

TEMPORARY DESIGN GUIDANCE FOR GUARDRAIL

Note: These temporary guidelines have been written in attempt to cover questions that may arise with moving towards use of the Midwest Guardrail System and the Manual for Assessing Roadside Safety Hardware (*MASH*). Chapter 10 of the Road Design Manual will be modified as soon as we can get it completed and approved by FHWA. Refer to DOT's internal guidance flowcharts for Determining Bridge Rail Attachment Upgrades located at the conclusion of this document.

NHS: National Highway System

NON-NHS: All state highways not on the National Highway System

DESIGN SCENARIO	GUARDRAIL STANDARD PLATES NECESSARY
NHS	
<p>Guardrail attached to Bridge: It is highly preferred that only concrete end-blocks accepting double (<i>nested</i>) thrie beam guardrail is allowed. New version of concrete end block (<i>location of thrie beam attachment location has changed from old version, see 630.50</i>) or old version of concrete end block (<i>will need extra blockout attached to concrete end block, see 630.51</i>) may be used. Only MGS may be attached to the Type 1 or Type 1 Retrofit Guardrail Transitions and end with an MGS MASH Tangent or MGS MASH Flared End Terminal. We will not transition from MGS or W Beam to a cable barrier.</p> <p>In some cases, it may only be feasible to modify the bridge rail to accommodate thrie beam rail across the structure and then use the appropriate transition.</p>	<p>Double (<i>nested</i>) Thrie Beam Guardrail attached to structure with Concrete End Block: 630.01, 630.20, 630.47, 630.49, 630.50 or 630.51, 630.87 or 630.89, 630.96, 630.97, and 630.99</p> <p>Double (<i>nested</i>) Thrie Beam Guardrail attached to structure with Thrie Beam Bridge Rail: 630.01, 630.20, 630.49, 630.54, 630.87 or 630.89, 630.96, 630.97, and 630.99</p>
NHS AND NON-NHS	
When using steel beam guardrail in a project	<p>Provide 630.96, 630.97, and 630.99</p> <p>Do not provide 630.96 if the plan is to not have a hard surfaced guardrail embankment.</p>
If replacing or need new steel beam guardrail based on deflection requirements, we will install MGS instead of old standard W Beam Guardrail.	630.20, 630.87 or 630. 89, 630.96, 630.97, 630.99, and other MGS plates as needed

DESIGN SCENARIO	GUARDRAIL STANDARD PLATES NECESSARY
NON-NHS	
<p>Attaching Guardrail to existing Bridge: This situation would be decided on a case by case basis. At a minimum, it is preferred that the Bridge Office revise the bridge rail to a Thrie Beam Type Rail across the structure. If the bridge is structurally adequate, other options would be to provide new concrete end blocks for attaching Double (<i>Nested</i>) Thrie Beam Guardrail or provide Concrete Bridge Rail with End Block for attaching Double (<i>Nested</i>) Thrie Beam Guardrail. If there is going to be a longer length of steel beam rail off of the bridge (200' +) we recommend MGS with an MGS MASH Tangent or MGS MASH Flared End Terminal over transitioning to cable because MGS meets MASH TL-3 while the cable and W beam to cable transition does not meet MASH. However, this would be decided on a case by case basis.</p> <p>If it is decided to use old Double (<i>nested</i>) W Beam Rail attached to structure then the Double (<i>nested</i>) W Beam transitions from Bridge ends/rails are on standard plates 630.60 to 630.63. If there is going to be a longer length of steel beam rail off of the bridge ((112.5' + End Terminal Length) and longer) we recommend transitioning from W beam guardrail to MGS with a MGS MASH Tangent or MGS MASH Flared End Terminal (<i>see 630.64 for transition from W Beam to MGS</i>) We recommend MGS over transitioning to cable because MGS meets MASH TL-3 while the cable and W beam to cable transition does not meet MASH. However, this would be decided on a case by case basis.</p>	<p>Double (<i>nested</i>) Thrie Beam Guardrail attached to structure:</p> <p>Minimum Length to long length (<i>over 200'</i>) that transitions to MGS: 630.01, 630.20, 630.47 (<i>if attached to concrete end block</i>), 630.49, 630.50 or 630.51 or 630.54, 630.87 or 630.89, 630.96, 630.97, and 630.99</p> <p>If transitioning to low tension 3 cable guardrail: 629.01, 629.05, 629.10, 629.15, 630.01, 630.10, 630.47 (<i>if attached to concrete end block</i>), 630.48, 630.52 or 630.53 or 630.55, 630.85, 630.96, 630.97, and 630.99</p> <p>Double (<i>nested</i>) W Beam Guardrail attached to structure:</p> <p>Short Length (<i>Less than 112.5' + End Terminal Length</i>): 630.10, 630.59 (<i>if attached to concrete end block</i>), 630.60 to 630.63 (<i>as necessary</i>), 630.86 or 630.88, 630.96, 630.97, 630.99, and use the W Beam Guardrail Flared or Tangent End Terminals as necessary</p> <p>Long Length (<i>112.5' + End Terminal Length</i>) and longer that transitions to MGS: 630.10, 630.20, 630.59 (<i>if attached to concrete end block</i>), 630.60 to 630.63 (<i>as necessary</i>), 630.64, 630.87 or 630.89, 630.96, 630.97, 630.99</p> <p>If transitioning to low tension 3 cable guardrail: 629.01, 629.05, 629.10, 629.15, 630.10, 630.59 (<i>if attached to concrete end block</i>), 630.60 to 630.63 (<i>as necessary</i>), 630.85, 630.96, 630.97, and 630.99</p>
LOCAL GOVERNMENT PROJECTS	
Guardrail should be designed in accordance with the Office of Local Government Assistance utilizing the SDDOT Local Roads Plan.	

GENERAL INFORMATION:

MGS is commonly known as Midwest Guardrail System. MGS is on standard plates 630.20, 630.22, 630.25, and 630.27. MGS is also shown in a number of the new transitions too. There will probably be different plates and types of MGS in the future as more versions are crash tested and approved.

We have six lists of approved products for steel beam guardrail end terminals. They are W Beam Guardrail Flared End Terminal, W Beam Guardrail Tangent End Terminal, MGS Flared End Terminal, MGS Tangent End Terminal, MGS MASH Flared End Terminal, and MGS MASH Tangent End Terminal. The MGS MASH Tangent and MGS MASH Flared End Terminals meet MASH TL-3 crash testing requirements.

There is currently NO transitions available that meet MASH crash test requirements for transitions from W Beam or MGS to High Tension Cable or 3 Cable Guardrail. We investigated this, and it appears it will be years before one can be developed and crash tested to MASH.

A new standard plate for a Type 3 Guardrail Transition (630.56) was added as an option to aid cases where the cross pipe of a drop inlet interferes with a guardrail post. The transition consists of a double (*nested*) three beam that transitions to MGS. The posts in the double (*nested*) three beam portion are spaced wider to accommodate more chances of missing an in place drop inlet cross pipe. If you are using minimum length guardrail in your design and this plate, the total guardrail length would be longer by 12'-6" due to the extra length of the transition. This plate is not mentioned in the table above. It is preferred, if possible due to outlet elevations, that any new drop inlet adjacent to bridges be designed such that the top of the cross pipe is at least 1 foot below the bottom of a 7-foot long guardrail post. Designing drop inlets at this deeper depth should eliminate interference with guardrail posts with future guardrail transition upgrades or changes.

On all the standard plates in the 630 series **READ** the **GENERAL NOTES** as these should help answer some questions you have. The notes have statements regarding measurement and payment and typically refer to the appropriate bid item to use.

GUIDELINES FOR HIGHWAY SYSTEMS:

NHS: Protecting motorists from steep slopes and other obstacles as listed in Chapter 10 of the Road Design Manual, use the appropriate guardrail based on allowable deflection requirements. W Beam Guardrail shall not be used. Use MGS instead of W Beam Guardrail.

NHS: We will use MGS MASH Tangent or MGS MASH Flared End Terminals on the NHS unless this is not feasible. The Flared End is flared a maximum of 3' and may not shorten the rail as much as the older flared ends used in the past. It is still preferred to use the MGS MASH Tangent End Terminals in the Interstate median as we could typically have more available space for snow collection as the rail could be further from the edge of the shoulder. This is due to the difference in the embankments necessary for the end terminals.

NHS: If we have a location where guardrail is attached to a structure and only minimum length is needed, the embankment slopes for the End Terminal must be adhered to. If the slopes are not obtainable, extend the guardrail to a place where the embankment can be constructed in accordance with plate 630.87 or 630.89.

NHS: Use only high tension cable guardrail instead of the low tension 3 cable guardrail, when deflection limits allow the use of cable barrier. We use 8' for deflection limits for the high tension cable guardrail as specified in the standard notes in Section B- Grading notes.

NON-NHS: We prefer to use high tension cable guardrail instead of the low tension 3 cable guardrail.

NON-NHS: There will be some instances where we can't update a bridge rail or end block, and the guardrail length needed is longer than 200'. At these situations, we would allow transitioning to 3 cable guardrail and terminate the cable with the slip base anchor. However, our preference would be to transition from the W beam to MGS then use MGS and terminate with the MGS MASH Tangent or MGS MASH Flared End Terminal.

NON-NHS: If we have a location where guardrail is attached to a structure and only minimum length is needed, the embankment slopes for the end terminal should be adhered to. If the slopes are not obtainable, extend the guardrail to a place where the embankment can be constructed in accordance with the appropriate standard plate 630.86, 630.87, 630.88, or 630.89. Another option is to break the 4:1 slope at the clear zone to a steeper slope to fit within the ROW.

HINTS FOR GUARDRAIL LAYOUTS/DESIGN:

Graphically design/layout the guardrail as the equations in Chapter 10 Road Design Manual (*RDM*) will not work as well because the Midwest Guardrail System has splices between posts and the transitions are of different lengths from old transitions.

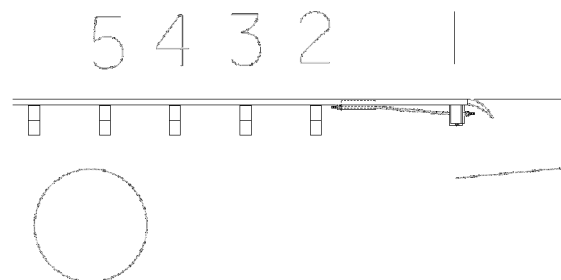
In Chapter 10 of the RDM use the design deflections and flare rates of W Beam Guardrail for the Midwest Guardrail System unless stated otherwise on a standard plate. Use the clear zones and runout lengths as we typically do for our designs. These are also obtained from Chapter 10 of the RDM.

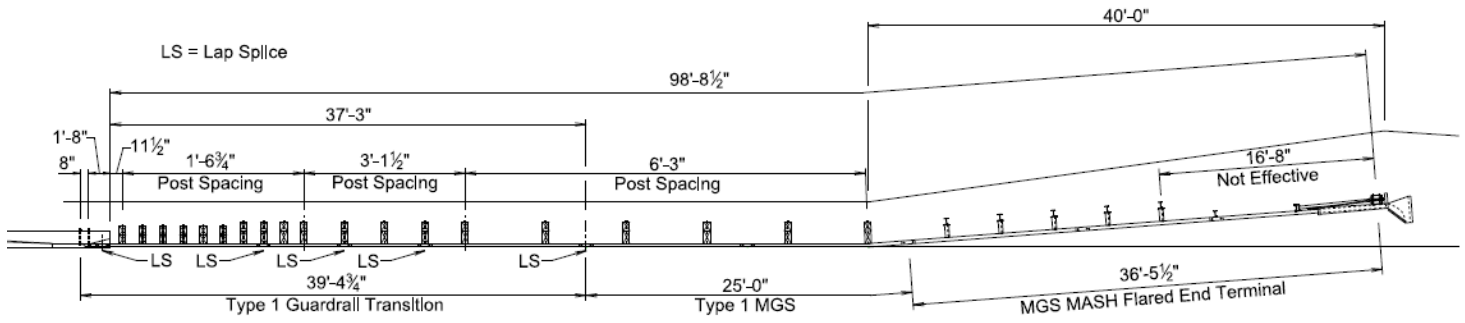
Pay special attention to standard plates 630.87 and 630.89 when drawing/designing MGS in regard to embankment limits and pay limits.

To aid in graphically laying out/designing the guardrail it is recommended to use the Steel Beam Guardrail Cell Library (*Microstation*) for the Steel Beam Guardrail and End Terminal cells. The cell library is available for download at: <https://dot.sd.gov/doing-business/engineering/design-services/downloadable-files>

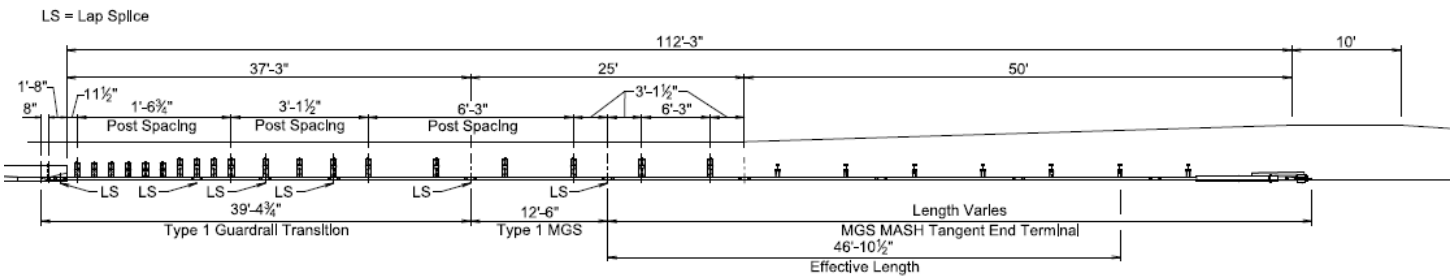
With MGS it is allowed to omit one post and blockout in a run of MGS. It is not allowed in any of the transitions. If the need to omit a post is close to an end terminal, close to a stiffness transition, MGS installed at the breakpoint of a 2:1 slope, MGS adjacent to a curb, certain conditions prevail and Bernie Clocksin should be contacted for a recommendation.

Research indicates that when using trailing end terminals, the 5th post from the end should be placed after the obstacle it is protecting. See example drawing below:





MINIMUM LENGTH OF MGS WITH FLARED END TERMINAL
 (Shown with MFLEAT, MGS MASH Flared End Terminal)
 (MFLEAT Terminal, by Road Systems, Inc., 12" Blocks, drawing name ls MFLT-12)



**MINIMUM LENGTH OF MGS WITH TANGENT END TERMINAL
 AND EFFECTIVE LENGTH OF MGS MASH TANGENT END TERMINAL**
 (The MGS MASH Tangent End Terminal shown is for illustrative purpose only.)

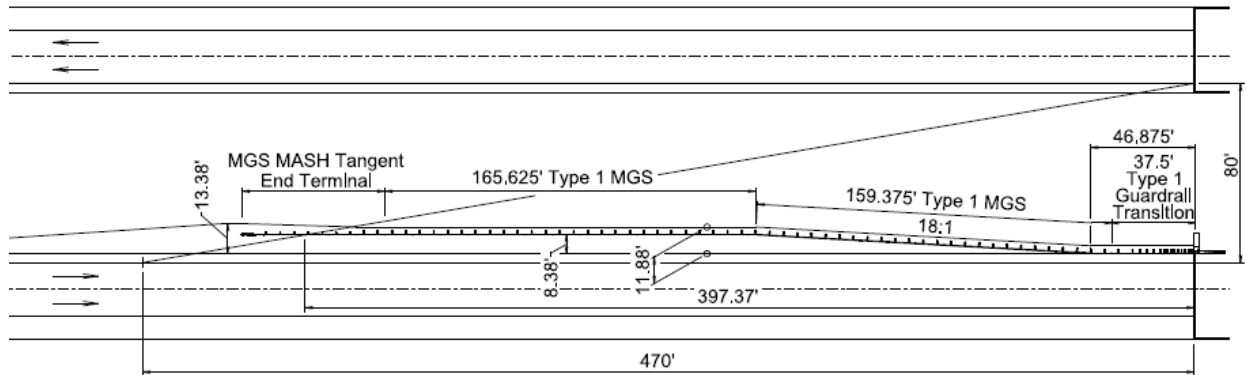
80 MPH

A complete MASH TL-3 crash tested system.

Runout Length = 470'

Length of Need = 397.37'

Flared MGS: 18:1 Flare Rate



EXAMPLE FOR MEDIAN GUARDRAIL DESIGN FOR INTERSTATE

The reasons we are making the current changes to our guardrail designs are to comply with the following agreement document. You will see more changes in the future as we move towards the whole guardrail system meeting the crash test requirements of MASH. Please be as patient as you can be as we continue making changes to our roadside safety appurtences and design guidance.

If you have questions regarding the standards plates or other guardrail issues, please call Bernie Clocksin, Standards Engineer, Office of Project Development at (605) 773-6646.


Thank You.



Memorandum

Subject: **INFORMATION:** AASHTO/FHWA
Joint Implementation Agreement for
Manual for Assessing Safety Hardware
(MASH)

Date: JAN - 7 2016

From: 
Thomas Everett
Director, Office of Program
Administration

In Reply Refer To:
HSST

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/memo111215/) 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

AASHTO. FHWA will continue its role in issuing letters of eligibility of roadside safety hardware for federal-aid reimbursement.

- Agencies are urged to establish a process to replace existing highway safety hardware that has not been successfully tested to NCHRP Report 350 or later criteria.
- Agencies are encouraged to upgrade existing highway safety hardware to comply with the 2016 edition of MASH either when it becomes damaged beyond repair, or when an individual agency's policies require an upgrade to the safety hardware.
- For contracts on the National Highway System with a letting date after the dates below, only safety hardware evaluated using the 2016 edition of MASH criteria will be allowed for new permanent installations and full replacements:
 - December 31, 2017: w-beam barriers and cast-in-place concrete barriers
 - June 30, 2018: w-beam terminals
 - December 31, 2018: cable barriers, cable barrier terminals, and crash cushions
 - December 31, 2019: bridge rails, transitions, all other longitudinal barriers (including portable barriers installed permanently), all other terminals, sign supports, and all other breakaway hardware
- Temporary work zone devices, including portable barriers, manufactured after December 31, 2019, must have been successfully tested to the 2016 edition of MASH. Such devices manufactured on or before this date, and successfully tested to NCHRP Report 350 or the 2009 edition of MASH, may continue to be used throughout their normal service lives.
- Regarding the federal-aid eligibility of highway safety hardware, after December 31, 2016:
 - FHWA will no longer issue eligibility letters for highway safety hardware that has not been successfully crash tested to the 2016 edition of MASH.
 - Modifications of eligible highway safety hardware must utilize criteria in the 2016 edition of MASH for re-evaluation and/or retesting.
 - Non-significant modifications of eligible hardware that have a positive or inconsequential effect on safety performance may continue to be evaluated using finite element analysis.

Flared W-beam Terminals
moved to December 31, 2019

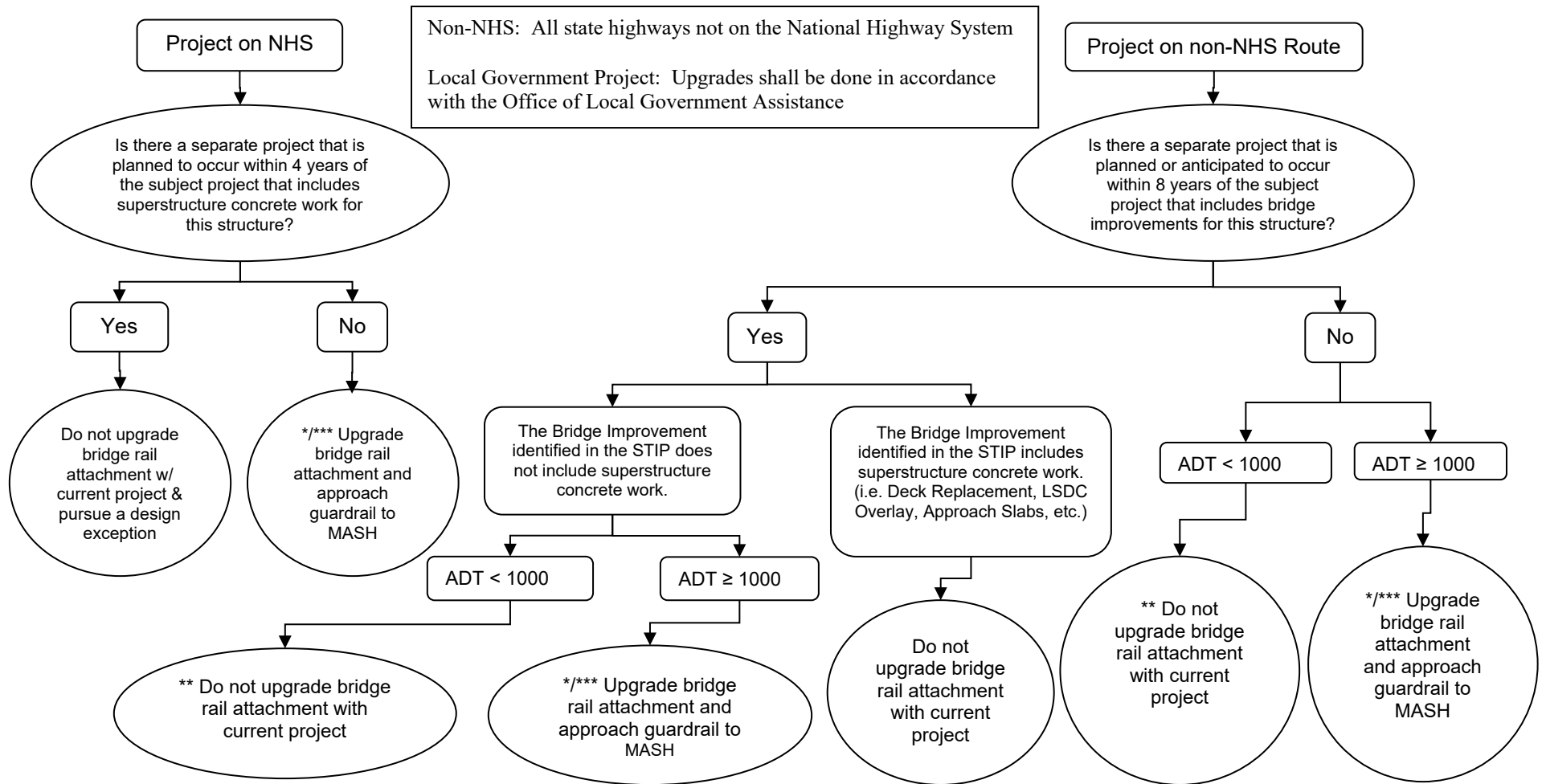
Moved

Division Offices should discuss the MASH implementation agreement with state transportation agency partners and monitor the actions taken and progress towards the dates established in the agreement.

If you have any questions or comments, please contact Brian Fouch in the Office of Safety at (202) 366-0744.

Guidance for Determining Bridge Rail Attachment Upgrades for the following Project Types: AC Resurfacing/Surfacing, Shoulder Widening, and Stand-alone Guardrail

This document has been developed to provide guidance that should be considered as bridge rail attachment upgrades are evaluated. The basis of the information originates from MASH criteria; however engineering judgement was used to give consideration to potential variables, that could be encountered, which are not specifically addressed within published criteria. Each decision may require further site specific analysis and/or engineering judgment.



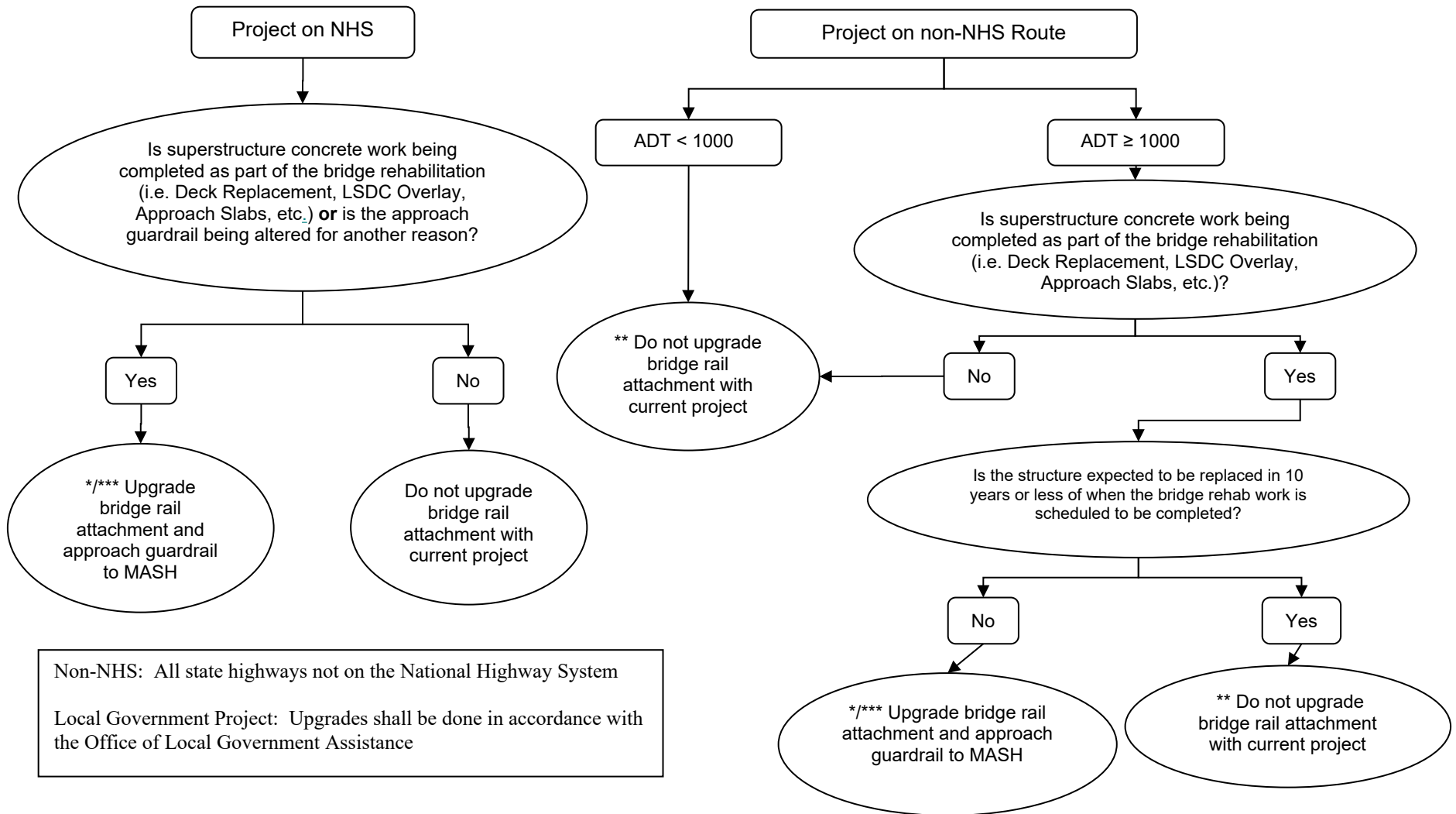
* Verify bridge can accommodate (withstand loading) new concrete bridge rail without requiring deck replacement. If deck replacement and/or other work would be required, consider pursuing a design exception.

** A bridge that currently has W-Beam bridge rail should be evaluated for a possible upgrade to Thrie Beam based on factors such as accident history, age of structure, ADT (near threshold), etc.

***If a concrete end block with Thrie Beam attachment is currently in place, top of guardrail height needs to be checked to ensure it will be within tolerance (31" +/-2"). If not within tolerance, consider a relocated 5 bolt connection location on the existing end block. If a relocated 5 bolt connection location will not work, a new thrie beam end block should be installed. In any case in which the bridge has an existing Thrie Beam attachment and the approach guardrail is less than 6 years old, consider resetting the existing approach guardrail instead of upgrading. For this situation, a design exception, referencing useful life of the existing guardrail system, will be needed if on the NHS.

Guidance for Determining Bridge Rail Attachment Upgrades on Bridge Rehab Projects

This document has been developed to provide guidance that should be considered as bridge rail attachment upgrades are evaluated. The basis of the information originates from MASH criteria; however engineering judgement was used to give consideration to potential variables, that could be encountered, which are not specifically addressed within published criteria. Each decision may require further site specific analysis and/or engineering judgment.



* Verify bridge can accommodate (withstand loading) new concrete bridge rail without requiring deck replacement. If deck replacement and/or other work would be required, consider pursuing a design exception.

** A bridge that currently has W-Beam bridge rail should be evaluated for a possible upgrade to Thrie Beam based on factors such as accident history, age of structure, ADT (near threshold), etc.

***If a concrete end block with Thrie Beam attachment is currently in place, top of guardrail height needs to be checked to ensure it will be within tolerance (31" +/-2"). If not within tolerance, consider a relocated 5 bolt connection location on the existing end block. If a relocated 5 bolt connection location will not work, a new thrie beam end block should be installed. In any case in which the bridge has an existing Thrie Beam attachment and the approach guardrail is less than 6 years old, consider resetting the existing approach guardrail instead of upgrading. For this situation, a design exception, referencing useful life of the guardrail system, will be needed if on the NHS.