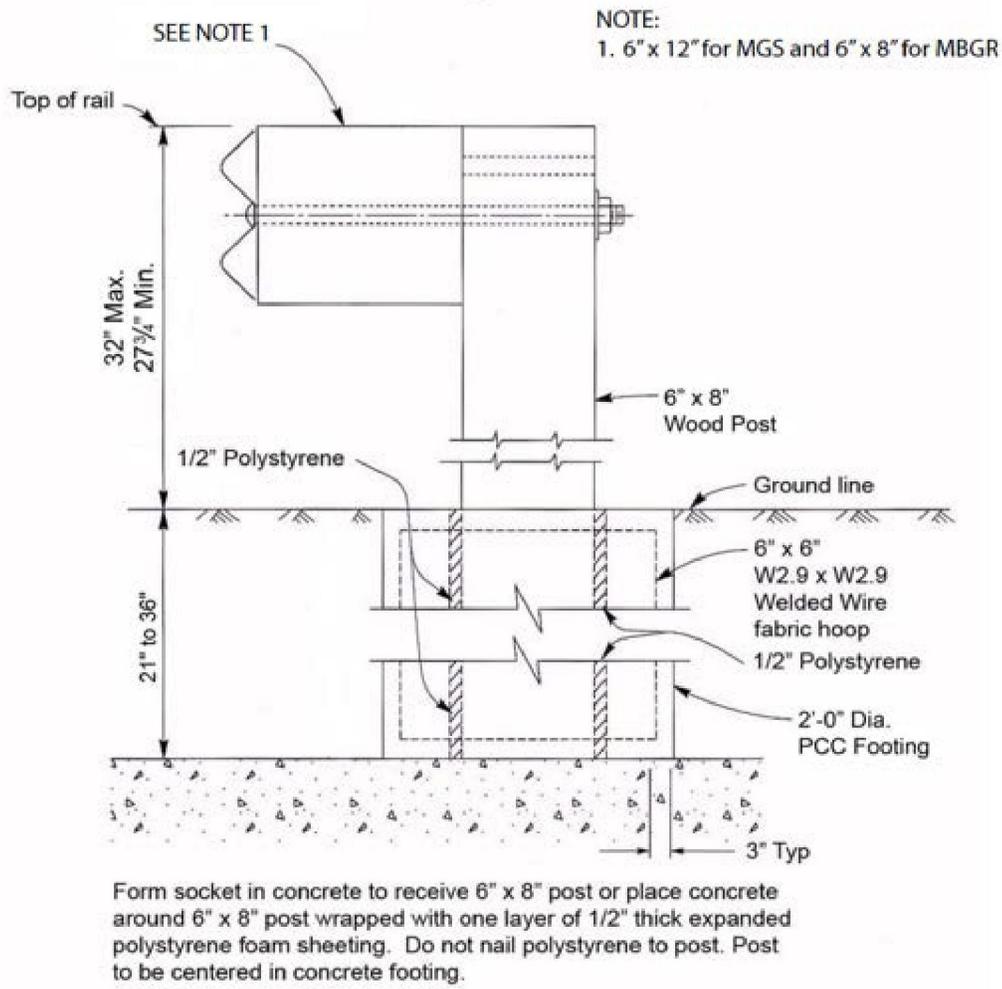


Figure 13: Special Post Footing Detail



Note: Use this detail only by approval of HQ Traffic Safety Devices Branch Chief

Figure 14a: Adjustable Height W-beam (2 Hole Post)

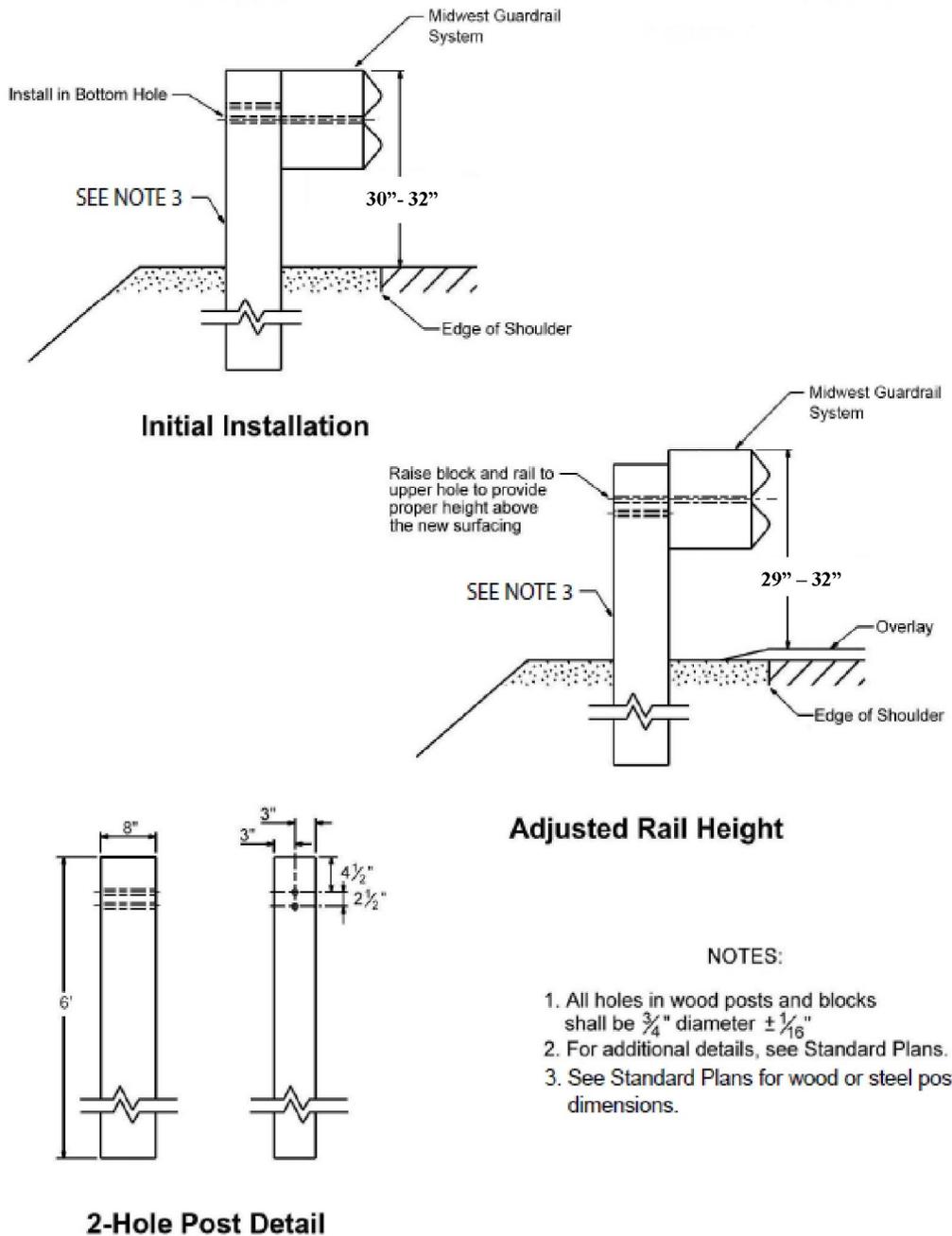
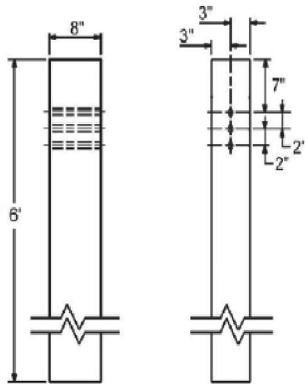
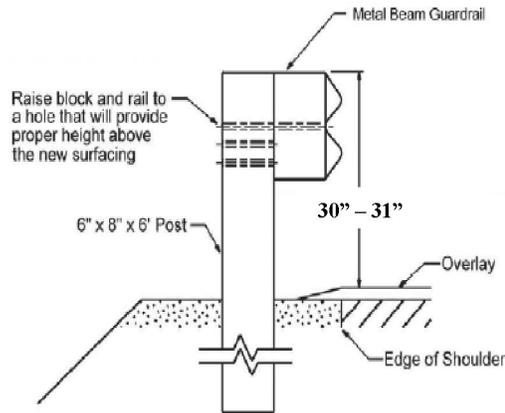
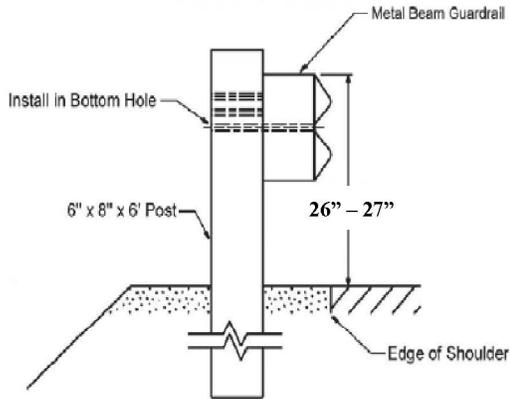


Figure 14b: Adjustable Height W- beam (3 Hole Post)



NOTES:

1. All holes in wood posts and blocks shall be $\frac{3}{4}$ " diameter $\pm \frac{1}{16}$ "
2. For additional details, see Standard Plans.

Figure 15 Midwest Guardrail Shift Post Detail

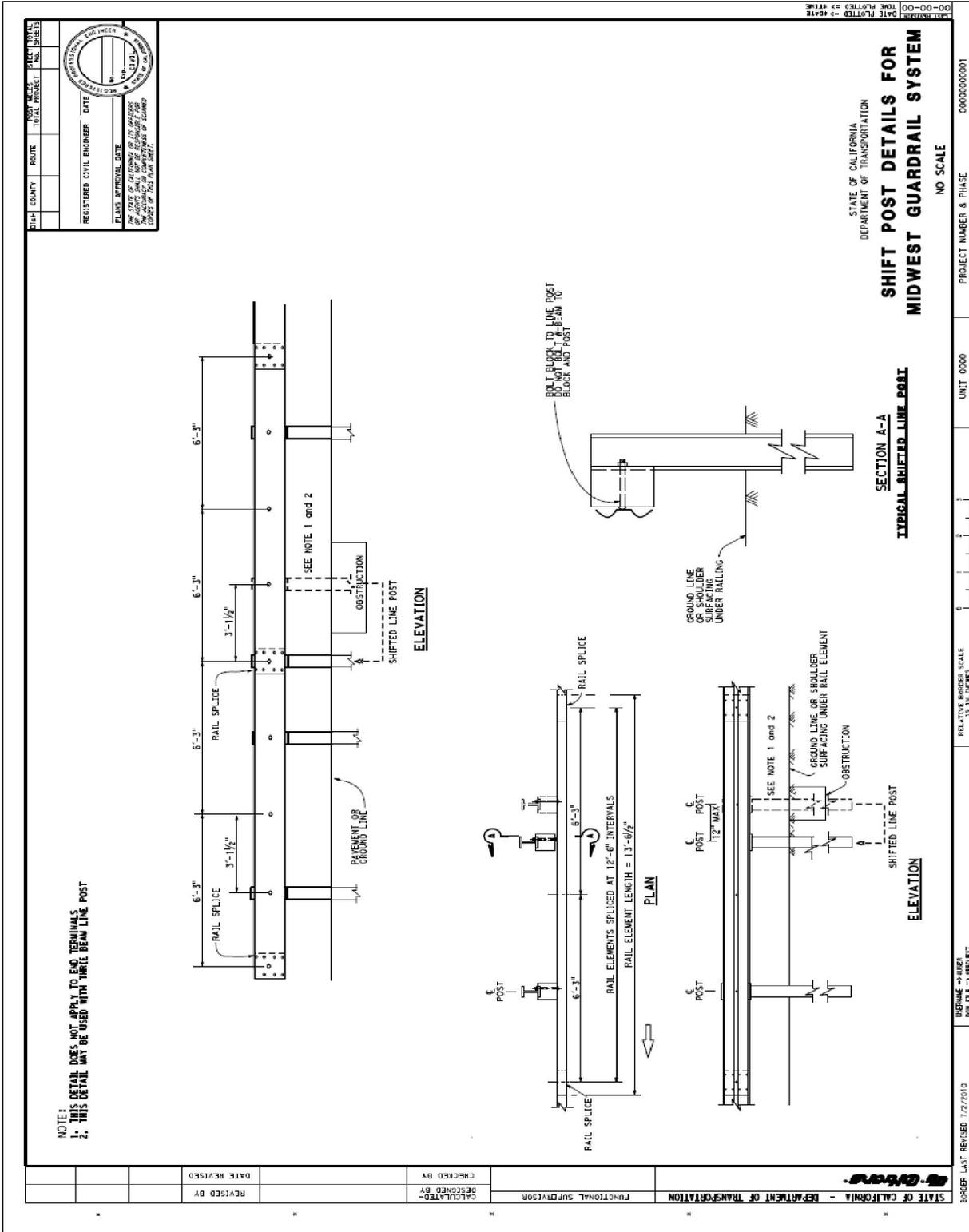


Figure 17 MGS Transition Detail for 27 3/4" Median Crash Cushion to Double Midwest Guardrail Systems

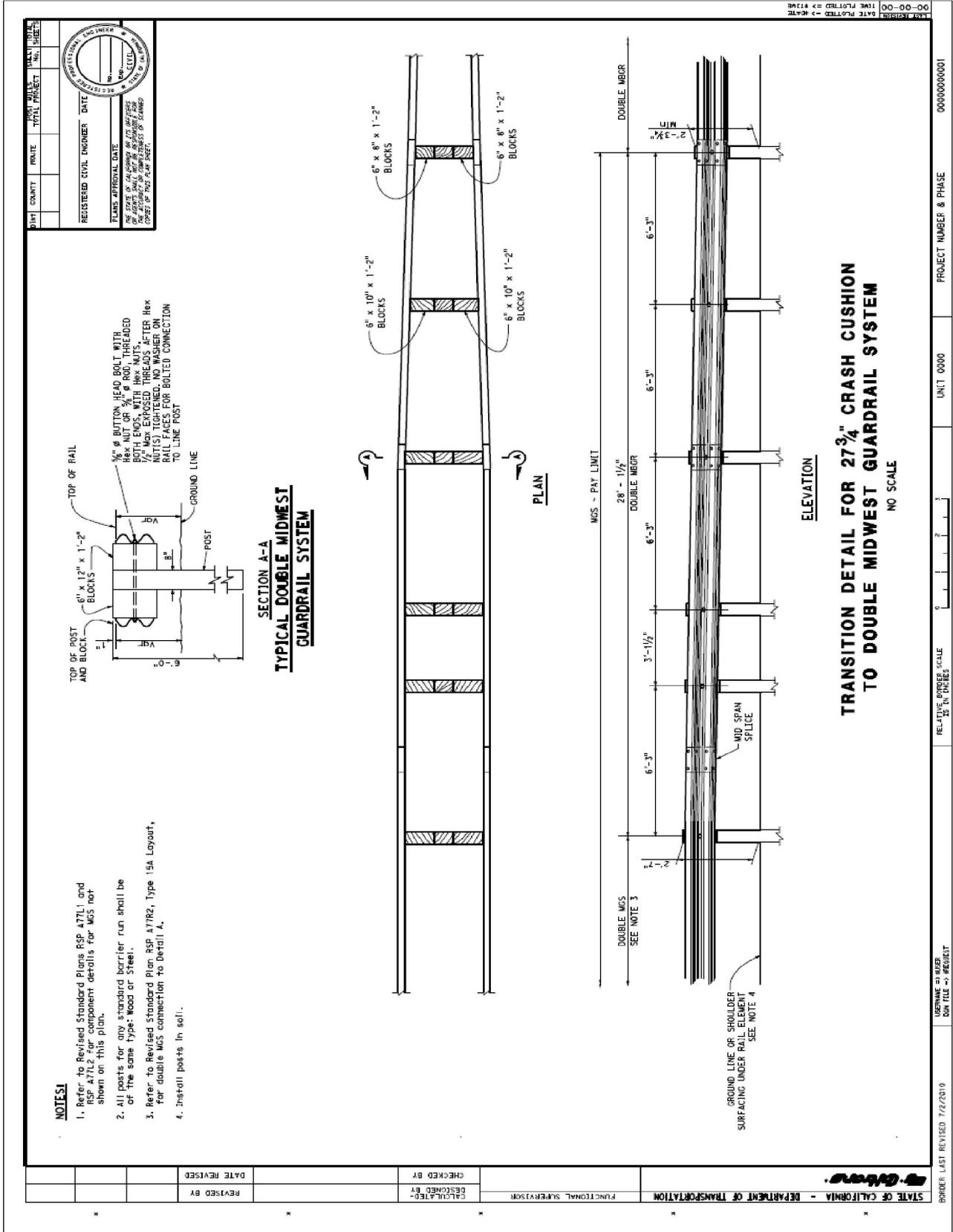
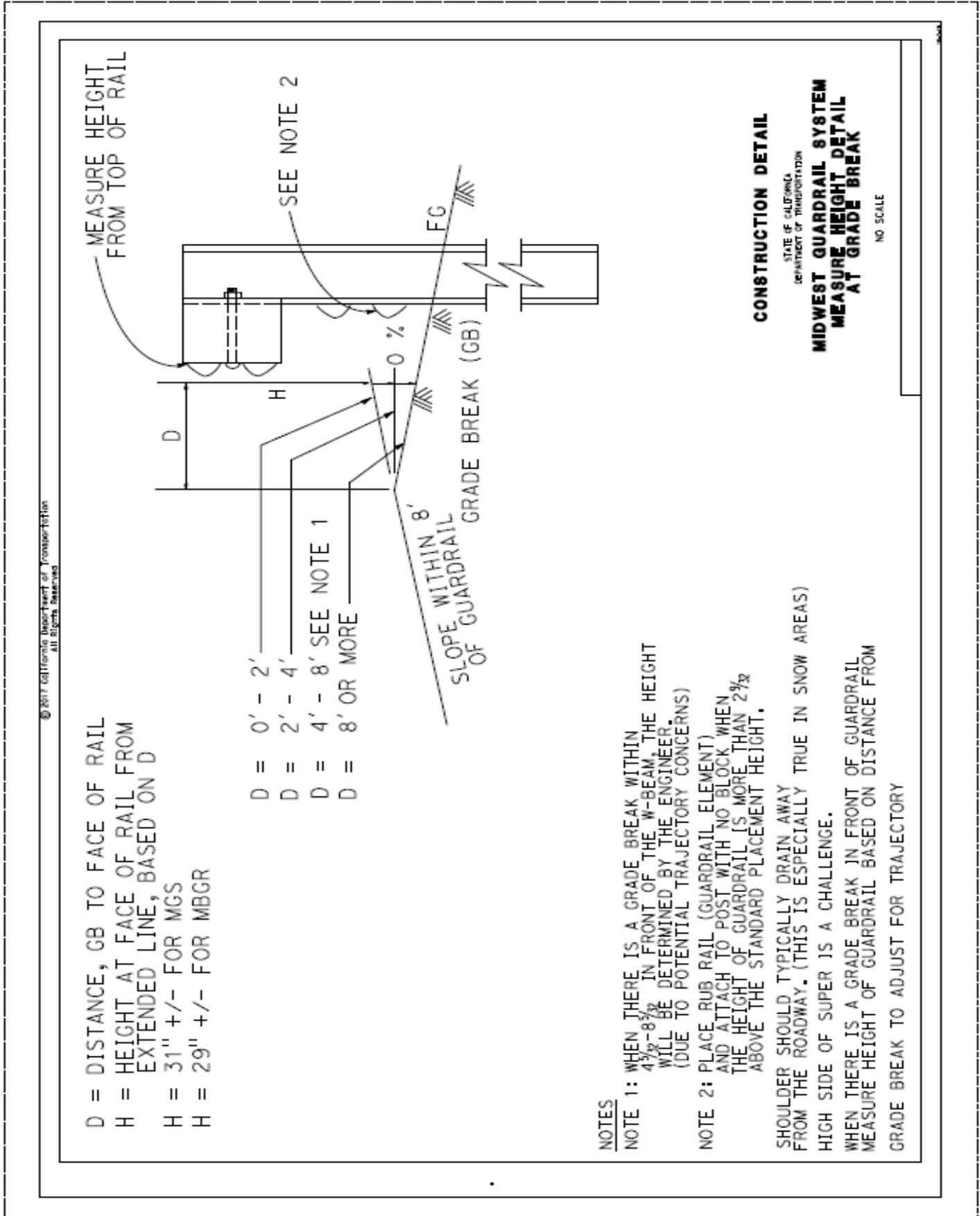


Figure 18 W-beam Height Measurement



D = DISTANCE, GB TO FACE OF RAIL
 H = HEIGHT AT FACE OF RAIL FROM EXTENDED LINE, BASED ON D
 H = 31" +/- FOR MGS
 H = 29" +/- FOR MBGR

- D = 0' - 2'
- D = 2' - 4'
- D = 4' - 8' SEE NOTE 1
- D = 8' OR MORE

NOTES

NOTE 1: WHEN THERE IS A GRADE BREAK WITHIN 4 1/2'-8 1/2' IN FRONT OF THE W-BEAM, THE HEIGHT WILL BE DETERMINED BY THE ENGINEER, (DUE TO POTENTIAL TRAJECTORY CONCERNS)

NOTE 2: PLACE RUB RAIL (GUARDRAIL ELEMENT) AND ATTACH TO POST WITH NO BLOCK WHEN THE HEIGHT OF GUARDRAIL IS MORE THAN 2 1/2' ABOVE THE STANDARD PLACEMENT HEIGHT.

SHOULDER SHOULD TYPICALLY DRAIN AWAY FROM THE ROADWAY. (THIS IS ESPECIALLY TRUE IN SNOW AREAS) HIGH SIDE OF SUPER IS A CHALLENGE.

WHEN THERE IS A GRADE BREAK IN FRONT OF GUARDRAIL MEASURE HEIGHT OF GUARDRAIL BASED ON DISTANCE FROM GRADE BREAK TO ADJUST FOR TRAJECTORY

CONSTRUCTION DETAIL
 STATE OF CALIFORNIA
 DEPARTMENT OF TRANSPORTATION
**MIDWEST GUARDRAIL SYSTEM
 MEASURE HEIGHT DETAIL
 AT GRADE BREAK**
 NO SCALE

Topic 04 – Median Barrier

4.1 Purpose

The purpose of median barriers is to reduce the risk of an errant vehicle crossing the median and colliding with opposing traffic. A cross-median collision is defined as one in which an errant vehicle crosses the median of a highway with four or more lanes and strikes, or is struck, by a vehicle from the opposite direction.

4.2 Function

Median barriers are designed to reduce the risk of an errant vehicle:

- Colliding with a vehicle traveling in the opposite direction,
- Being deflected back into the traffic stream traveling in the same direction, or,
- Decelerating beyond tolerable occupant limits.

While median barriers are capable of preventing nearly all cross-median collisions, they are a fixed object and their installation can result in collisions that might not otherwise occur.

4.3 Barrier Types

The approved standard types of median barriers for new installation are:

1. Concrete median barrier (Type 60M series),
2. Thrie Beam barrier (single or double),
3. Cable barrier (three or four strand), and
4. Portable Concrete Barrier (PCB) (Type K and Type 60 K, for interim use only).

More information on the different types of median barriers is located in [Topic 4.5](#).

4.4 Study Warrants

The collision study warrant and freeway volume/width study warrant are used to identify locations for investigation. These study warrants, their uses and limitations are described below.

Collision Study Warrant

The following collision study warrants are applicable to freeways, expressways, and conventional highways with four or more lanes:

- A collision study warrant for any severity is met if a location has three or more cross-median collisions and a total cross-median collision rate of at least 0.5 collisions per mile per year in a five year period, or
- The Fatal collision study warrant is met if a location has three fatal collisions or more and a fatal cross-median collision rate of at least 0.12 collisions per mile per year in a five year period.

Highway locations with four or more lanes satisfying either of the above collision warrants should be studied. The collision warrant for two- or three-lane highways is based on the above fatal study warrant criteria only.

Freeway Traffic Volume/Width Study Warrant

The freeway median barrier volume/width study warrant, illustrated in [Figure 19](#), has been developed through an extensive study of freeway cross-median collisions. The need for a median barrier should be considered on freeways whenever the volume and median width plot in the gray area. The probability of an errant vehicle crossing the freeway median and colliding with an opposing vehicle is low when either one or both of the following conditions exist:

- The Annual Average Daily Traffic is less than 20,000, or
- The median width is more than 75 feet.

Use of Study Warrants

1. *Freeways:* A freeway is defined as a divided arterial highway with full control of access and with grade separations at intersections. The Highway Safety Improvement Program Guidelines, Chapter 4, Section 4.1.2.1, titled “Multilane Cross Median Collision” provides guidance for study warrants.

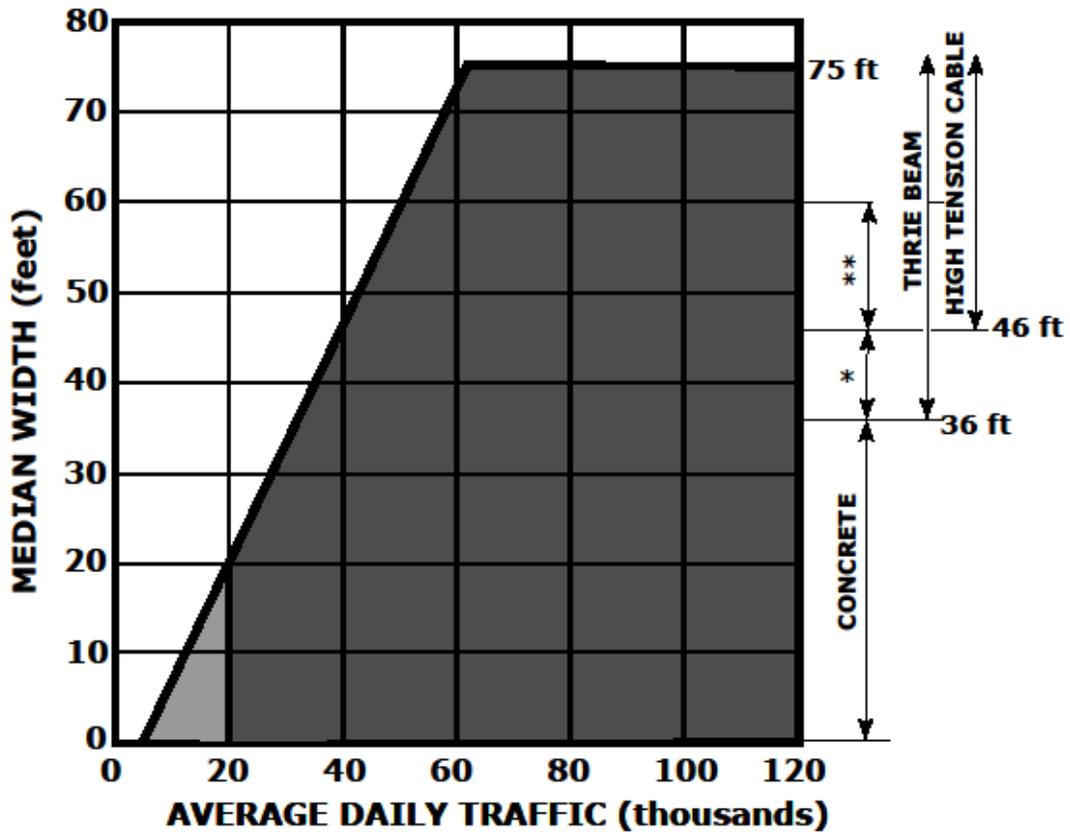
Freeway locations without median barrier are to be studied when the collision or volume/width study warrant is met. The need for a median barrier should also be studied

when building a new freeway or when adding a lane to an existing freeway.

If the median barrier volume/width study warrant will be met within five years of completion of construction, then the feasibility of placing a median barrier should be considered.

All studies, and any changes to the studies, must document the decision to install or not to install a median barrier on the freeway system. The District Traffic Safety Engineer must approve the decision to install or not install median barrier, and any changes to the studies and the decision must be documented in the project files.

Figure 19: Freeway Median Barrier Study Warrant



Light Gray Box: BARRIERS IN THESE CASES SHOULD BE CONSIDERED ONLY IF THERE IS AN UNUSUALLY HIGH NUMBER OR RATE OF CROSS-MEDIAN COLLISIONS

Dark Gray Box: STUDY WARRANT

* CONSULT WITH THE HEADQUARTERS TRAFFIC LIAISON

** OFFSET UP TO 17FT. FROM THE ETW AND PAVE UP TO THE BARRIER FACE

2. *Expressways*: An expressway is defined as an arterial highway with at least partial control of access, and which may or may not be divided. Expressways normally do not have grade separations at intersections.

Expressway locations are to be reviewed when the collision study warrant is met. The freeway volume/width study warrant, although developed for freeways, may be used for studying expressways as a proactive measure for the installation of median barrier prior to appearing on the cross median collision warrant list.

For new construction, and when upgrading from a conventional highway to an expressway, if there are less than five year of existing collision data the District Traffic Safety Engineer must be consulted to determine if a study should be conducted to install median barrier. Any decision to install or not to install a median barrier must be documented in the study.

Note: Access openings on expressways, multilane conventional highways and two-lane and three-lane conventional highway facilities present sight distance issues with respect to installation of a median barrier. All access openings must be analyzed to maintain both corner sight distance at approach intersections and stopping sight distance on the specific facility types themselves (see the *Highway Design Manual* for sight distance standards).

Some of the issues to consider in the study include but are not limited to the following:

- Collision history
- Travel speed on the facility
- Out of direction travel and turn around points for the abutting property owners,
- Accommodation for design vehicles to turn around
- The need for crash cushions where the median barrier stops adjacent to travel

3. *Multilane Conventional Highways*: A multilane conventional highway (two or more lanes in each direction) is defined as a highway without control of access, where property owners have a right to access highway facilities with driveways and at grade intersections. These highways may or may not be divided.

Median barriers may be an appropriate solution to cross-median or cross-centerline collisions on multilane conventional highways. Multilane conventional highway locations are to be studied when the collision study warrant is met. The freeway volume/width study warrant, although developed for freeways, may be used to study multilane conventional highways as a proactive measure for installation of a median barrier prior to appearing on the cross median collision warrant list.

Installation of a median barrier on multilane conventional highways may not be feasible due to the numerous issues presented in the note under *Expressways*. The District Traffic Safety Engineer may consider installation of a raised median or buffer, with a 6-inch dike or curb and gutter, to reduce cross centerline collisions on urban or suburban facilities operating at 45 mph or less.

4. *Two- and Three-Lane Conventional Highways*: Two- and three-lane conventional highways are defined as highways without control of access, and where property owners have a right to access highway facilities with driveways, and there are at-grade intersections. The Highway Safety Improvement Program guidelines, Chapter 4, Section 4.1.2.2, titled “Two- and Three-Lane Cross Centerline Collision”, along with Deputy Directive 50, provide guidance on study warrants and median barrier policy for two- and three-lane facilities, respectively.

Installation of a median barrier on two- and three-lane highways is rare, and requires analysis of the issues presented in the note under expressways above. In addition, consideration is to be given to the fact that a median barrier will eliminate any passing zones and may impact emergency vehicle response within the barrier’s limits.

Note: Due to operational and environmental considerations, right of way purchases, impacts to the abutting property owners of the state highway and other considerations, incremental improvements should be considered on two- and three-lane conventional highways. These incremental improvements include, but are not limited to: barrier striping, rumble strips on the outside paved shoulder, shoulder widening with rumble strips, centerline buffer zones, rumble strips on the centerline stripe, surface mounted channelizes on a centerline buffer zone, and other appropriate devices and applications.

4.5 Criteria for Choice of Type

After the decision to install permanent median barriers has been made, [Table 7](#), Median Barrier Type Selection Table, is to be used to determine the appropriate barrier type at a given location. (Note:

All median barrier offset dimensions are measured from the edge of traveled way to the bottom face of barrier.)

Any exceptions to the barrier type selection criteria listed in [Table 7](#) must be approved by the Headquarters Traffic Safety Systems Branch.

Table 7: Median Barrier Type Selection

		Median Width			
		Equal to or less than 36 feet (ft)	Greater than 36 ft to less than 46 ft	Equal to 46 ft to less than 60 ft	Equal to or Greater than 60 ft
NO PLANTINGS	Barrier Type	Type 60M concrete ¹	Consult HQ Traffic Safety Systems Branch	Type 60M concrete, Thrie beam or cable ³	Thrie beam or cable ³
	Placement	On centerline ² pave up to face of barrier	Consult HQ Traffic Safety Systems Branch	Offset up to 17 ft and pave up to it, or on centerline (no paving)	On centerline
PLANTINGS	Barrier Type	Type 60M concrete ¹	Type 60M concrete or Thrie beam	Thrie beam	Thrie beam
	Placement	On each side of planting, pave up to the barrier	Consult HQ Traffic Safety Systems Branch	On each side of plantings, minimum offset 17 ft	On each side of plantings, minimum offset 17 ft

¹Obtain approval from the District Maintenance Engineer for using thrie beam barrier.

²Except when offset for barrier openings.

³ Cable barrier requires approval by the Deputy District Directors of Traffic Operations and Maintenance.

Each barrier system has properties that make a certain type of barrier better suited in one location than another. These characteristics are:

1. **Concrete Barrier: The Concrete Barrier Type 60M series is the current standard and shall be used when concrete barrier is to be constructed (see the Standard Plans).** The Type 60M series is to the current MASH standards. This barrier is rigid and does not deflect upon impact, but dissipates impact energy within the vehicle suspension system at shallow angle impacts and by displacement of vehicle

sheet metal at severe impact angles. The severity of impact may be greater with concrete than with thrie beam barriers at high impact angles. Because impact angles tend to increase as the distance to the barrier increases, the use of concrete median barrier is guided by [Figure 19](#) and [Table 7](#). For median widths equal to or less than 36 feet, concrete barriers are the preferred barrier type.

Concrete barrier requires little maintenance; consequently, traffic is not disrupted by extensive maintenance operations, and maintenance workers are not exposed to large volumes

of relatively high-speed traffic. Concrete barrier have the highest percentage of unreported collisions. In shallow angle collisions with concrete barrier, most vehicles are redirected with minimal damage and can be driven away. Also, concrete barrier has no projections to collect debris.

If an aesthetic appearance for concrete barrier is desired, they need to have been previously crash tested and cannot reduce the amount of concrete over the reinforcing bars found in the Standard Plans. Furthermore, the aesthetic treatments must not have protrusions or indentations 1 inch or greater. If there are then they must be above 48 inches from the base of the barrier or, 72 inches if integrated with a wall structure (Also See HDM, Section 210.5 Aesthetic Consideration).

Use of Aesthetic Treatments to concrete barriers must be concurred by the District Traffic Safety Engineer.

For more on Aesthetic Barrier Treatments, and the options, refer to Landscape Architecture, Highway Barrier Aesthetics, at:

http://www.dot.ca.gov/hq/Land-Arch/16_la_design/aesthetics/barriers/index.htm

Concrete barriers must not be used as retaining walls and are not to be constructed for this purpose. Furthermore the Type 60C concrete barrier can only be placed along roadbed structural sections and must not be placed along or on soil.

If appurtenances are needed on top of concrete barriers, such as steel sign posts, refer to [Topic 3.2\(2\)](#) for guidance and restrictions.

Proposed appurtenances on top of concrete barriers, such as steel sign supports or chain link fence, must be approved by the District Traffic Safety Engineer and documented in the project files.

2. **Thrie Beam Barrier: Thrie Beam barrier is the current standard and shall be used when metal median barrier is to be constructed (see the Standard Plans).** This barrier is semi-rigid and may deflect up to 2 feet on impact, providing some dissipation of energy through the displacement of posts and flattening of barrier elements. Thrie beam barrier can sustain minor impacts without requiring immediate and extensive restoration work. This barrier system is wider than concrete barrier, and has

higher maintenance costs. Vegetation control may be considered beneath thrie beam barrier, and details are in the Standard Plans. If an aesthetic appearance for thrie beam barrier elements is desired, refer to [Topic 3.6\(10\)\(g\)](#), Aesthetic Metal Guardrail Treatment, for options.

For new installations of thrie beam barrier, a minimum distance of 17 feet between the face of rail and the edge of travel way shall be provided for maintenance activities. If the 17 feet distance cannot be provided due to plantings, concrete barrier should be placed instead.

Thrie beam barriers may also be installed in medians where there is a history of sand accumulation the median due to high wind, or in designated Federal Emergency Management Agency floodplain areas. Refer to [Table 7](#) for requirements for exceptions where thrie beam barrier is necessary under these conditions.

At the time of publication, October 31, 2019, is when all Thrie Beam Barrier will have to meet MASH standards.

3. **Cable Barrier:** Three or four-strand cable barrier is a flexible barrier and may be placed in wider medians with no plantings. Although lower in cost than concrete or thrie beam barrier, cable barrier experiences large deflections upon impact. Approved high tension cable barriers may be considered for medians 46 feet or wider.

At the time of publication, October 31, 2019, is when all Cable Barrier will have to meet MASH standards.

Installation of any new cable barrier must be approved by the Deputy District Directors of Traffic Operations and Maintenance

4. **Portable Barrier:** If there is widening or other type of work that will reposition barriers in five years or less, consider a Portable Concrete Barrier (PCB), such as Portable Concrete Barrier (Type 60K) or Temporary Railing (Type K), as an interim barrier. This applies to all median widths with or without plantings. Cases in which an interim barrier may be used include stage construction where a PCB is left in place after project acceptance, a programmed project to construct permanent median barrier and a programmed project in the State Transportation Improvement Program (STIP). The project which repositions the barrier shall include the cost of installing the permanent median barrier.

Another type of portable barrier are Portable Steel Barriers (PSB). These systems may have retractable wheels so that they can be easily moved, be light in weight, and may have gate sections that can be installed with the system for passage of equipment. These systems are proprietary and can be found on the Traffic Safety Devices Approved Products site: <http://traffic.onramp.dot.ca.gov/safety-devices-approved-products>.

Approved safety end treatments such as inertial barriers (sand barrels) must be used in conjunction with the PCB to shield the approach ends of the barrier. Refer to the Standard Plans for PCB staking details and conditions of use.

The interim PCB offset distance must be approved by the Headquarters Traffic Safety Systems Branch. In addition, use of the PCB exceeding five years must be approved by the Headquarters Traffic Safety Systems Branch.

At the time of publication, October 31, 2019, is when all Portable Barrier will have to meet MASH standards.

4.6 Barrier Design Details

The details for each type of barrier installed in medians are background for the criteria used in the selections of those types. This topic provides the details of those barrier designs.

1. *Concrete Barriers:* Construction details for concrete barriers are shown in the Standard Plans. The Concrete barrier Type 50 series, with its “Jersey-style” sides and a height of 32 inches, was the standard concrete barrier for many years. It has been replaced by the single slope concrete barrier Type 60M series, with the Type 60M having a height of 42 inches and a constant slope on each side. With the full implementation of MASH the minimum height of Type 60MS is 36 inches and must be maintained. If glare screen is required, the 56-inch tall Type 60MG concrete barrier is to be used. Refer to Topic 4.9 for more information about use of glare screens. With the adoption of the MASH standards the use of Type 60S series is no longer allowed. The Type 60MP, Type 60PR and Type 60AP concrete barrier series are for installing steel sign post on top of the

barrier (see Standard Plans for details). Various modified barrier details, which are not part of the Standard Plans, such as the Type 60SD for covering only one side of a row of columns and Type 60R used for minimum shoulder width, can be found on the Structures XS Sheets. The use of these nonstandard barriers are only done by weighing all the engineering parameters and must not be used to only preserve shoulder width without any other considerations. All modified barriers require the approval of both the District Traffic Safety Engineer and the Headquarters Traffic Safety Systems Branch and the Exception to Traffic Safety System Standards to be completed.

The Type 60M concrete barrier is normally constructed by slip-forming without a footing on pavement. Ends of the barrier at gaps or contraction joints where the concrete and reinforcement is not continuous requires a 10-inch deep by 10-foot long footing under the end of the barrier. This is intended to prevent displacement of the barrier in an impact at the end. For runs of Type 60M barrier that are 1000 feet in length or longer a footing may be added every 500 feet to minimize displacement of the barrier. Concrete barrier footings must be in pavement. The pavement must extend a minimum of 1 foot beyond the concrete barrier footing or constructed monolithically with the concrete footing. (see [Figure 8](#)). Other versions of the Type 60M series concrete barriers usually require fixed forms for construction. Concrete barriers must be on pavement or well compacted base.

Pavement overlays can compromise the performance of existing concrete median barriers. Formerly, Type 50 concrete barrier could tolerate the addition of 3 inches of pavement against its base, reducing its effective height to 29 inches, without replacement of the barrier. With the full adoption of MASH the minimum height of single slope concrete barrier is 36 inches per [Table 6](#). The Type 60MS series cannot tolerate overlays of pavement that would reduce the effective height to not less than 36 inches without replacement of the barrier per [Table 6](#). Where overlays are planned, the designer needs to be cognizant of what the existing and end result effective barrier height will be. If the end result height is less than 36 inches, replace with new barrier for all projects except those overlaying 0.15 feet (2 inches) or less. For those projects, taper the pavement cross

slope to no steeper than 10:1 to maintain the barrier's effective height, if feasible.

2. *Thrie Beam Barrier*: Construction details for Thrie Beam barriers are shown in the Standard Plans. Thrie beam barrier is a corrugated galvanized steel beam, nominally 20-inch wide by 3¼-inch deep, mounted on wood or plastic blocks fastened to wood or galvanized steel posts. The top of the barrier element is 32 inches above the surface at the face of the barrier. Line posts must not be installed in structural pavements that would restrict movement of the posts during impact, also see Section 3.6(8). The ends of thrie beam barrier are anchored to ensure proper performance.

Where larger posts are required in transitions approaching fixed objects, refer to "Thrie Beam Barrier at Fixed Objects in the Median" in the Standard Plans for more details.

Where transitions are needed to concrete bridge barriers, the single thrie beam barrier transition railing (Type STBB) and double thrie beam barrier transition railing (Type DTBB) are used. Refer to the Type STBB and Type DTBB transition railings in the Standard Plans for more details. Where a transition is needed to Type 60M concrete median barrier, refer to "Double Thrie Beam Barrier Connection to Concrete Barrier" in the Standard Plans.

Where a double-faced thrie beam barrier is proposed to accommodate cross-median drainage and a saw-toothed median section requires the rail elements to be mounted at different elevations, the thrie beam elements on the lower roadway shall be used with 6-inch x 12-inch x 22-inch blocks. Approval must be obtained from the Headquarters Traffic Safety Systems Branch.

Steel posts shall be used for the construction of a saw-toothed median section. Field drilling a second pair of holes parallel to each other and the original pair should not be done.

3. *Cable Barriers*: The approved high-tension cable barriers are three- and four-strand types and are proprietary. These systems are pre-stretched prior to installation. The deflections of the high-tension barriers are typically 6 to 12 feet but are dependent on post spacing. These systems may be considered for permanent use in medians according to [Table 7](#). The conditions for use and the design details (which vary between the approved systems) are available on

the Department's Pre-Qualified Products List for Highway Safety Features.

4. *End Treatments*: All blunt ends of median barriers are fixed objects and need to be shielded. This may be done by flaring the end of the barrier away from approaching traffic or placing an appropriate crash cushion at the approach end of the barrier. Sloping ends, or ends that are turned down into the ground, must not to be constructed.

4.7 Median Design Considerations

Many of the issues encountered with irregular medians or continuous obstruction in the median can be mitigated by the following considerations:

1. *Longitudinal Median Dikes*: The restrictions for use on the placement of curb or dike in front of barrier are as followed:
 - *Thrie Beam Barrier*: When required, the dike should be as close to the thrie beam barrier as possible. **If six-inch high dike is needed with thrie beam barrier, the dike may be placed under the barrier but the front edge of the dike shall not be more than seven inches in front of the face of the barrier. Dikes over two inches high shall not be placed between seven inches and 13 feet in front of thrie beam barrier.**
 - *Concrete Barrier*: Dike must not be placed in front of concrete barriers.
 - *Cable Barrier*: Cable Barriers are proprietary systems. If dike is needed then install dike per manufactures recommendations.
2. *Median Ditches*: Drainage ditches should be as shallow and as flat as possible. Where deep ditches are unavoidable, a barrier may be needed on both sides of the ditch. See the *Roadside Design Guide*, Chapter 6, for recommended barrier placement.
3. *Median Drainage*: Thrie beam barrier is adaptable to most median drainage conditions. Where thrie beam barrier crosses a drainage inlet and one or more posts are installed within the depression or swale, a rub rail may be needed. The rub rail prevents a vehicle from snagging the post with a wheel and spans the length of the depression or swale See Figure 14. Concrete median barrier, however, may require special designs to provide drainage. Slotted drain inlets are the recommended means of providing drainage in paved medians with concrete median barrier. Design details for slotted

drains are contained in the Standard Plans. Where a concrete barrier spans or crosses an existing drainage inlet, special barrier gap closure details are available. Passing runoff under a concrete median barrier with scuppers on an all-paved cross section is not advisable. What was sheet flow becomes concentrated flow across the lower roadway. Scuppers, if used, should not extend higher than 3 inches at the base of the barrier. Also, each scupper should be no more than 3 feet long and a series of scuppers should not occupy more than 25 percent of any 20-foot length of concrete barrier.

The District Traffic Safety Engineer must approve the decision to install scuppers. The decision must be documented in the project files.

For additional discussion of median drainage, see the *Highway Design Manual*, Index 834.2, Median Drainage.

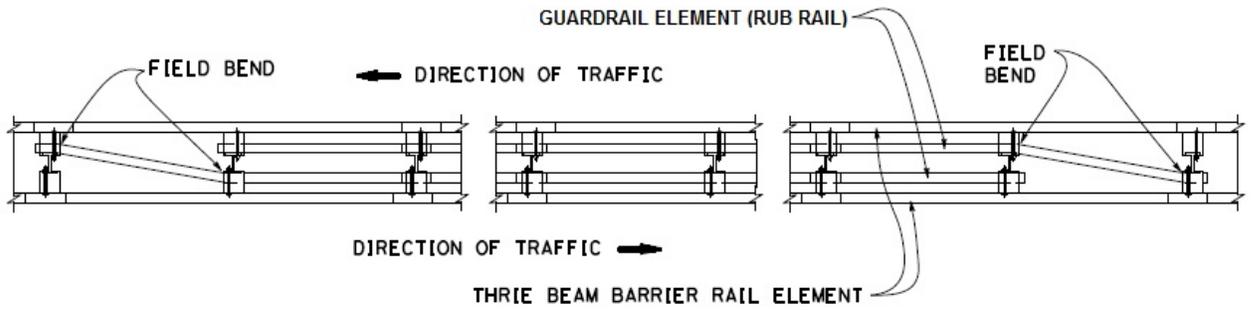
4. *Raised Medians:* Median barriers should not be placed on raised medians. For proposed or existing median barrier on a raised median, the barrier should be flush with curb face and the barrier height is measured from top of curb.
5. *Flat Medians:* On paved medians, 10:1 cross slope or flatter, the barrier height is measured from the paved surface exclusive of any localized ditch surface. Consideration should be given to paving medians adjacent to concrete barriers to reduce maintenance activities. See the *Highway Design Manual*, Topic 305.5 for paving requirements.
6. *Planted Medians:* **Where plants are located in the median and the plantings cannot be removed, two barriers, one on each side of the plants, shall be placed.** See Topic 4.5, Criteria for Choice of Type, to determine if the use of concrete or thrie beam barrier is appropriate. Existing earth berms used with median plantings are to be eliminated.
7. *Future Construction:* Where traffic lanes are to be added to the median within five years of barrier construction, the median grade line should be adjusted and the barrier installed for the ultimate condition. If it is not practical to do this, concrete barrier should not be used since, unlike the other barrier types, the height of concrete cannot be readily adjusted.
8. *Median Cross-Slope:* Where median cross-slopes are greater than 10:1, vehicle trajectory can affect barrier performance. If median cross-slopes are greater than 10:1, refer to the *Roadside Design Guide*, Chapter 6, for recommended barrier placement.

To ensure desired barrier performance, the relationship between median and traveled way cross-slopes must be checked using the procedures outlines in Traffic Bulletin No. 15 and approved by the District Traffic Safety Engineer. The approval must be documented in the project files.
9. *Adding Lanes in the Median:* Where lanes are added in the median, thereby reducing the median width, the median barrier type to be used is selected in accordance with [Topic 4.5](#), Criteria for Choice of Type. In some cases it will be necessary to evaluate the need to upgrade or replace existing non-concrete barrier. Costs associated with upgrading the barrier type shall be included in the preliminary scoping document estimate.
10. *Structure Approach:* Where traffic is one-way, approach speeds are less than 45 mph, and thrie beam barrier connection to bridge curb or sidewalk is needed, [Figure 21](#) may be used.
11. *Effective Barrier Height:* **Overlay and rehabilitation projects, including any maintenance activities, which will impact existing barriers, shall include required actions in accordance with the guidelines in [Table 6](#), Barrier Restoration Practice. If an overlay results in a barrier height out of the indicated tolerances, then the barrier shall be reconstructed or replaced.** The standard heights and tolerances listed in [Table 6](#) for each type of barrier are recommended limits based on crash test performance.
12. *Wildlife Passageways:* Openings in concrete barriers for animals should be considered if recommended by district environmental staff. See

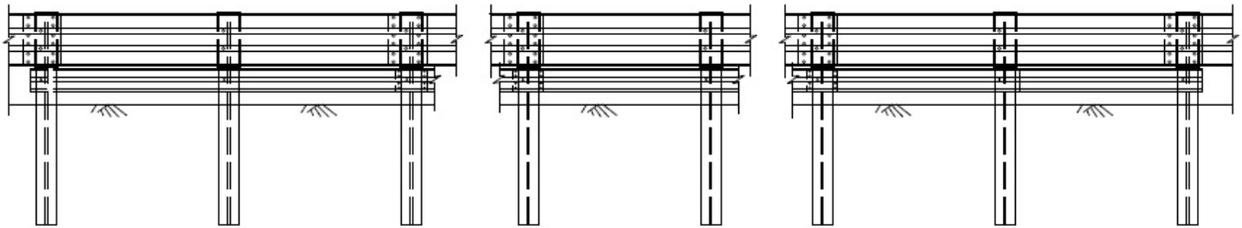
the Standard Plans for details of wildlife passageways in concrete barriers for small, medium and large animal.

The District Traffic Safety Engineer must approve the decision to wildlife passageways. The decision must be documented in the project files.

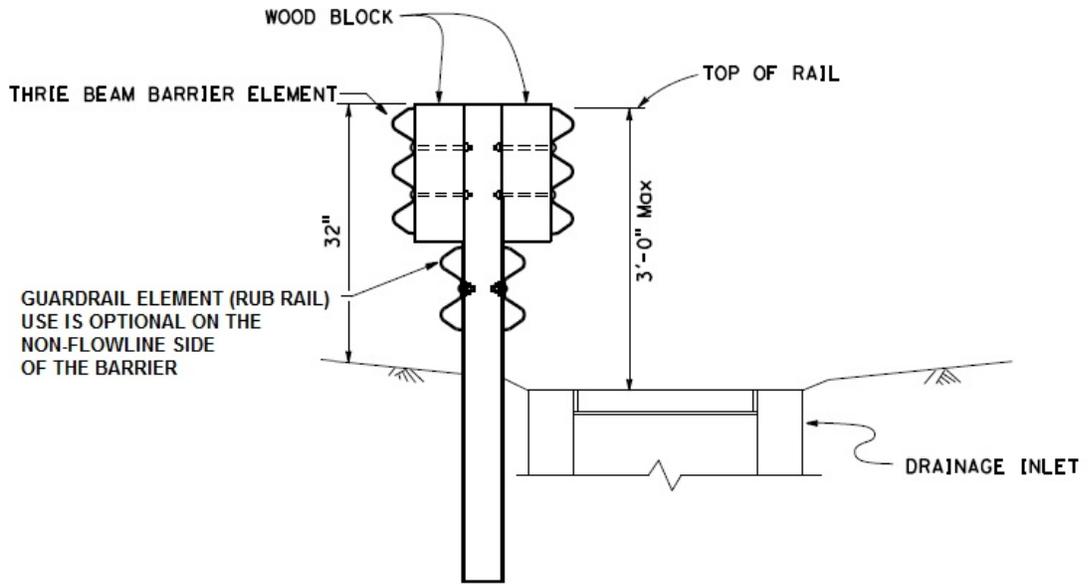
Figure 20: Thrie Beam Barrier Rub Rail Detail



PLAN



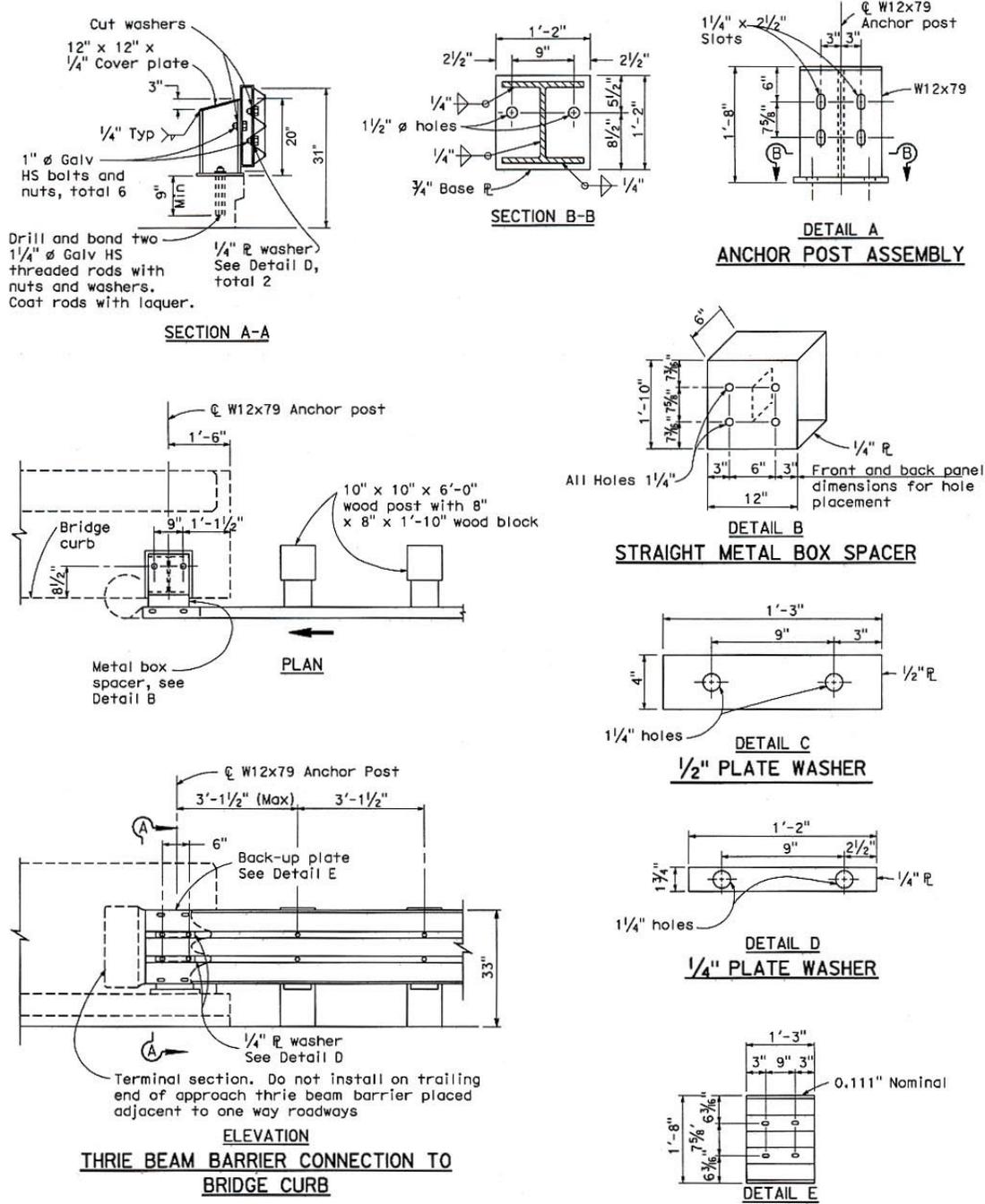
ELEVATION



RUB RAIL DETAIL

NO SCALE

Figure 21: Thrie Beam Connection to Bridge Curbs



(Same shape as thrie beam rail element. Required when thrie beam rail is attached to bridge railing with metal box spacer and terminal section not used).

4.8 CHP Enforcement Areas / Emergency Passageways

Except for CHP enforcement areas/emergency passageways in median barriers, median openings are not allowed on freeways. The use of passageways are to be kept to a minimum and carefully located to provide adequate stopping sight distance to and from the opening along the freeway. Emergency passageways may be appropriate for highway patrol vehicles, emergency service vehicles such as tow trucks, ambulances, firefighting apparatus and maintenance equipment. Emergency openings in glare screens for passage of stretchers or personnel are covered in [Topic 4.9](#).

The need for CHP enforcement areas/emergency passageways and their locations must be established by the District Traffic Safety Engineer in cooperation with the local Department of Highway Patrol office, fire district and emergency services. The decision must be documented in the project files.

Where emergency openings are provided, they are to be designed based on the following considerations:

1. *Types of Vehicles*: Emergency passageways are designed for motorcycles or for motor vehicles. Openings for motorcycles are 6 feet to 8 feet long, and openings for motor vehicles are 12 feet to 16 feet long.
2. *Types of Passageways*: Permanent openings and temporary openings with removable sections of barrier are the two types of emergency passageways used. Emergency passageways may be either temporary, removable sections of barrier or permanent openings where the barrier ends are offset away from approaching traffic. All temporary openings are to be closed immediately after use.
3. *Spacing of Passageways*: Access to the opposite side of the freeway may be provided by a combination of interchange ramps and emergency passageways. **Emergency Passageway shall not be placed at less than three mile intervals.**
4. *Median Widths*: The median needs to be wide enough to accommodate turning vehicles safely and contain the barrier with any necessary tapers. Therefore, motorcycle emergency passageways are typically not

provided where the median is less than 22 feet wide, and motor vehicle emergency passageways are typically not provided where the median is 32 feet or less in width, unless there are unusual circumstances.

5. *Barrier Design Details*: Designs for barrier emergency passageways are shown under Emergency Passageways in the Standard Plans.
6. *CHP Enforcement Area*: For CHP enforcement area design details refer to the HOV Guidelines at: http://www.dot.ca.gov/hq/traffops/traffmgmt/hov/files/hov_guidelines/HOV%20Guideline.pdf

4.9 Glare Screens and Type 60MG Concrete Barrier

Glare screens are designed to screen out the headlight glare of opposing traffic. Glare screens may be considered on new or existing median barriers where the median is 22 feet or less in width. Glare screens are typically not installed in medians wider than 22 feet.

On narrow medians of 36 feet or less the standard Type 60MG concrete barrier that is 56-inch tall, may also be used to give additional clearance for pavement overlays even when headlight glare of opposing traffic is not a concern. The decision to use Type 60MG, must be approved by the District Traffic Safety Engineer when the need for the use of Type 60MG on facilities where pavement overlays are likely, and a reduction in the effective height of the barrier is expected over time.

All other uses of Type 60MG and glare screen may only be installed where an engineering evaluation shows it would be of overall benefit to the motorist considering the cost and other impacts of the glare screen. Engineering evaluations should consider glare due to the combined effects of grades, horizontal alignment, traffic volumes, as well as any public complaints.

Where glare is determined to affect safety performance and glare screen is not cost-effective or creates impacts that cannot be mitigated, highway lighting should be considered to reduce the level/intensity and effects of headlight glare. On route segments with scenic views, the sensitivity of the public to the blocking of these views should be considered.

Glare screen and Type 60MG concrete barrier must be approved by the District Traffic Safety Engineer and must be incorporated in the project between the project initiation documents to the PS&E when it is determined to be need.

Based on an engineering evaluation, glare screens may be installed on segments or spot locations along frontage roads. Chain link fence with slats may be appropriate in these situations.

Glare screens are subject to the following considerations:

1. *Thrie Beam Barrier*: Glare screen is not generally used with thrie beam barrier.
2. *Concrete Barrier*: When glare screen is determined appropriate, the standard permanent glare screen is the 56-inch tall Type 60MG concrete barrier due to its resistance to damage.
3. *Emergency Openings*: When glare screen is included with the barrier, openings may be provided at approximately 600-foot intervals if requested by local emergency agencies. In areas with above average traffic collision rates, openings may be spaced at 300-foot intervals. Spacing may be varied to provide such an opening at each structure crossing over the highway.

Glare can also be reduced by the addition of highway lighting. This can be done by median lighting or high mast lighting. Medial lighting can be combine with Type 60MG concrete barrier.

4.10 Delineation

To provide enhanced delineation, approved retro-reflective units may be placed on thrie-beam and concrete barrier for narrow medians 36 feet wide of less. When the clearance from the barrier to the edge of traveled way is less than 12 feet the barrier should be delineated. For further details regarding delineation and placement on median barriers, refer to the Standard Plans and the California MUTCD.

Topic 5 – Outer Separation Barrier

5.1 Introduction

The need for outer separation barrier between a freeway and a frontage road should be considered when there are concerns regarding collisions of vehicles crossing these separated facilities. Installation of an outer separation barrier is generally studied at locations where the freeway volume/width warrant or the collision warrant is met. Refer to [Topics 4.4](#) and [5.2](#) for more information about these study warrants.

5.2 Outer Separation Barrier Criteria

The following criteria shall be satisfied for installation of outer separation barrier:

1. The direction of travel of the frontage road opposes freeway traffic, and
2. The opposing frontage road traffic volume is greater than or equal to 5,000 annual average daily traffic (AADT), and
3. The location meets the criteria described in Figure 11: Freeway Median Barrier Study Warrant. Use the distance from the freeway edge of traveled way to the frontage road edge of traveled way for the width, and for the traffic volume, use one-half the freeway AADT plus the opposing AADT on the frontage road. Or:
 - a. A collision study warrant for any severity is based on a location having three or more collisions involving frontage road and freeway vehicles, and a total frontage road and freeway collision rate of at least 0.5 collisions per mile per year in a five year period, or
 - b. The Fatal collision study warrant is based on a location having three or more fatal collisions involving frontage road and freeway vehicles, and a fatal frontage road and freeway collision rate of at least 0.12 collisions per mile per year in a five year period.
4. If a location does not meet the above three criteria, but can be shown to meet either of the two criteria below, then a barrier may be recommended if:
 - a. A collision study warrant for any severity is based on a location having three or more collisions involving frontage road and freeway vehicles, and a total frontage road and freeway collision rate of at least 0.5 collisions per mile per year in a five year period, or
 - b. The Fatal collision study warrant is based on a location having three or more fatal collisions involving frontage road and freeway vehicles, and a fatal frontage road and freeway collision rate of at least 0.12 collisions per mile per year in a five year period.

Topic 6 – Crash Cushions

6.1 Purpose

Crash cushions, also known as impact attenuators, are intended to shield fixed objects that cannot be removed or where other protective system such as guardrail and not suitable. When a vehicle strikes a crash cushion it decelerates by the transfer of inertia in displacing sand or water, expending kinetic energy through compressing a hydraulic cylinder or collapsible material, tearing metal, or moving a metal cable or strap through a restricted path.

6.2 Available Crash Cushion Types

The types of crash cushions currently available include several mechanical systems previously mentioned, arrays of sand-filled plastic drums, and water-filled modules. These types vary in regard to costs of installation, size, ease of repair and maintenance. These aspects should be carefully evaluated in order to select an appropriate crash cushion or equal alternatives for a location based on site geometrics, anticipated repair and maintenance effort. For more information on which crash cushions are MASH approved for use on California State Highways, contact your District Traffic Safety Systems Coordinator or refer to the Authorized Material List (AML).

6.3 Placement

Crash cushions are to be installed at fixed objects that cannot be economically removed or made breakaway and where other protective systems such as guardrail are not suitable, such as at the gore point on a separated structure. Crash cushions are also generally used to shield objects such as piers, columns, overhead signs supports, and median barrier installations.

Concrete barriers or walls that are taller than shielding crash cushions require modification at the connecting ends of the barriers. The top of the wall or barrier should be tapered at maximum of 4:1 to meet no more than 1 inch above the top of the crash cushion.

The District Traffic Safety Engineer must concur with the decision to install or not to install a crash cushion. The statement of concurrence must be documented in the project files (see [Topic 1.3](#) for guidance).

Copies of the Summary of Quantities and applicable Layout Sheets from the Project Plans may supplement the documented statement of concurrence in the project files.

As of, October 31, 2018, new installations of Crash Cushions will have to meet MASH standards.

6.4 Temporary Crash Cushions

Temporary crash cushions can be practical in construction staging where temporary fixed objects are shielded, such as Temporary Railing systems such as guardrail are not suitable. When a vehicle strikes a crash cushion it decelerates by the transfer of inertia in displacing sand or water, expending kinetic energy through compressing a hydraulic cylinder or collapsible material, tearing metal, or moving a metal cable or strap through a restricted path.

(Type K or Type 60K). Proprietary crash cushions have been developed that use expedient methods for installation and removal, such as base plate mountings for the attenuators with pre-drilled holes for pavement anchor rods or stakes. These features are useful for moving attenuators between locations and typically allow anchorage in existing pavements. When using crash attenuators with Type 60 K contact your District Traffic Safety Systems Coordinator.

Commonly used non-proprietary crash cushions are arrays of sand-filled modules. Sand-filled modules are lower cost attenuators, but are also more maintenance intensive. [Figure 22](#) shows arrays of sand-filled modules for temporary use on highways in unidirectional travel and where approach speeds are less than 25 and 35 mph. See the Standard Plans for details of arrays of sand-filled modules for approach speeds of 45 mph or greater.

6.5 Severe Duty Crash Cushions

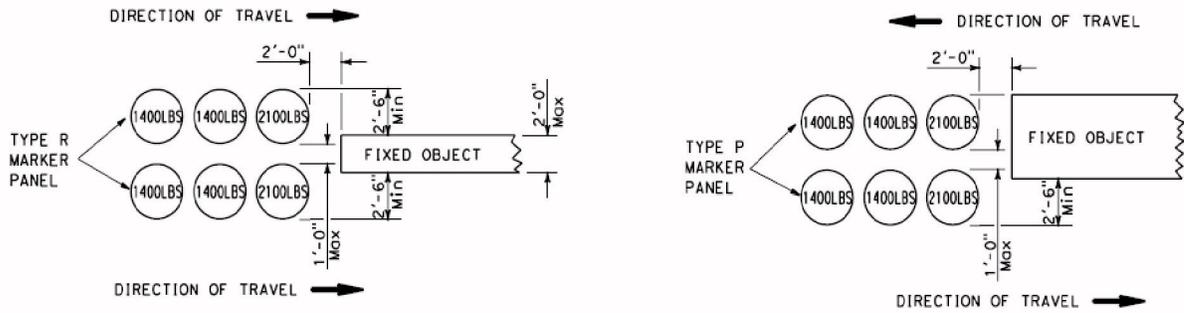
Severe duty crash cushions are appropriate for high-incidence roadway locations, offering superior cost effectiveness and improved safety for the traveling public and highway workers. The crash cushions perform well in high-speed frontal and side impact tests, thereby reducing repair costs and the time needed for repairs. For the current approved list, specific cri-

teria, and guidance of Severe Duty Crash Cushions, contact your District Traffic Safety System Coordinator.

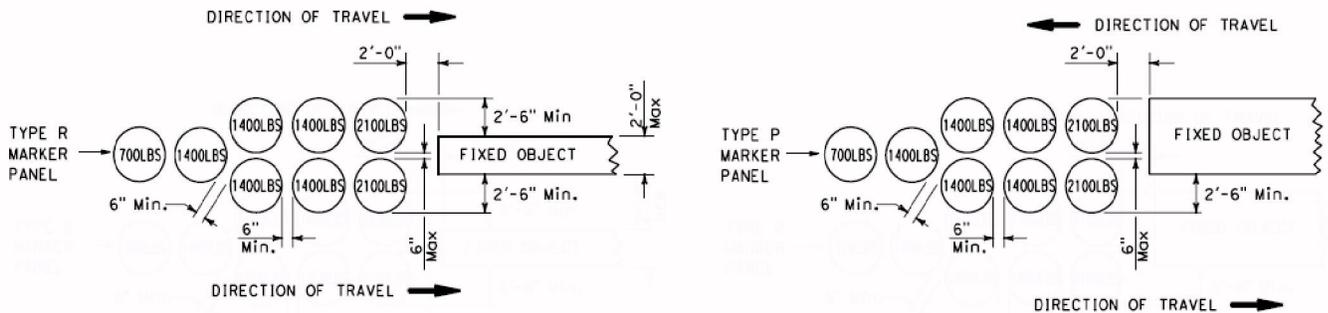
6.6 Reusable Crash Cushions

Reusable crash cushions have major components that may survive most impacts and can be salvaged when the crash cushion is being repaired on site. Some of the other components need to be replaced after an impact to make the entire crash cushion crashworthy again. For the current approved list, specific criteria, and guidance of Reusable Crash Cushions, contact your District Traffic Safety Systems Coordinator.

Figure 22: Sand Barrel Arrays



**TEMPORARY CRASH CUSHION
SAND BARREL ARRAY
25 MPH OR LESS**



**TEMPORARY CRASH CUSHION
SAND BARREL ARRAY
35 MPH OR LESS**

Notes:

1. ## indicates sand filled module location and weight of sand in pounds for each module. Module spacing is based on the greater diameter of the module.
2. All sand weights are nominal.
3. Temporary crash cushion arrays shall not encroach on the traveled way.
4. Place the Type P marker panel so that the bottom of the panel rests upon the ground.
5. Refer to Standard Plan A73B for marker details.
6. Approach speeds indicated conform to NCHRP 350 Report criteria.
7. Use of pallets is optional.

APPENDIX A

EXCEPTION TO TRAFFIC SAFETY SYSTEM STANDARDS

(See *Traffic Safety Systems Guidance* for definitions and applications)

Check One Box

- DISTRICT APPROVAL REQUIRED
- HEADQUARTERS APPROVAL REQUIRED

Prepared By:

(NAME) _____
DATE

District Approval By or Recommended By if
 Headquarters Approval Required:

DISTRICT TRAFFIC SAFETY ENGINEER _____
DATE

Headquarters Approval By:

HQ TRAFFIC SAFETY SYSTEMS BRANCH, CHIEF _____
DATE

1. NONSTANDARD CONDITION / FEATURE

Briefly describe the nonstandard condition(s), the specific standard(s) and source document (e.g. Standard Plan, Caltrans Traffic Safety Manual, etc.). Specify if the nonstandard feature is an existing condition that will be retained, or if a nonstandard feature will be introduced

2. REASON(S) FOR REQUESTING EXCEPTION

Summarize engineering and other reasons that support or justify the deviation(s). Reasons are typically related to the expected vehicle operating speed, major physical constraints (for spot / incremental improvement projects), and engineering analysis related to the expected performance of the safety system.

3. CONSULTATIONS

If relevant, identify other “specialists” who concur with the proposed nonstandard feature / condition.