



2021 DelDOT Lessons Learned Workshop: Guardrail/MASH Updates

March 8, 2021



Agenda

- MASH Implementation
- Standard Construction Detail Updates
 - Guardrail
 - Common Field Issues
 - Concrete Barrier
- Approved Products List



MASH Implementation

- 2009 MASH
 - Anticipated manufacturers would develop MASH-compliant devices
 - No sunset requirements of NCHRP 350 devices
 - Safety benefits not realized
- 2016 MASH
 - FHWA/AASHTO Joint Implementation Agreement
 - Sunset dates of NCHRP-350 roadside hardware
 - 12/31/2017: W-beam barriers and cast-in-place concrete barriers
 - 6/30/2018: W-beam terminals
 - 12/31/2018: Cable barriers, cable barrier terminals and crash cushions
 - 12/31/2019: Bridge rails, transitions, all other longitudinal barriers, all other terminals, sign supports and all other breakaway hardware
 - Specific requirements for work zone devices dependent on normal service life



Memorandum

Subject: **INFORMATION:** AASHTO/FHWA Joint Implementation Agreement for Manual for Assessing Safety Hardware (MASH) Date: JAN -7 2016

From: *Thomas D. Everett*
Thomas Everett
Director, Office of Program Administration In Reply Refer To:
HSST

Michael S. Griffith *Michael S. Griffith*
Director, Office of Safety Technologies

To: Division Administrators
Directors of Field Services
Federal Lands Highway Division Directors

Purpose

The purpose of this memorandum is to share information regarding the American Association of State Highway and Transportation Officials (AASHTO)/FHWA Joint Implementation Agreement for the AASHTO Manual for Assessing Safety Hardware (MASH). Recently, the agreement was successfully balloted by AASHTO's Standing Committee on Highways and approved by FHWA.

Information

On November 12th, 2015, FHWA issued a memorandum (http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/policy_memo/mo111215/) indicating that all modifications to NCHRP 350-tested devices will require testing under MASH in order to receive a Federal-aid eligibility letter from FHWA. In addition, a Federal Register Notice (<https://www.federalregister.gov/articles/2015/11/13/2015-28753/manual-for-assessing-safety-hardware-mash-transition>) was also issued regarding this action. This action provided a significant step forward to the implementation of MASH.

Through the AASHTO/FHWA partnership, the agreement was executed to define actions needed for full implementation of MASH over the course of several years. Per the agreement, the implementation of the forthcoming edition (anticipated Spring 2016) of the AASHTO Manual for Assessing Safety Hardware (MASH) will be as follows:

- The AASHTO Technical Committee on Roadside Safety will continue to be responsible for developing and maintaining the evaluation criteria as adopted by

MASH Compliance

- MASH Compliance is determined by the User Agency.
- Excerpts from an April 9, 2018 FHWA memo to Division Administrators, Federal Lands Division Engineers and Directors of Field Services:
 - The FHWA's longstanding policy is that all roadside safety hardware installed on the NHS be crashworthy.
 - Roadside safety hardware is eligible for Federal funding if it has been determined to be crashworthy by the user agency (i.e. State DOT).
 - It is each State's responsibility to determine crashworthiness and to approve new or modified roadside safety hardware meeting the State's specific needs.
 - The determination of crashworthiness of roadside safety hardware, acceptance for use on highway projects, and installation and maintenance are responsibilities handled at the State and local level.



Memorandum

Subject: **ACTION:** Evaluating a State DOT's Process to Determine Roadside Safety Hardware Crashworthiness on the National Highway System (NHS) Date: April 9, 2018

From: Michael S. Griffith *Michael S. Griffith* In Reply Refer To: HSA
Director, Office of Safety Technologies

To: Division Administrators
Federal Lands Division Engineers
Directors of Field Services

PURPOSE

The purpose of this memorandum is to provide guidance to the FHWA Division Offices to assist in their evaluation that a State DOT has an acceptable process for determining the crashworthiness of roadside safety hardware used on the National Highway System (NHS).

BACKGROUND

The FHWA's longstanding policy is that all roadside safety hardware installed on the NHS be crashworthy. To support this policy, the [joint implementation agreement](#) for the American Association of State Highway Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH) was adopted by AASHTO and FHWA. This agreement established dates for implementing AASHTO MASH as the criteria for determining crashworthiness of roadside safety hardware.

The FHWA continues to provide a voluntary service of reviewing crash test results and issues eligibility letters for *new* roadside safety hardware only. The FHWA no longer provides Federal-aid eligibility letters for modifications made to an AASHTO MASH-crash tested device. An eligibility letter is not a requirement for roadside safety hardware to be determined eligible for Federal funding. Roadside safety hardware is eligible for Federal funding if it has been determined to be crashworthy by the user agency (i.e., State DOT).

An FHWA eligibility letter should not be the sole basis for a State's determination of crashworthiness. It is each State's responsibility to determine crashworthiness and to approve new or modified roadside safety hardware meeting the State's specific needs. Each State should consider its own operational issues such as installation and

DeIDOT's MASH Implementation Status

Status of DeIDOT meeting the FHWA/AASHTO Sunset Dates

- ✓ W-Beam Barrier
- ✓ W-Beam Terminals *Approved Products List*
https://deldot.gov/Business/prodlists/pdfs/APL_EndTerminals.pdf?cache=1603198531574
- ✓ Cast-in-Place Concrete Barrier
- ✓ Cable Barrier and Cable Barrier Terminals *2020 Standard Specifications require MASH compliant devices*
- ✓ Crash Cushions (Permanent Impact Attenuators) *Approved Products List*
https://deldot.gov/Business/prodlists/pdfs/APL_ImpactAttenuators.pdf?cache=1603198475022
- ✓ Bridge Railing
- ✓ Transitions
- ✓ All other longitudinal barriers } *2020 Standard Specifications require MASH compliant devices*
- ✓ All other terminals } *2020 Standard Specifications require MASH compliant devices*
- ✗ Sign supports } *NCHRP 350 Devices in use until suitable*
- ✗ Other Breakaway Hardware } *MASH compliant devices are available*
- ? Work Zone Devices *See Approved Products List for Delaware specific sunset dates*
https://deldot.gov/Business/prodlists/pdfs/APL_TTCDevices.pdf?cache=1603198772332

DeIDOT MASH Committee

- MASH Committee
 - Policy Implement
 - Purpose of committee
 - Primary technical group regarding roadside safety hardware
 - Development of standard details regarding roadside safety hardware
 - Recommendations of roadside safety hardware for the Approved Products Lists
 - Review of crash testing paperwork
 - Establishment of Delaware specific sunset dates
 - Review/recommendation for approval of self-certification documents
 - Review/recommendations for approval of devices that are exempt from MASH certification

DeIDOT MASH Committee

- MASH Committee
 - Roadside safety hardware approval
 - If hardware has approved crash testing from a recognized national crash testing facility, device may be approved without self certification.
 - Hardware requiring self certification
 - Document why crash tested hardware cannot be used
 - Justification with appropriate engineering calculations regarding why the proposed hardware is acceptable
 - Prepared by the DeIDOT group that is the appropriate subject matter expert
 - Reviewed and voted on by the MASH Committee
 - If approved, signed by the DeIDOT SME, Committee Chair and forwarded to Chief Engineer for review and approval.



Whitman, Requardt & Associates, LLP
Engineers · Architects · Environmental Planners Est. 1915

MEMORANDUM

Date: July 21, 2020

To: James Osborne, DeIDOT
From: David Nizamoff, P.E.
Adam Weiser, P.E., PTOE, RSP
Subject: DeIDOT Concrete Barrier Standard Construction Details
CC: Jeff VanHorn, DeIDOT Safety
Mark Buckalew, DeIDOT Construction
Barry Benton, GPI

Work Order Number: 032197.001
Contract Number: N/A
Project: DeIDOT MASH Standard Construction Details Update

In 2009, the American Association of State Highway Transportation Officials (AASHTO) published the *Manual for Assessing Safety Hardware (MASH)* which superseded NCHRP Report 350 *Recommended Procedure for Safety Performance Evaluation of Highway Features* as the guidelines for roadside safety hardware performance evaluation. In 2016, AASHTO published the second edition of MASH as well as agreed to a joint implementation agreement with the Federal Highway Administration (FHWA). The joint implementation agreement outlined the sunset dates for NCHRP 350 compliant roadside safety hardware and sunrise dates for MASH 2016 compliant roadside safety hardware for projects on the National Highway System (NHS). The agreement stated that "all w-beam and cast-in-place concrete barriers" would be MASH 2016 compliant for contracts let after December 31, 2017.

On May 28, 2017, the FHWA issued an open letter to the states which stated that "The FHWA's Federal-aid eligibility letters are provided as a service to the States and are not a requirement for roadside safety hardware to be eligible for federal-aid reimbursement." This letter also went on to state, "Since its official launch, questions about the AASHTO MASH criteria have been identified by a range of stakeholders. Until such time these questions are answered, and the transportation community has more experience with AASHTO MASH requirements, FHWA will require manufacturers and States to run all AASHTO MASH recommended crash tests in order to qualify for a FHWA Federal-aid eligibility letter." In addition, a letter from the FHWA to its Division Administrators issued on April 8, 2019 stated that "An eligibility letter is not a requirement for roadside safety hardware to be determined eligible for Federal funding. Roadside safety hardware is eligible for Federal funding if it has been determined to be crashworthy by the user agency (i.e., State DOT)." Both letters are attached to this memorandum.

DeIDOT's Engineering Support section has been working to update all guardrail and barrier standard construction details to be MASH compliant. DeIDOT historically has maintained standard construction details for cast-in-place and slip formed 32-inch tall F-shape concrete median barriers. The Department desires to add 36-inch and 42-inch F-shape median and roadside barriers and a 42-inch single slope barrier to its standard construction details. The purpose of this memorandum is to document the development of the new concrete barrier standard construction details and to provide a recommendation as to their crashworthiness in accordance with MASH standards.

Summary of testing on height determination by Test Levels: The Texas Transportation Institute (TTI) conducted research regarding bridge railing and barrier heights based on MASH crash testing procedures. Report TTI 9-1002.05¹ found that the minimum height for a Test Level 4 bridge railing or barrier is 30-inches. The research conducted a full-scale crash test on a 36-inch tall single slope bridge railing. The test, conducted using a single-unit truck, was passed successfully. The report indicates that while a single sloped barrier was used in the testing, the results are considered applicable to other safety shapes, e.g. the New Jersey shape and F-shape profiles. Based on this information, it was determined for the purposes of DeIDOT's Standard Construction Details, the minimum height for a TL-4 barrier would be 38-inches for median and roadside applications. In addition, a 42-inch tall TL-4 barrier detail was developed for

¹ TTI Report 9-1002.05 <https://static.tti.tamu.edu/tti.tamu.edu/documents/9-1002-5.pdf>

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Guardrail Details

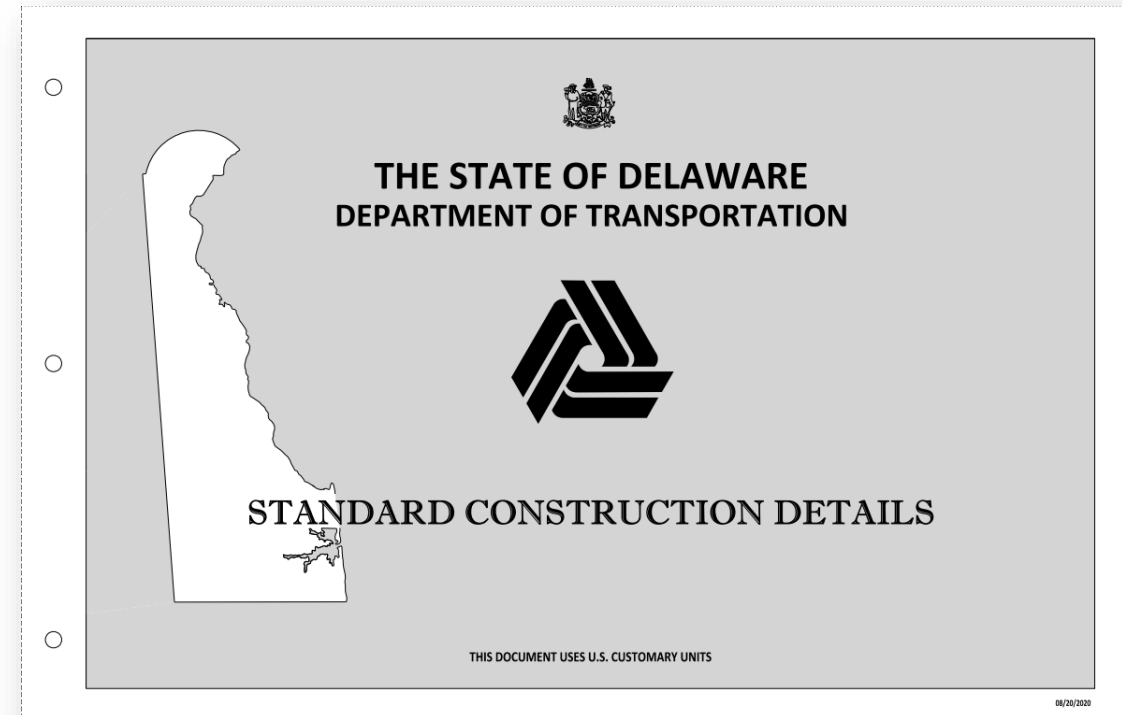
- Update Summary
 - Overall MASH compliance review
 - Updated existing details as needed
 - Eliminated non-compliant details
 - Maintained some NCHRP 350 compliant details as needed
 - Remove metric dimensions
 - New details
 - Type 1-31 Guardrail with Omitted Post
 - With and without curb
 - Type 1-31 Guardrail on Steep Slope
 - Type 3-31 Guardrail-to-Barrier Connection
 - Includes Concrete Buttresses
 - End Anchorage, Type 31
 - Buried-in-Backslope, Type 31



Guardrail Details

2020 Standard Construction Details: Guardrail

- B-1: Guardrail Applications
 - Type 1-31, 2-31, 3-31; Plan, Elevation and Section Views
 - Type 1-31 Guardrail with Omitted Post
 - Type 1-31 Guardrail on Steep Slope
- B-2: Grading for Guardrail End Treatments (Types 1, 2 and 3)
- B-3: Guardrail over Culverts (Types 1-31, 2-31 and 3-31)
- B-4: End Anchorage, Type 1-31
- B-7: W-Beam, Type 1-27 to Type 1-31 Transition Section
- B-8: Guardrail to Barrier Connection – Approach and Exit Type 31
- B-10: Guardrail to Barrier Connection – Type 3-31
- B-13: Hardware
- B-15: Guardrail Applications (Types 1-27, 2-27 and 3-27)
- B-17: Guardrail End Treatment, Type 4-27
- B-18: Curved Guardrail Section, Type 1-27
- B-20: Buried in Back Slope End Terminal, Type 1-31



Guardrail Applications

• Detail B-1: Guardrail Applications

- Type 1-31: 4'-0" deflection
- Type 2-31: 2'-6" deflection
- No break-away hardware in the deflection zone

- Interaction between guardrail deflection and breakaway hardware has not been tested

TYPE 1-31 GUARDRAIL PLACEMENT
POST SPACING 6'-3"

REQUIRED CLEARANCE 4'-0" MIN FROM BACK OF POST

EDGE OF SHOULDER

EDGE OF TRAVEL LANE

SHOULDER

TYPE 1-31 GUARDRAIL
TYPICAL GUARDRAIL TREATMENT WHEN THE REQUIRED 4'-0" CLEARANCE TO THE OBSTRUCTION IS AVAILABLE
MASH COMPLIANT SYSTEM - FHWA ELIGIBILITY LETTER B-212
MASH Compliant System

TYPE 2-31 GUARDRAIL PLACEMENT
POST SPACING 3'-1 1/2"

25'-0" MIN

25'-0" MIN

REQUIRED CLEARANCE 2'-6" MIN FROM BACK OF POST

EDGE OF SHOULDER

EDGE OF TRAVEL LANE

SHOULDER

TYPE 2-31 GUARDRAIL
TYPICAL GUARDRAIL TREATMENT WHEN 2'-6" TO 4'-0" OF CLEARANCE TO OBSTRUCTION IS AVAILABLE
NCHRP-350 COMPLIANT SYSTEM UTILIZE CURRENT DETAIL UNTIL FURTHER NOTICE.
NCHRP 350 Compliant System

TYPE 3-31 GUARDRAIL
TYPICAL MEDIAN GUARDRAIL TREATMENT
MASH COMPLIANT SYSTEM - DESIGN BASED ON TTI REPORT 9-1002-12-8
MASH Compliant System

4'-0" MIN SEE NOTES 1 & 2

4'-0" MIN SEE NOTES 1 & 2

EDGE OF TRAVEL LANE

EDGE OF TRAVEL LANE

6'-3" (TYP.)

TYPE 3-31 GUARDRAIL PLACEMENT OR APPROPRIATE END TREATMENT (TYP.)

NOTES:
1). MAXIMIZE THE DISTANCE FROM THE EDGE OF THE TRAVEL LANE OR SHOULDER TO THE FACE OF GUARDRAIL. THIS AREA SHALL BE GRADED 10:1 OR FLATTER.
2). GRADE THIS AREA 10:1 OR FLATTER.

FLARE RATES

DESIGN SPEED	FLARE RATE
70 MPH	15:1
60 MPH	14:1
55 MPH	12:1
50 MPH	11:1
45 MPH	10:1
40 MPH	8:1
30 MPH	7:1

DeIDOT

RECOMMENDED

09/01/2020

TYPES 1-31, 2-31, AND 3-31 GUARDRAIL APPLICATIONS

STANDARD NO. B-1 (2020)

SHT. 1 OF 5

REVIEWED

APPROVED

09/01/2020

09/01/2020



Guardrail Applications

- Detail B-1: Guardrail Applications
 - Type 1-31
 - Also known as Midwest Guardrail System (MGS)
 - Standard guardrail application, basis for all other guardrail details
 - Guardrail height = 31"
 - Post spacing = 6'-3" or 75"
 - 12" Offset Blocks
 - Minimum clearance to obstruction = 4'-0"
 - Guardrail splices midspan
 - MASH Compliant system
 - Type 2-31
 - Half post spacing, 3'-1 ½" or 37.5"
 - Minimum clearance to obstruction = 3'-0"
 - Not compliant with MASH; testing still underway
 - Type 3-31
 - Median guardrail (double sided)
 - 8" Offset Blocks
 - Standard post spacing
 - MASH compliant system



Guardrail Applications

- Detail B-1: Guardrail Applications

SCALE: NTS

GUARDRAIL SECTION SHOULDER APPLICATION

GUARDRAIL SECTION MEDIAN APPLICATION

GUARDRAIL SECTION BEHIND CURB APPLICATION

TYPE	POST SPACING	CLEAR AREA BEHIND POST
1	6'-3"	4'-0" MIN
2	3'-1½"	2'-6" MIN

NOTES:

- SEE STANDARD SPECIFICATION FOR OFFSET BLOCK MATERIALS.
- ON ROADWAYS WITH A POSTED SPEED LESS THAN OR EQUAL TO 50 MPH, WHERE THE FACE OF THE GUARDRAIL IS TO BE PLACED FLUSH WITH THE FACE OF THE CURB, THE HEIGHT OF THE CURB SHALL BE NO MORE THAN 6 INCHES. THE FACE OF THE GUARDRAIL SHALL BE INSTALLED FLUSH WITH THE FACE OF THE CURB OR NO MORE THAN 6 INCHES BEHIND THE FACE OF THE CURB.
- ON ROADWAYS WITH POSTED SPEEDS GREATER THAN 50 MPH, WHERE THE FACE OF THE GUARDRAIL IS TO BE PLACED FLUSH WITH THE FACE OF THE CURB, THE HEIGHT OF THE CURB SHALL BE NO MORE THAN 4 INCHES. THE FACE OF THE GUARDRAIL SHALL BE INSTALLED FLUSH WITH THE FACE OF THE CURB OR NO MORE THAN 6 INCHES BEHIND THE FACE OF THE CURB.
- H IS DEFINED AS THE MAXIMUM CURB HEIGHT FOR THE CURB/ GUARDRAIL APPLICATION.
- GUARDRAIL HEIGHT MEASURED FROM TOP OF CURB SHALL BE 31'-32". GUARDRAIL HEIGHT MEASURED FROM GROUND SURFACE DIRECTLY ADJACENT TO FACE OF RAIL SHALL BE NO MORE THAN 34".
- GUARDRAIL BEHIND CURB IS BASED ON MASH CRASH TEST REPORT TRP-03-237-10.

POSTED SPEED	D	H (SEE NOTE 4)
< 45 MPH	4'-0" MIN. - 12'-0" MAX. (SEE NOTE 6)	6" MAX

RECOMMENDED DATE: 09/01/2020

TYPES 1-31, 2-31, AND 3-31 GUARDRAIL APPLICATIONS

STANDARD NO. B-1 (2020) SHT. 3 OF 5

REVIEWED DATE: 09/01/2020

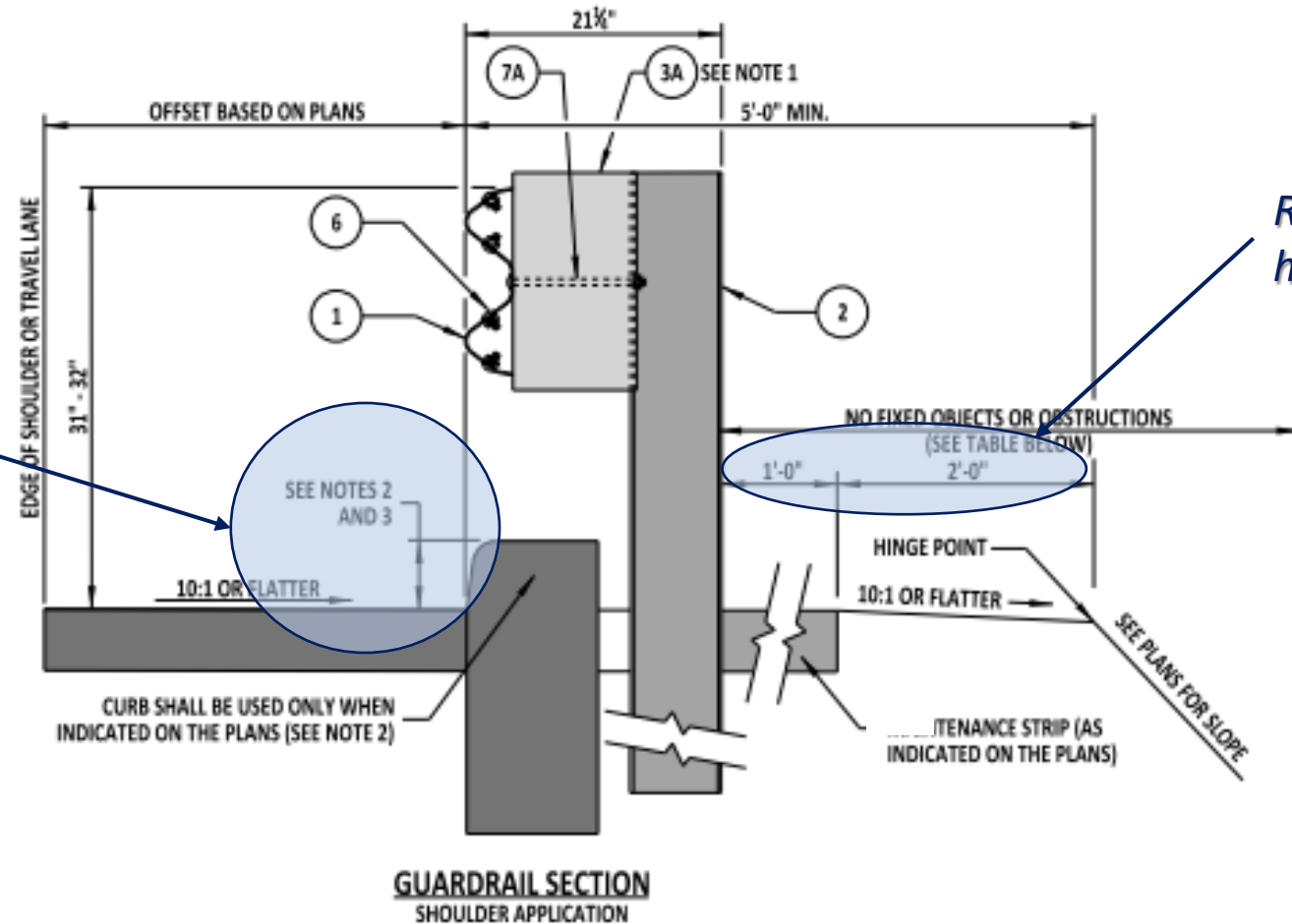
APPROVED DATE: 09/01/2020

Guardrail Applications

• Detail B-1: Guardrail Applications

- Posted speed \leq 50 MPH: Curb height \leq 6"
- Posted speed $>$ 50 MPH: Curb height \leq 4"
- Face of guardrail \leq 6" behind face of curb (flush is preferred)

Revised curb placement allowances



Revised offset to hinge point

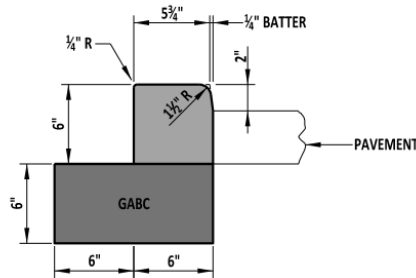
Guardrail Applications



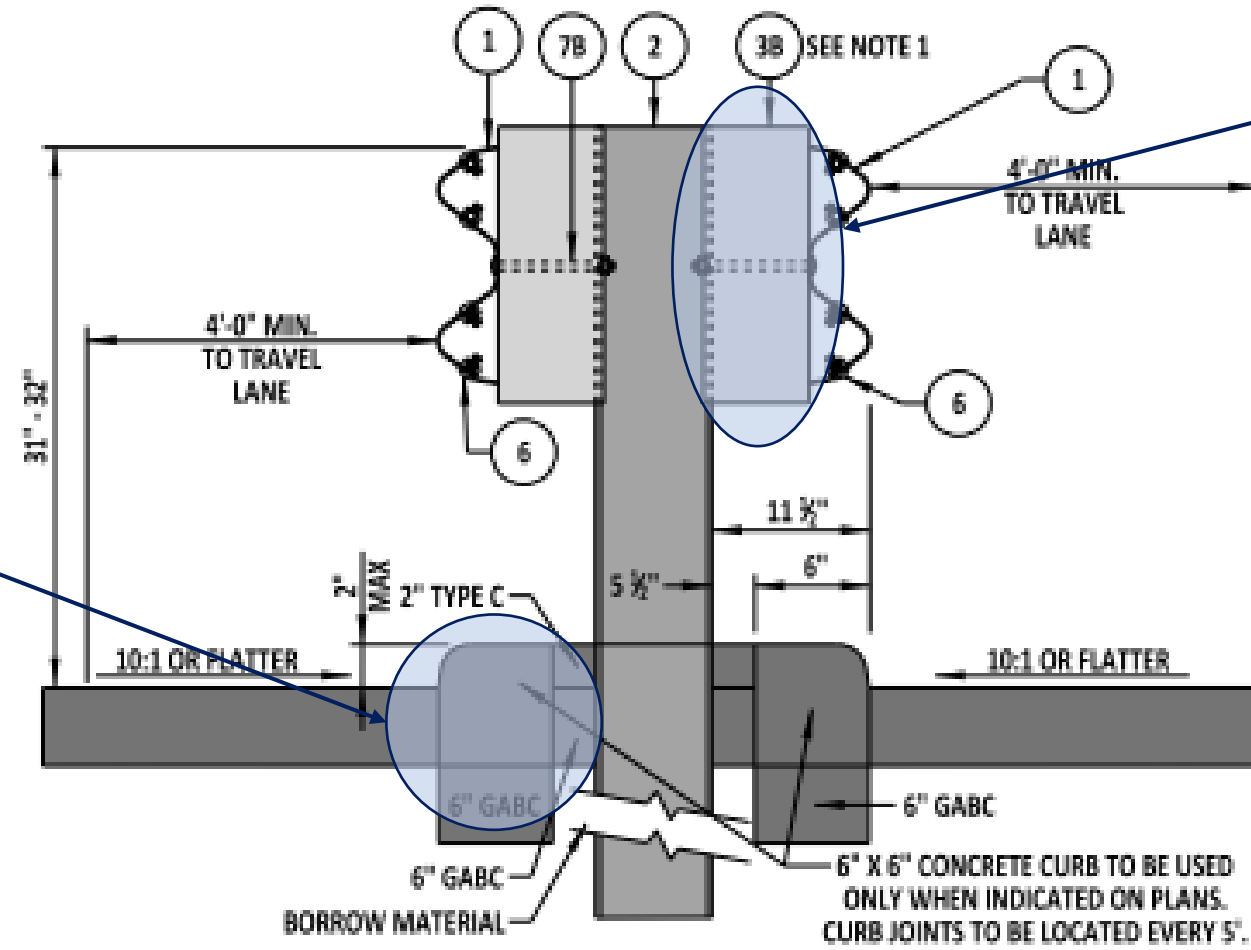
Guardrail Applications

- Detail B-1: Guardrail Applications

Type 1-2 Curb
(when required)
Detail C-1, sheet 4



PCC CURB
TYPE 1-2 GUARDRAIL MEDIAN CURB
INSTALL JOINTS AT 5'



8" Offset Blocks,
only

GUARDRAIL SECTION
MEDIAN APPLICATION

6" GABC
6" GABC
6" X 6" CONCRETE CURB TO BE USED ONLY WHEN INDICATED ON PLANS. CURB JOINTS TO BE LOCATED EVERY 5'.
BORROW MATERIAL

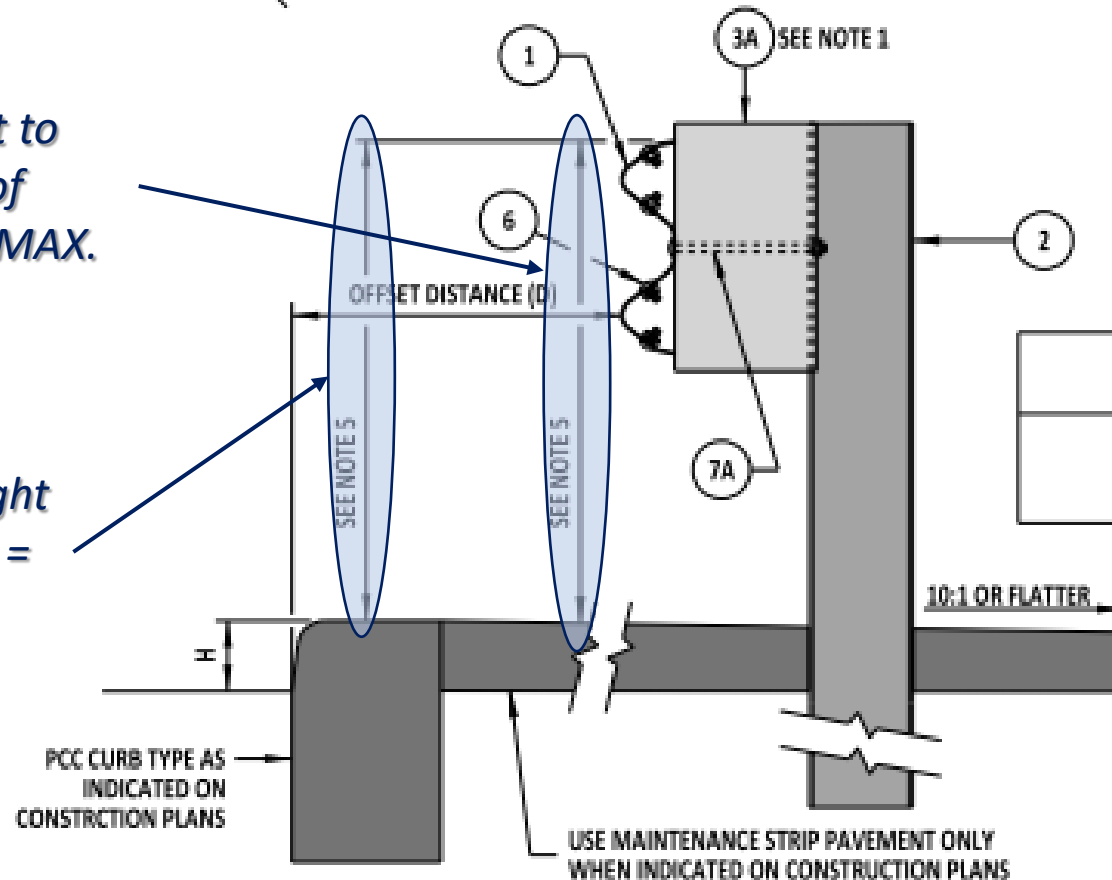
Guardrail Applications

- Detail B-1: Guardrail Applications

***This application ONLY for low speed conditions
<45 MPH***

Guardrail height to ground at face of guardrail = 34" MAX.

Guardrail height at top of curb = 31" – 32"

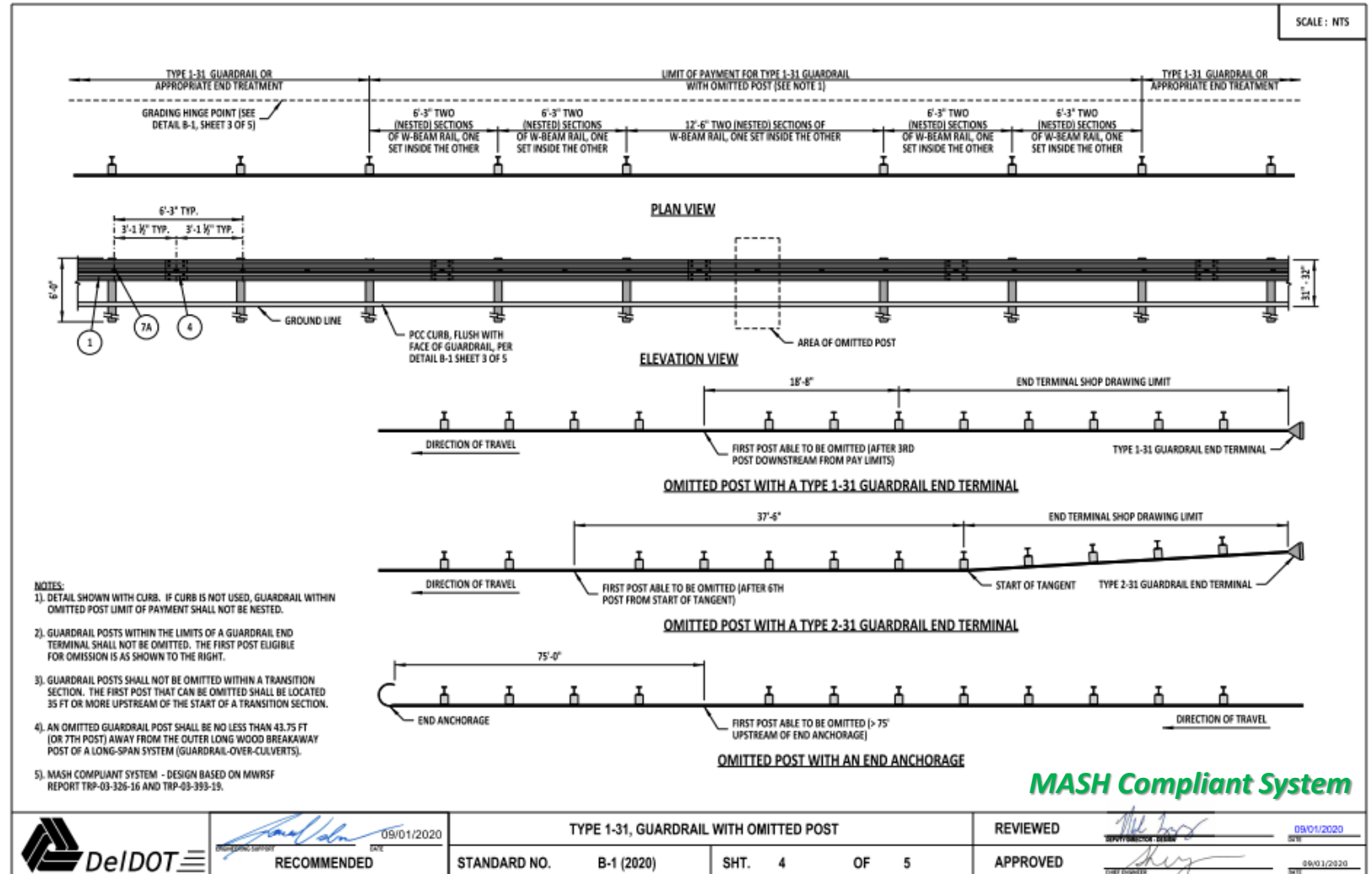


POSTED SPEED	D	H (SEE NOTE 4)
< 45 MPH	4'-0" MIN. - 12'-0" MAX. (SEE NOTE 6)	6" MAX

**GUARDRAIL SECTION
BEHIND CURB APPLICATION**

Guardrail Applications

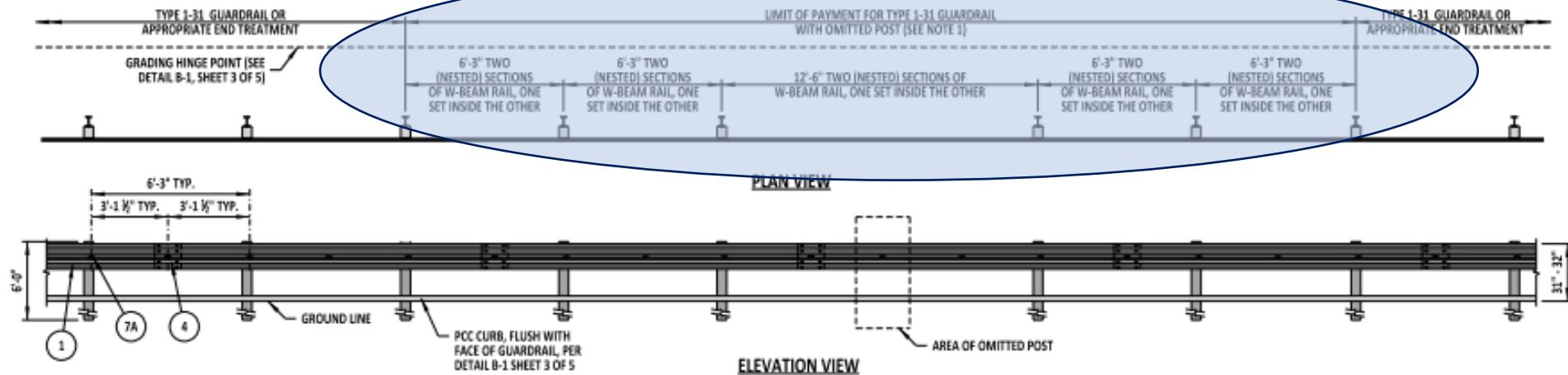
- Detail B-1, Sheet 4: Type 1-31 Guardrail with Omitted Post



Guardrail Applications

- Detail B-1, Sheet 4: Type 1-31 Guardrail with Omitted Post

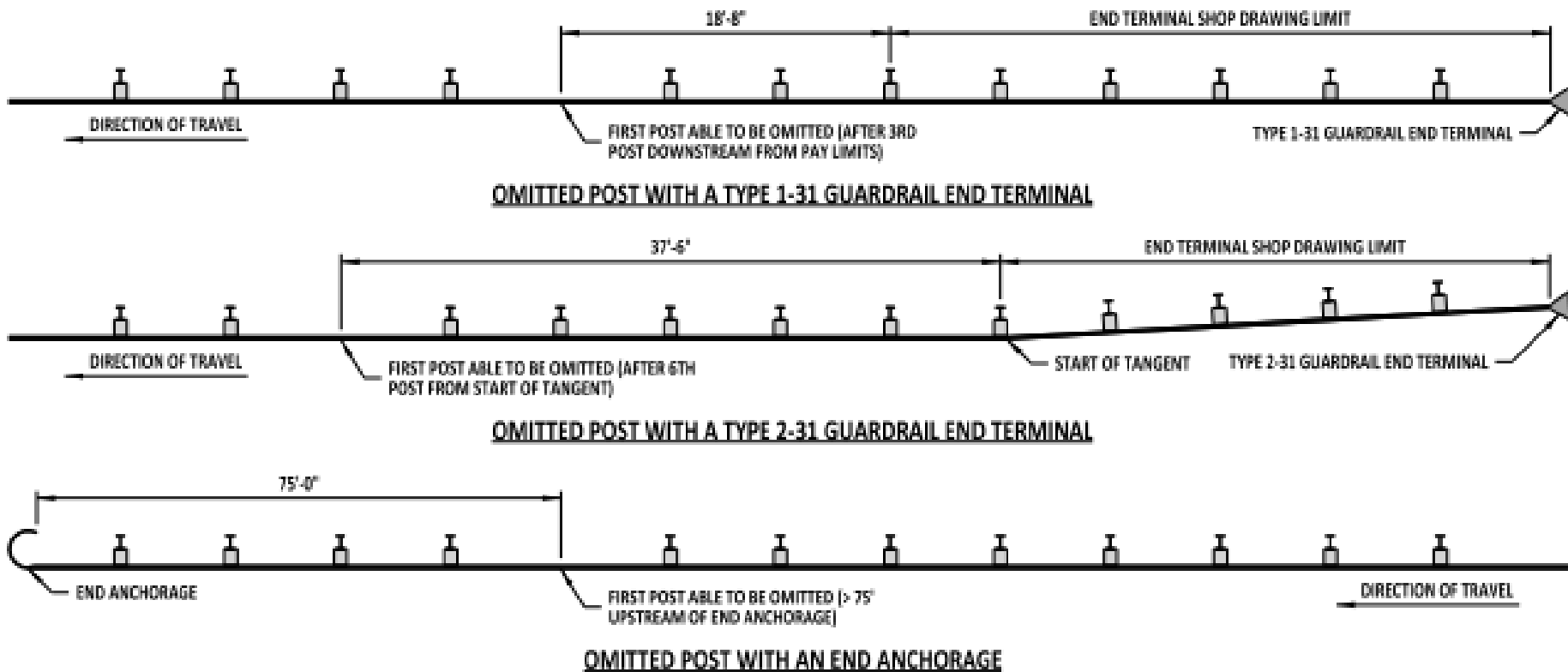
- Nested guardrail within limit of payment when curb is present*
- Guardrail is not nested when there is no curb*



Guardrail Applications

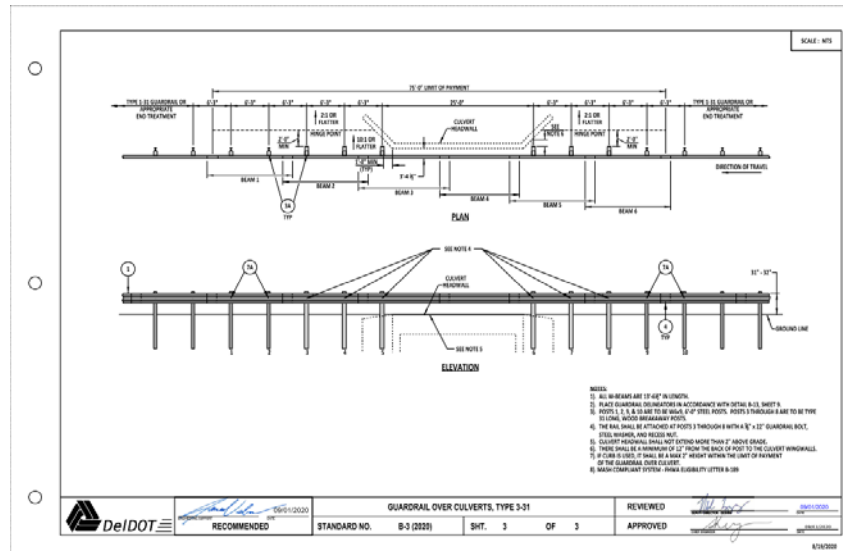
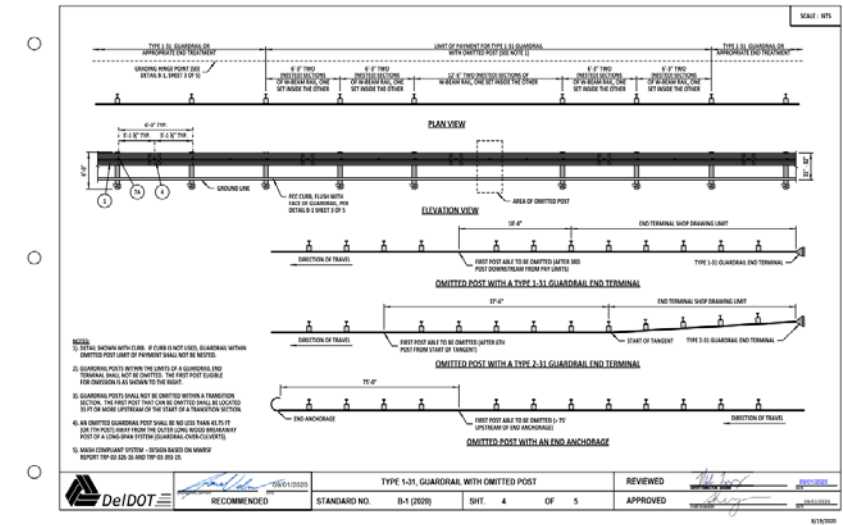
- Detail B-1, Sheet 4: Type 1-31 Guardrail with Omitted Post

Location of omitted post within proximity of an end terminal is critical



Design Considerations

- Guardrail with Omitted Post
 - Use only where one post needs to be omitted
 - Curb openings
 - Span an underground utility conflict
- Guardrail over Culvert
 - Use to span pipe or box culverts
 - Unsupported span lengths between 12'-6" and 25'-0"
 - Max span length 25'-0"



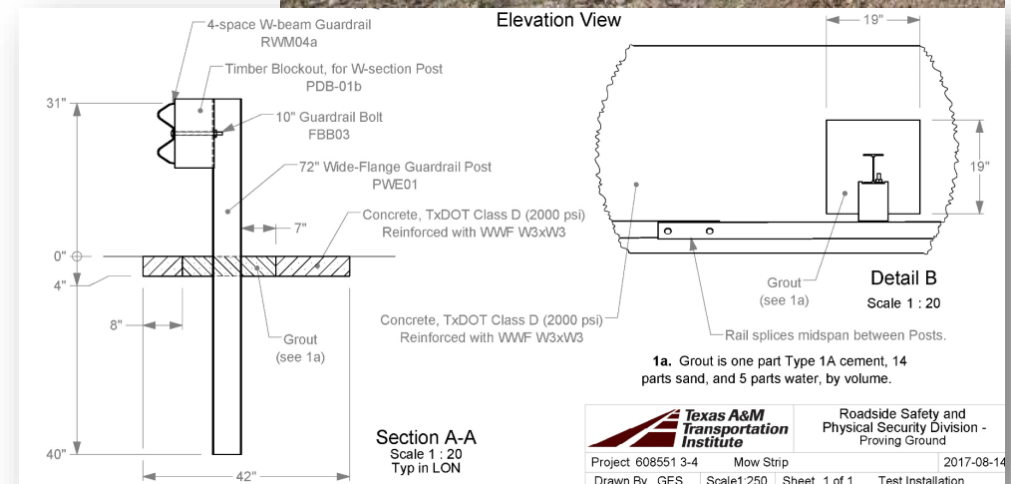
Guardrail Applications

- Post omission must follow new standard detail
 - Plan curb openings at appropriate locations
 - Some guardrail layout in design and in field may be necessary to avoid post omissions



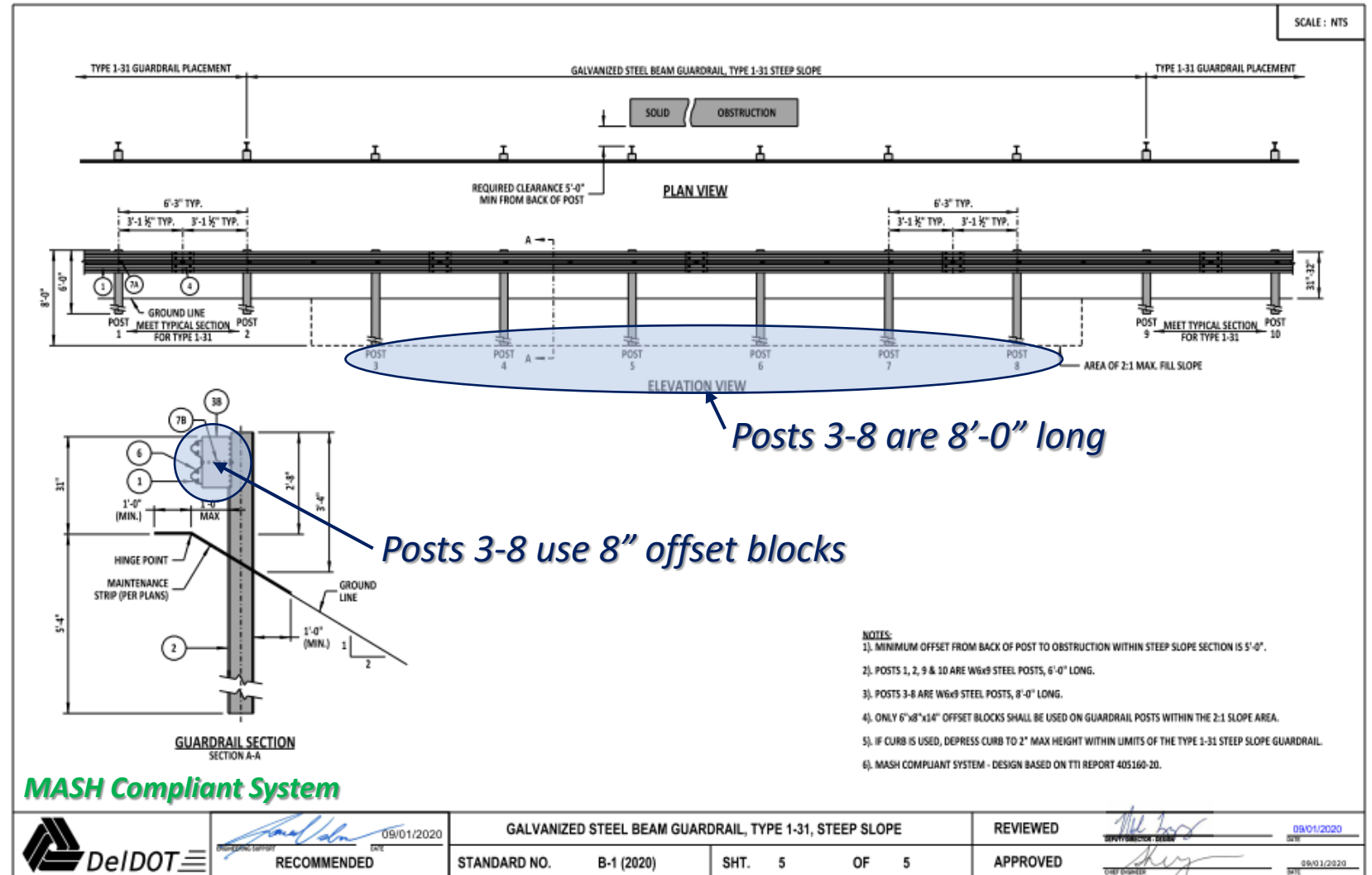
Guardrail Applications

- Guardrail Post Leave Outs
 - Used if guardrail post is placed in concrete
 - Allows the post to rotate and deflect upon impact
 - Previously tested and passed NCHRP 350
 - Recent MASH testing by TTI for both steel & wood post guardrail systems
 - Both car and truck tests passed MASH for steel post
 - Wood post test failed the pickup truck test
- Leave out requires a low strength grout
 - 1 part Type 1A cement, 14 parts sand, 5 parts water, by volume
 - No additives



Guardrail Applications

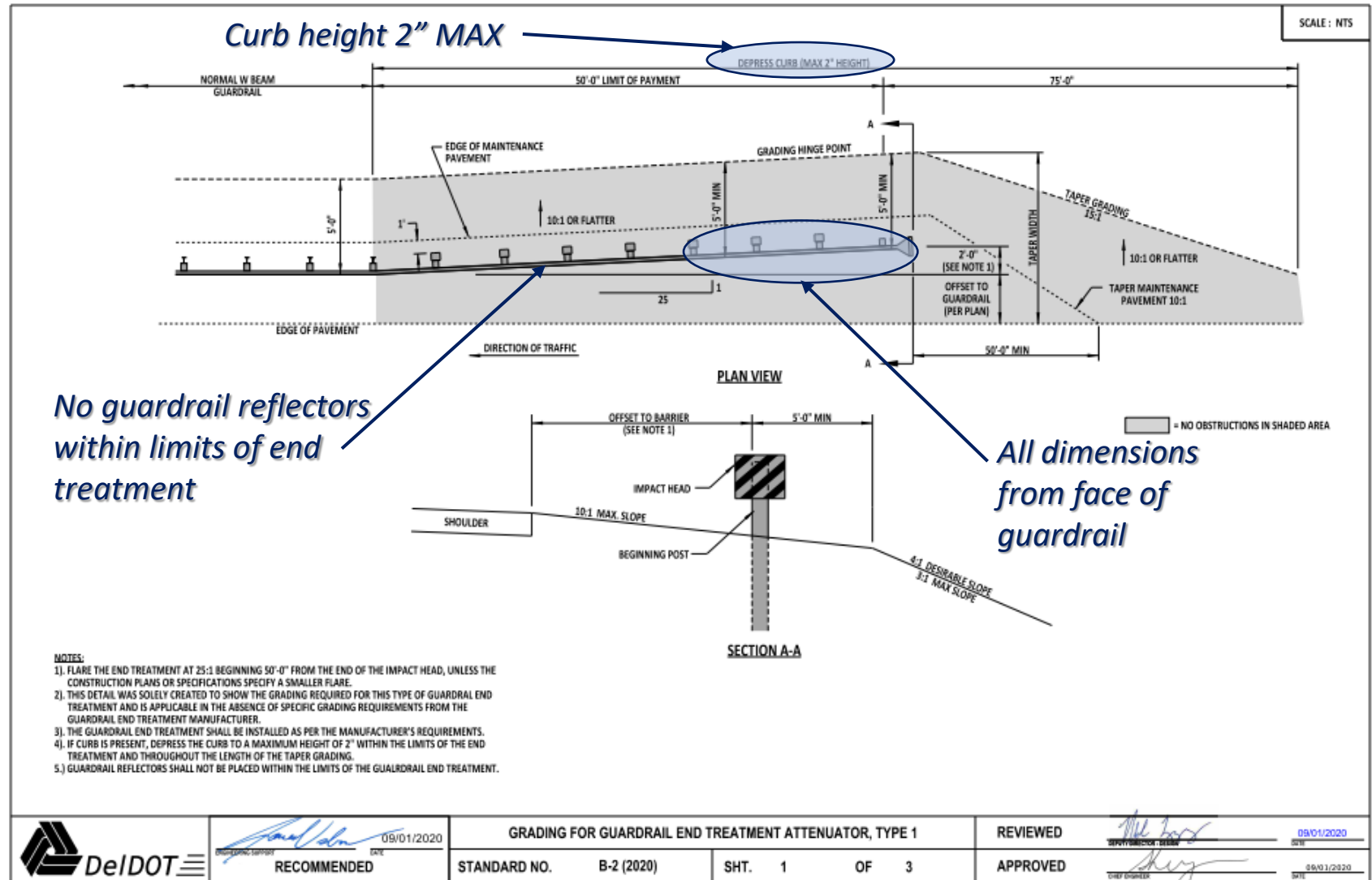
- Detail B-1, Sheet 5:
Type 1-31 on a Steep Slope



Grading for Guardrail End Treatments

- Detail B-2: Grading for Guardrail End Treatment, Type 1
 - See Approved Products List for allowable systems

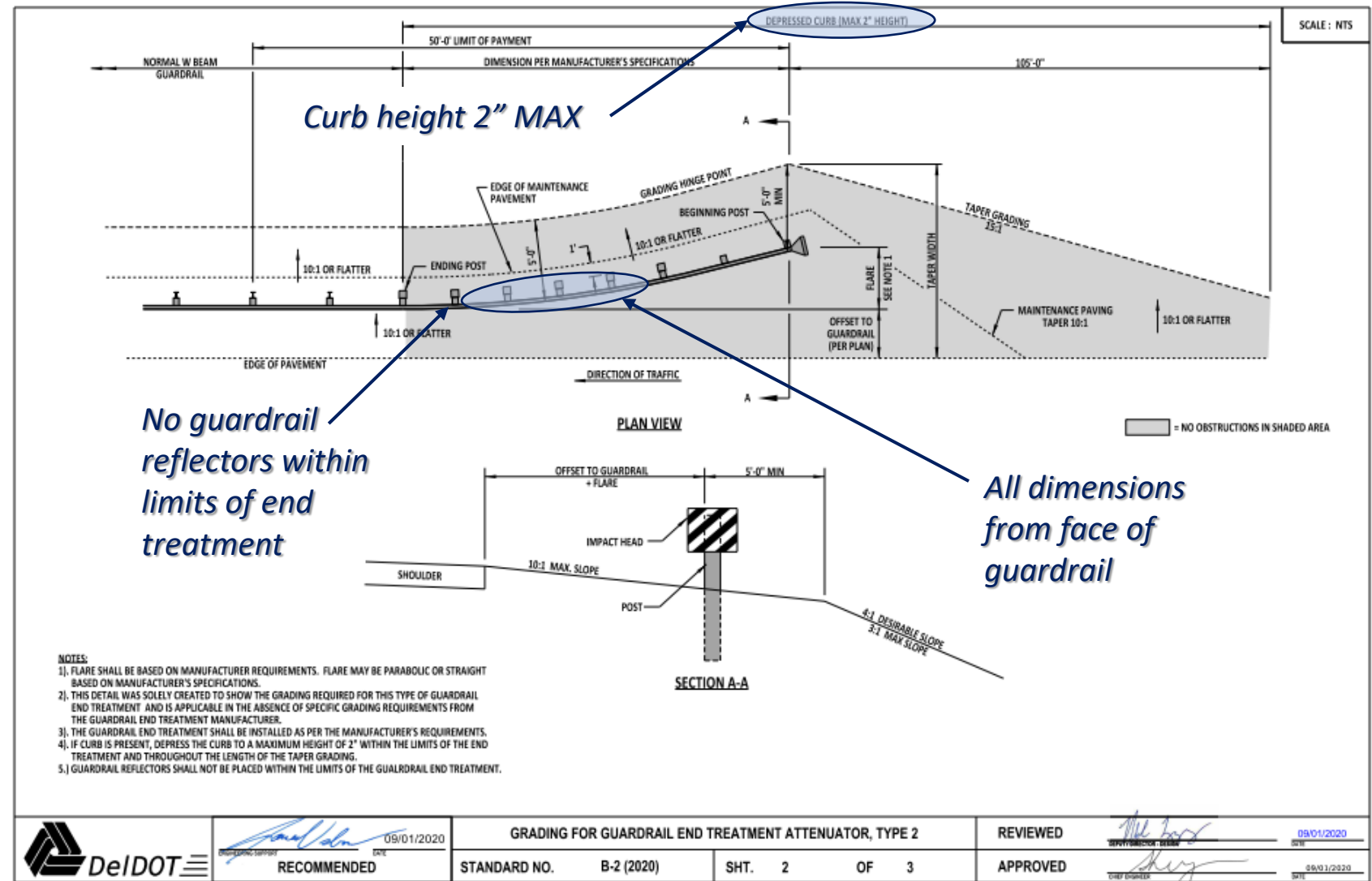
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Grading for Guardrail End Treatments

- Detail B-2: Grading for Guardrail End Treatment, Type 2
 - See Approved Products List for allowable systems

https://deldot.gov/Business/prodlists/pdfs/APL_EndTerminals.pdf?cache=1603391579291



No guardrail reflectors within limits of end treatment

All dimensions from face of guardrail

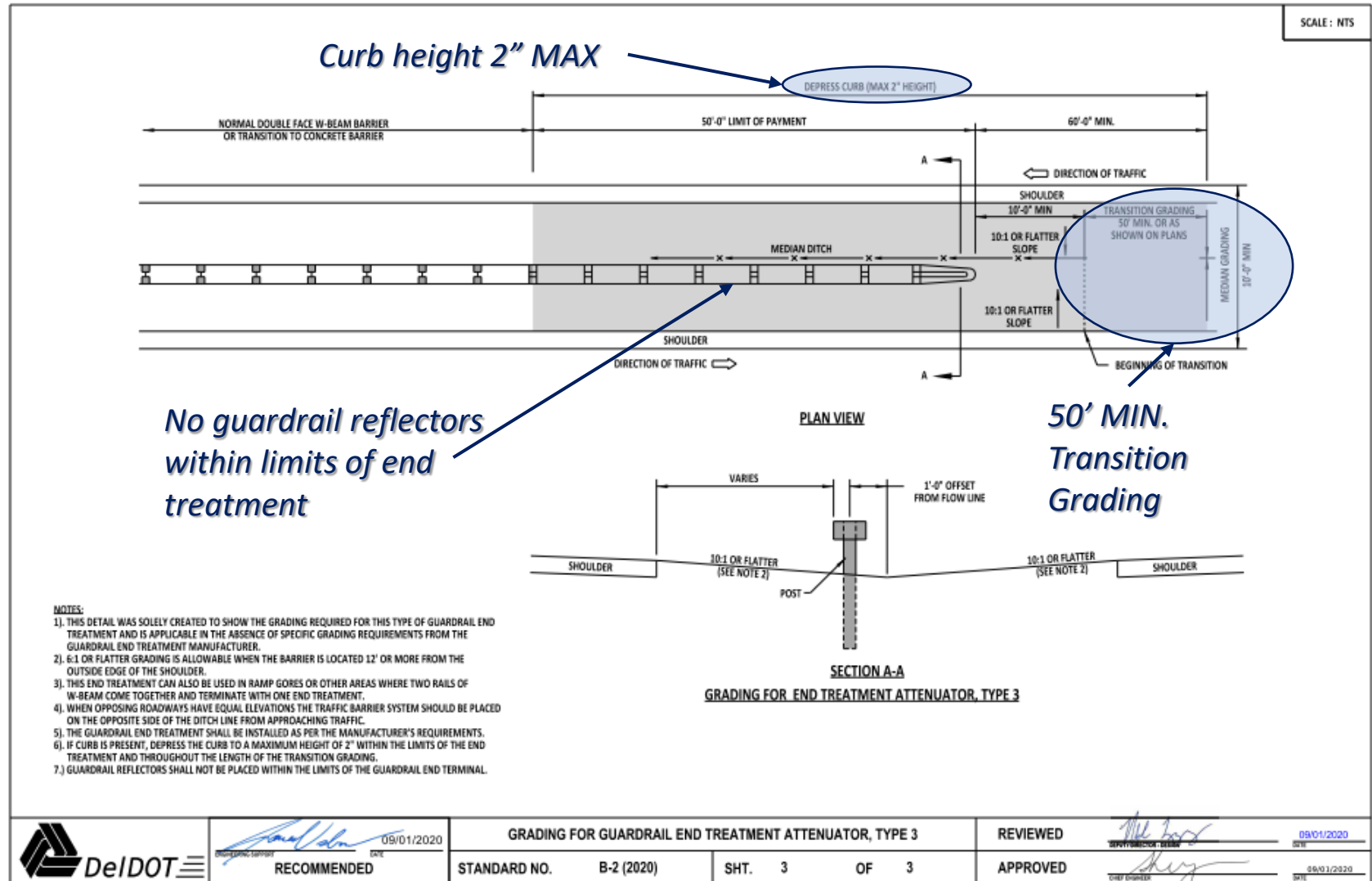


	 DATE: 09/01/2020	GRADING FOR GUARDRAIL END TREATMENT ATTENUATOR, TYPE 2		REVIEWED DATE: 09/01/2020
	RECOMMENDED	STANDARD NO. B-2 (2020)	SHT. 2 OF 3	APPROVED DATE: 09/01/2020

Grading for Guardrail End Treatments

- Detail B-2: Grading for Guardrail End Treatment, Type 3
 - See Approved Products List for allowable systems

https://deldot.gov/Business/prodlist/s/pdfs/APL_EndTerminals.pdf?cache=1603391579291



Grading for Guardrail End Treatments



This curb needs to be no taller than 2"

A wide bay attenuator attached to the guardrail protecting the pier may be a better solution and minimize the amount of guardrail needed

Guardrail End Treatments

- Common Inspection Issues
 - Grading around and in advance of the terminal
 - This is extremely important for the terminal to function correctly and for the striking vehicle to not rollover
 - Curb must be eliminated or lowered per the detail
 - Area behind the terminal must be clear of fixed objects, including breakaway devices
 - End treatment installation
 - Install per manufacturer instructions
 - Strut between posts 1 and 2 must be at ground level
 - Bearing plate oriented properly
 - Flare rate for end treatment



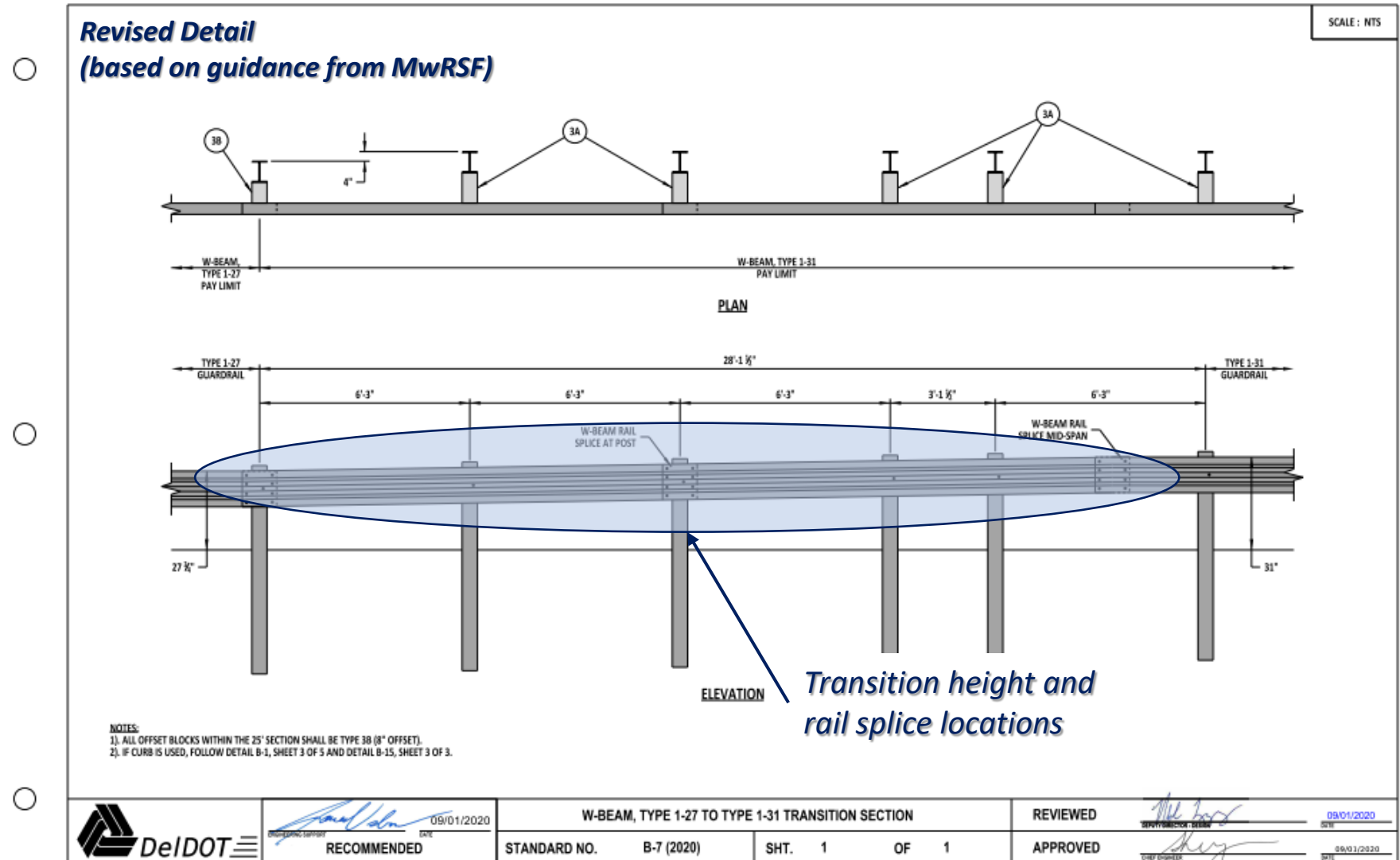
Guardrail End Treatments

- New Style End Treatments
 - Trinity Safe Stop
 - Extruded rail at bottom of end treatment, lays flat on ground
 - Post 1 and 2 are not installed in line with each other
 - MAX-Tension from Barrier Systems
 - Energy absorbing end treatment
 - Downstream “coupler” which absorbs energy and cuts the downstream rail sections upon impact
 - Special bolts for coupler, must be installed correctly to work properly



Guardrail Transitions

- Detail B-7: Transition from 1-31 to 1-27



Guardrail Transitions

- Unacceptable method of transitioning height

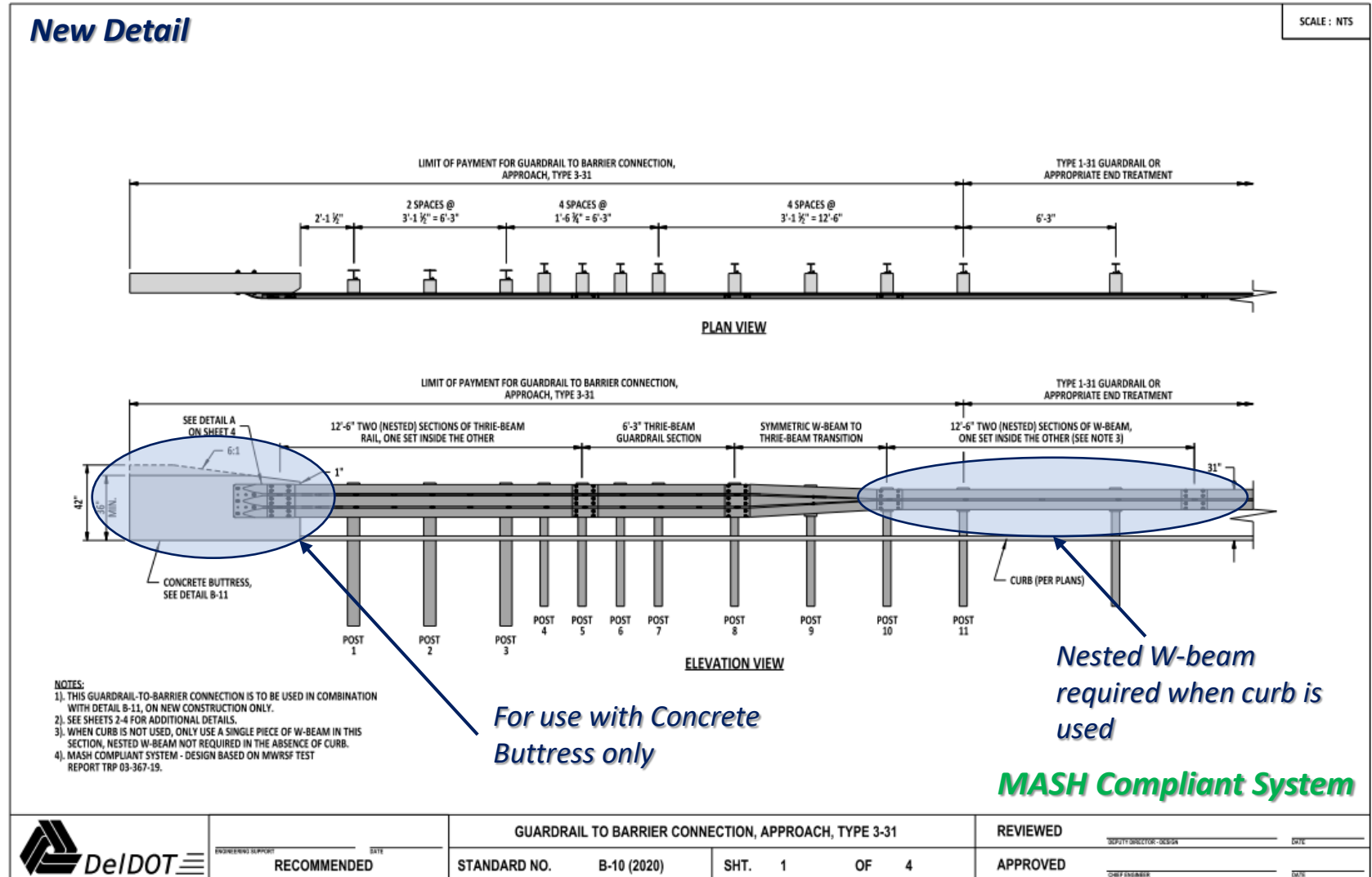


Approach Guardrail Transitions

- Detail B-10: Guardrail-to-Barrier Connection, Type 3-31



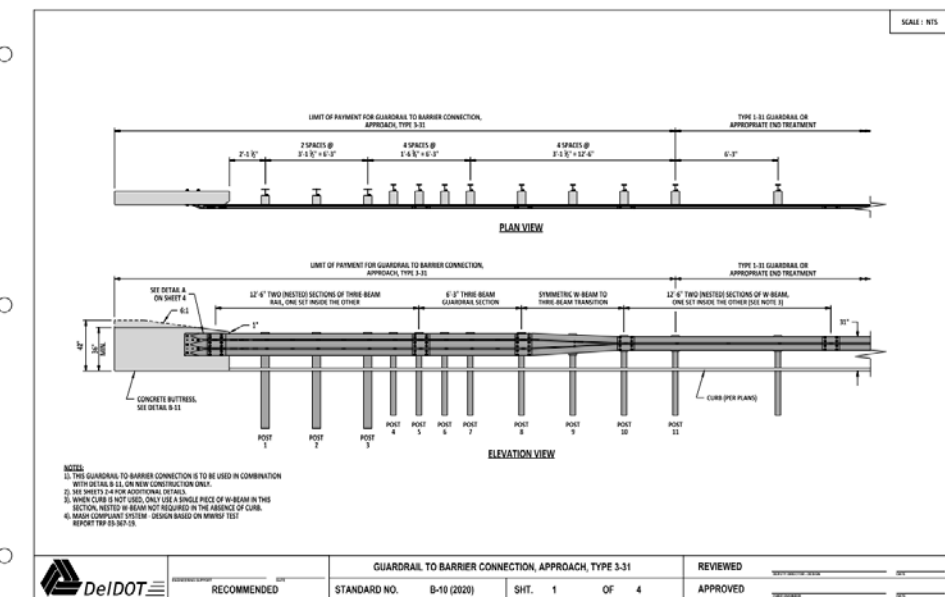
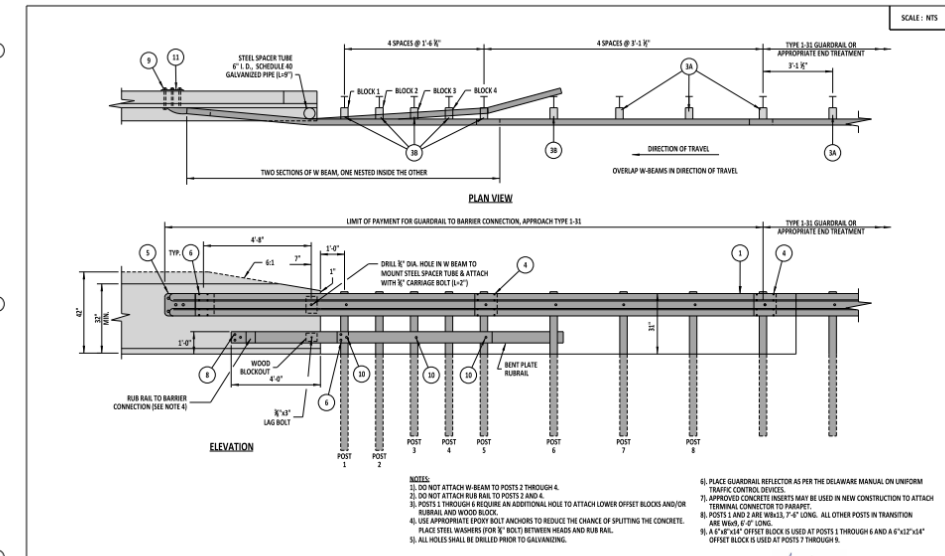
Source: Midwest Roadside Safety Facility



Approach Guardrail Transitions

Design Considerations

- Use Type 1-31 AGT for retrofit applications at existing F-shape barrier wall attachments
- Use Type 3-31 AGT for new construction or where it is desirable to construct the concrete buttress
- Consult MASH Committee and/or Bridge Design for retrofit situations where the Type 3-31 AGT may be beneficial



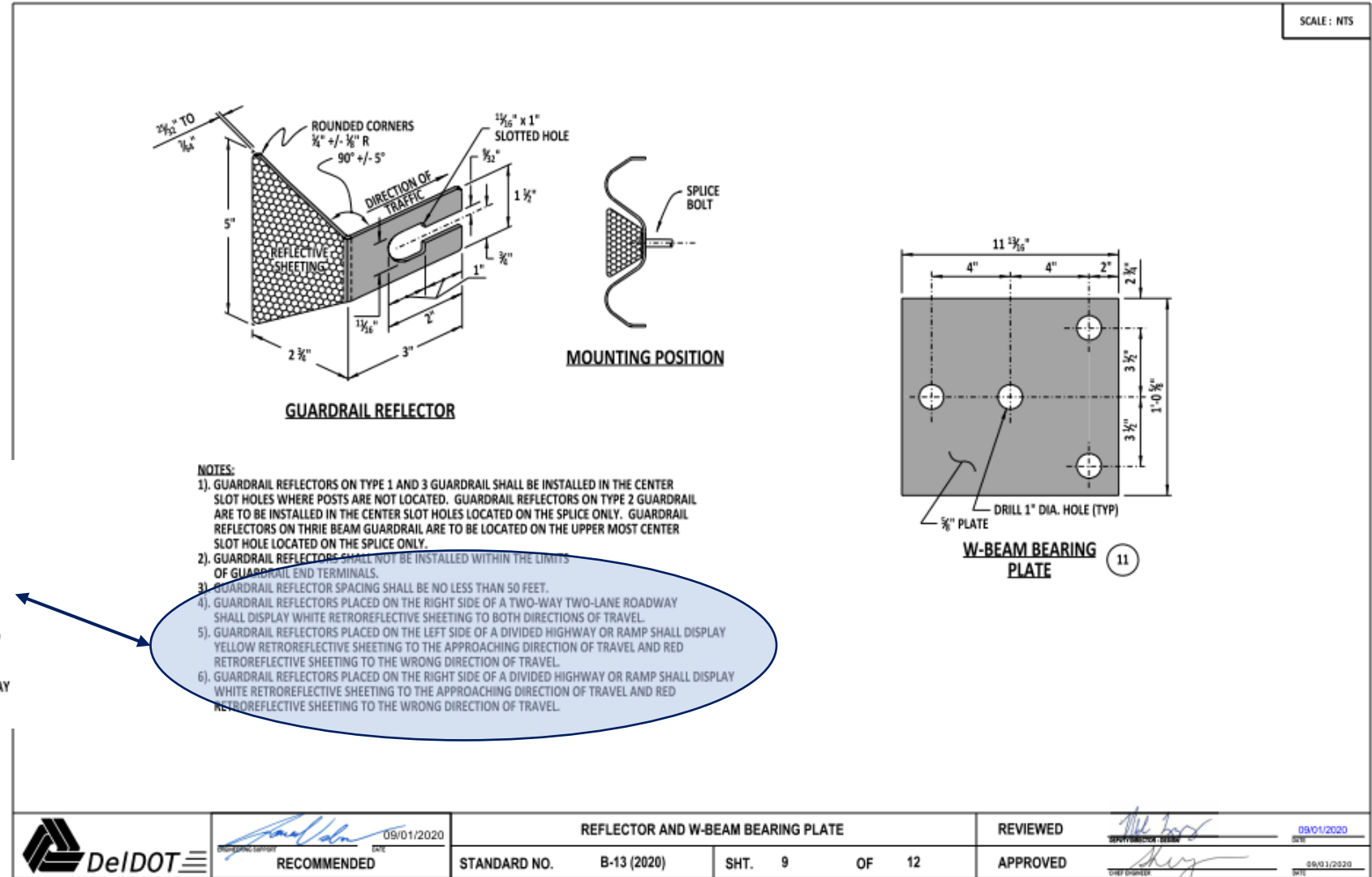
Barrier Hardware

- Detail B-13, Sheet 9: Guardrail Reflector

Added reflector color and placement requirements (based on DE MUTCD, Section 3F.04)

NOTES:

- 1). GUARDRAIL REFLECTORS ON TYPE 1 AND 3 GUARDRAIL SHALL BE INSTALLED IN THE CENTER SLOT HOLES WHERE POSTS ARE NOT LOCATED. GUARDRAIL REFLECTORS ON TYPE 2 GUARDRAIL ARE TO BE INSTALLED IN THE CENTER SLOT HOLES LOCATED ON THE SPLICE ONLY. GUARDRAIL REFLECTORS ON THRIE BEAM GUARDRAIL ARE TO BE LOCATED ON THE UPPER MOST CENTER SLOT HOLE LOCATED ON THE SPLICE ONLY.
- 2). GUARDRAIL REFLECTORS SHALL NOT BE INSTALLED WITHIN THE LIMITS OF GUARDRAIL END TERMINALS.
- 3). GUARDRAIL REFLECTOR SPACING SHALL BE NO LESS THAN 50 FEET.
- 4). GUARDRAIL REFLECTORS PLACED ON THE RIGHT SIDE OF A TWO-WAY TWO-LANE ROADWAY SHALL DISPLAY WHITE RETROREFLECTIVE SHEETING TO BOTH DIRECTIONS OF TRAVEL.
- 5). GUARDRAIL REFLECTORS PLACED ON THE LEFT SIDE OF A DIVIDED HIGHWAY OR RAMP SHALL DISPLAY YELLOW RETROREFLECTIVE SHEETING TO THE APPROACHING DIRECTION OF TRAVEL AND RED RETROREFLECTIVE SHEETING TO THE WRONG DIRECTION OF TRAVEL.
- 6). GUARDRAIL REFLECTORS PLACED ON THE RIGHT SIDE OF A DIVIDED HIGHWAY OR RAMP SHALL DISPLAY WHITE RETROREFLECTIVE SHEETING TO THE APPROACHING DIRECTION OF TRAVEL AND RED RETROREFLECTIVE SHEETING TO THE WRONG DIRECTION OF TRAVEL.



NOTES:

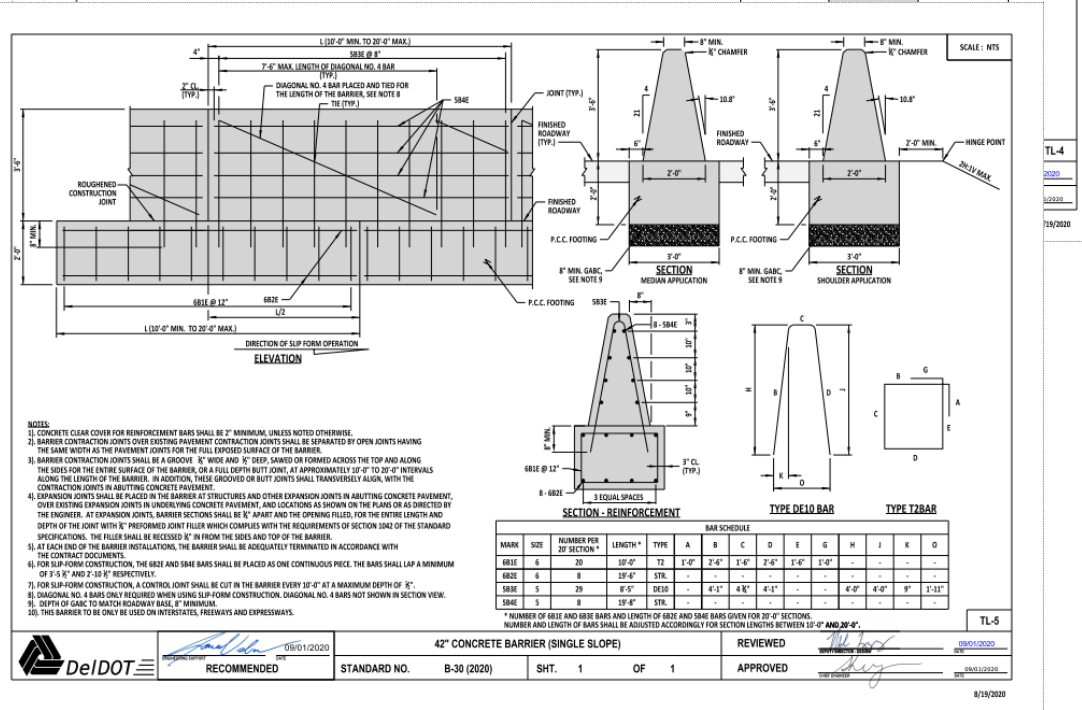
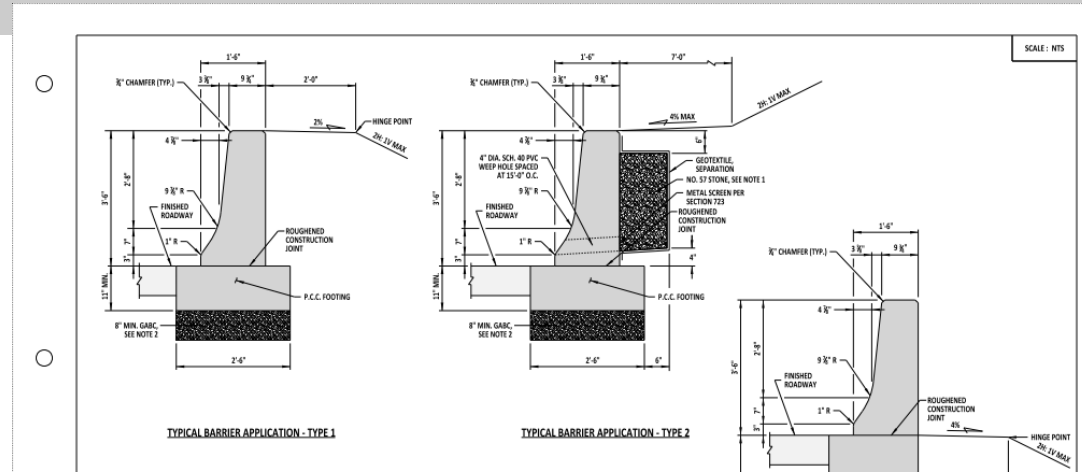
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	 09/01/2020 DATE	REFLECTOR AND W-BEAM BEARING PLATE		REVIEWED	 09/01/2020 DATE
	RECOMMENDED	STANDARD NO.	B-13 (2020)	SHT. 9 OF 12	APPROVED



Concrete Barrier Details

- Update Summary
 - Overall MASH compliance review
 - Resulted in elimination of existing concrete barrier details
 - Added new concrete barrier details
 - Address common Department uses
 - Minimizes need for project specific details
 - Roadside Concrete Barrier
 - 36" F-Shape, Single Face (Test Level 4)
 - 42" F-Shape, Single Face (Test Level 4)
 - Median Concrete Barrier
 - 32" F-Shape (Test Level 3)
 - 36" F-Shape (Test Level 4)
 - 42" F-Shape (Test Level 4)
 - 42" Single Slope (Test Level 5)
 - Designs based on available MASH crash testing and appropriate structural analyses



42" CONCRETE BARRIER (SINGLE SLOPE) RECOMMENDED STANDARD NO. B-30 (2020) SHT. 1 OF 1

REVIEWED [Signature] 09/01/2020

APPROVED [Signature] 09/01/2020

TL-4
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12222
7/5/2020

TL-5
09/01/2020
09/01/2020
8/79/2020

Approved Products List

- Guardrail End Treatments and Permanent Impact Attenuators must be on APL to be used on a project

Delaware Department of Transportation Approved Products List
W-Beam Guardrail End Terminals

Standard Item		Manufacturer	Product Name	MASH Test Level	Tangent	Flared	FHWA Eligibility Letter
2001 Standard Specifications	2016 Standard Specifications						
720585	721000	Barrier Systems by Lindsay	MAX-Tension	TL-2	X		CC-134
720585	721001	Barrier Systems by Lindsay	MAX-Tension	TL-3	X		CC-133
720588	721004	Barrier Systems by Lindsay	MAX-Tension Median	TL-3	X		CC-141
720585	721000	Road Systems, Inc.	MASH Sequential Kinking Terminal (MSKT)	TL-2	X		CC-126D
720585	721001	Road Systems, Inc.	MASH Sequential Kinking Terminal (MSKT)	TL-3	X		CC-126, 126A, 126C, CC-126F
720585	721000	Trinity Highway Products, LLC	SoftStop System	TL-2	X		CC-115B, 115E, 115H, 115I
720585	721001	Trinity Highway Products, LLC	SoftStop System	TL-3	X		CC-115, 115A, 115D, 115G, 115H, 115I
720586	721003	Road Systems, Inc.	Flared Energy Absorbing Terminal (MFLEAT)	TL-3		X	CC-143

End terminals not listed above shall not be used on any DeIDOT construction contracts without prior written approval from the DeIDOT Safety Programs Manager, who is responsible for the above Approved Products List (APL).

All manufacturers and distributors seeking approval for new products must submit a completed copy of the DeIDOT APL new product evaluation form, product materials technical data sheet, installation instructions, material safety data sheet, and copies of all related FHWA approval letters.

The ET-Plus® System end terminals manufactured by Trinity Highway Products are not permitted for use on any DeIDOT construction contracts.

Delaware Department of Transportation Approved Products List (MASH 2016)
Permanent Impact Attenuators

Standard Item		Manufacturer	Product Name	MASH Test Level	FHWA Eligibility Letter
2001 Standard Specifications	2016 Standard Specifications				
720585	724002	EASI	3-Bay QuadGuard M10 (QG M10) Narrow	TL-2	CC-121, CC-112C
720585	724002	EASI	3-Bay QuadGuard M10 (QG M10) Wide	TL-2	CC-121, CC-112C
720585	724002	EASI	QuadGuard Elite M10; 4-Bay Standard Width	TL-2	CC-112A, CC-112C
720585	724002	EASI	QuadGuard Elite M10; 4-Bay Wide Backup Width	TL-2	CC-112A, CC-112C
720585	724005	EASI	QuadGuard Elite M10; 8-Bay Standard Width	TL-3	CC-112A, CC-112C
720585	724005	EASI	QuadGuard Elite M10; 8-Bay Wide Backup Width	TL-3	CC-112A, CC-112C
720585	724005	EASI	2-Bay to 6-Bay QuadGuard M10 CZ (24", 30" and 36")	TL-3	CC-112B, CC-112C
720585	724005	Energy Absorption Systems, Inc.	6-Bay QuadGuard M10	TL-3	CC-112, CC-112C
720585	724005	Energy Absorption Systems, Inc.	6-Bay QuadGuard M10 Wide	TL-3	CC-112, CC-112C
720517	724006	Work Area Protection	SCI SmartCushion® TL-3 SCI100GM Impact Attenuator	TL-3	CC-128
720585	724002	Lindsay Transportation Solutions, Inc.	Universal TAU-M MASH Crash Cushion	TL-2	CC-146
720585	724005	Lindsay Transportation Solutions, Inc.	Universal TAU-M MASH Crash Cushion	TL-3	CC-147



Thank you!

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