

# MASH Implementation of W-Beam Guardrail

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INDOT Standards and Policy



## What Do We Want you to Get From this Session?

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- MGS w-beam guardrail systems are different than w-beam guardrail systems. For design guidance on MGS w-beam guardrail refer to Design Memos 17-10 and 17-17. If you have questions, ask.
- If you need to modify a guardrail system or bridge railing, send your recommendation in for review, [DesignManualInquiries@indot.IN.gov](mailto:DesignManualInquiries@indot.IN.gov)

# Sunsetting from NCHRP 350/MASH 2016

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## Why MGS w-beam system?

The AASHTO **M**anual for **A**ssessing **S**afety **H**ardware (**MASH**) is the new state of the practice for the crash testing of safety hardware devices and INDOT is revising policy to follow the new practice.



# Updates

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The following slides go over several items that have been updated or will be updated soon.



# When to Upgrade Guardrail and End Treatments

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- Similar to most code changes, the implementation to MASH as the current standard for crash testing roadside hardware does not require that all existing guardrail be replaced immediately.
- In addition to the sunset dates for new installations and full replacements, the FHWA-AASHTO Implementation Plan urged State DOTs to establish a process to replace existing highway hardware. The focus being on systems that have not been successfully tested to NCHRP Report 350 or later criteria.
- INDOT encourages looking for opportunities to upgrade.
  - Instead of asking “do I have to upgrade?” consider “is this the opportunity to upgrade?” or, “is it cost effective?”
  - Again, if you have a question, ask.



# When to Upgrade Guardrail and End Treatments

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- **Items to review when considering guardrail upgrade include:**
  - **What system is currently in place?** Is the system NCHRP-350 TL-3 Tested, does it match Standard Drawing Series E601-WBGA? If the blockouts are steel, it is not NCHRP-350 TL-3.
  - **Scope of the project.** 4R, 3R, or Preventative Maintenance (PM)?
  - **Functional classification of the roadway.** Interstates should have a higher priority for upgrading, regardless of project scope.
  - **How much guardrail removal is required,** if any.
  - **Crash history.** Frequent crash locations may benefit (in safety and maintenance) from upgrading.
  - **Traffic Counts.** High traffic volumes are typically associated with higher risk.
  - **Time frame of future work.** If your project is a short term bandage and the entire roadway is being reconstructed 5 years from now, the second project is likely the better opportunity for upgrading. If the guardrail only serves to protect the bridge ends, then the concrete overlay project (even though PM) may be the right opportunity to upgrade.

# When to Upgrade Guardrail and End Treatments

EXISTING GUARDRAIL END TREATMENT (TREATMENTS) <sup>4</sup>			
Work Type	Existing End Treatment Test Type		
	Type I End Treatment	NCHRP-350	MASH
Interstate (All Work Type, except PM)	Replacement Required	D : Replacement Recommended <sup>1</sup> M: Leave in-place <sup>2</sup>	Leave in-place <sup>3</sup>
Interstate (PM)	D : Replacement Recommended <sup>1</sup> M: Leave in-place <sup>2</sup>	D : Replacement Recommended <sup>1</sup> M: Leave in-place <sup>2</sup>	Leave in-place <sup>3</sup>
Non-Interstate (4R)	Replacement Required	D : Replacement Recommended <sup>1</sup> M: Leave in-place <sup>2</sup>	Leave in-place <sup>3</sup>
Non-Interstate (3R)	See Non-Interstate (4R)		
Non-Interstate (Functional or Structural)	See Non-Interstate (4R)		
Non-Interstate (PM)	D : Replacement Recommended <sup>1</sup> M: Leave in-place <sup>2</sup>	D : Replacement Recommended <sup>1</sup> M: Leave in-place <sup>2</sup>	Leave in-place <sup>3</sup>

Superscript numbers will require the designer to check the existing guardrail to be replaced, coordinate with the District to determine the existing condition, etc.

# When to Upgrade Guardrail and End Treatments

Work Type (Preventative Maintenance (PM), 3R, or 4R)	Existing Guardrail Compliance	EXISTING GUARDRAIL ANALYSIS (TREATMENT)			
		Existing Guardrail Run to be Removed <sup>1</sup>			No proposed Removal <sup>3</sup>
		Percent Removed <sup>2</sup>			
		≥50% of the run <sup>3</sup>	<50% of the run but > 200 ft <sup>3</sup>	≤ 200ft <sup>3</sup>	
Interstate (3R and 4R)	Non NCHRP-350	Full Replacement Required	Full Replacement Required	Full Replacement Required	Full Replacement Required
	NCHRP-350	D:Full Replacement M:Partial Replacement <sup>6</sup>	D:Partial Replacement <sup>6</sup> M:Reset Existing <sup>4</sup>	Reset Existing <sup>4</sup>	Leave In-Place <sup>8</sup>
Interstate (PM)	Non NCHRP-350	Full Replacement Required	D:Full Replacement M:Partial Replacement <sup>7</sup>	D:Full Replacement M:Reset Existing <sup>4</sup>	D:Full Replacement M:Leave In-Place <sup>8</sup>
	NCHRP-350	D:Full Replacement M:Partial Replacement <sup>7</sup>	D:Partial Replacement <sup>7</sup> M:Reset Existing <sup>4</sup>	Reset Existing <sup>4</sup>	Leave In-Place <sup>8</sup>
Non-Interstate (4R)	Non NCHRP-350	Full Replacement Required	Full Replacement Required	Full Replacement Required	Full Replacement Required
	NCHRP-350	Full Replacement Required	D:Partial Replacement <sup>6</sup> M:Reset Existing <sup>4</sup>	Reset Existing <sup>4</sup>	Leave In-Place <sup>8</sup>
Non-Interstate (3R)	Non NCHRP-350	Full Replacement Required	D:Full Replacement M:Partial Replacement <sup>5</sup>	D:Full Replacement M:Reset Existing <sup>5</sup>	D:Full Replacement M:Leave In-Place <sup>8</sup>
	NCHRP-350	D:Full Replacement M:Partial Replacement <sup>7</sup>	D:Partial Replacement <sup>7</sup> M:Reset Existing <sup>4</sup>	Reset Existing <sup>4</sup>	Leave In-Place <sup>8</sup>
Non-Interstate (Functional or Structural)	Non NCHRP-350	See Non-Interstate (3R)			D:Full Replacement M:Leave In-Place <sup>8</sup>
	NCHRP-350				Leave In-Place <sup>8</sup>
Non-Interstate (PM)	Non NCHRP-350	See Non-Interstate (3R)			Leave In-Place <sup>8</sup>
	NCHRP-350				Leave In-Place <sup>8</sup>

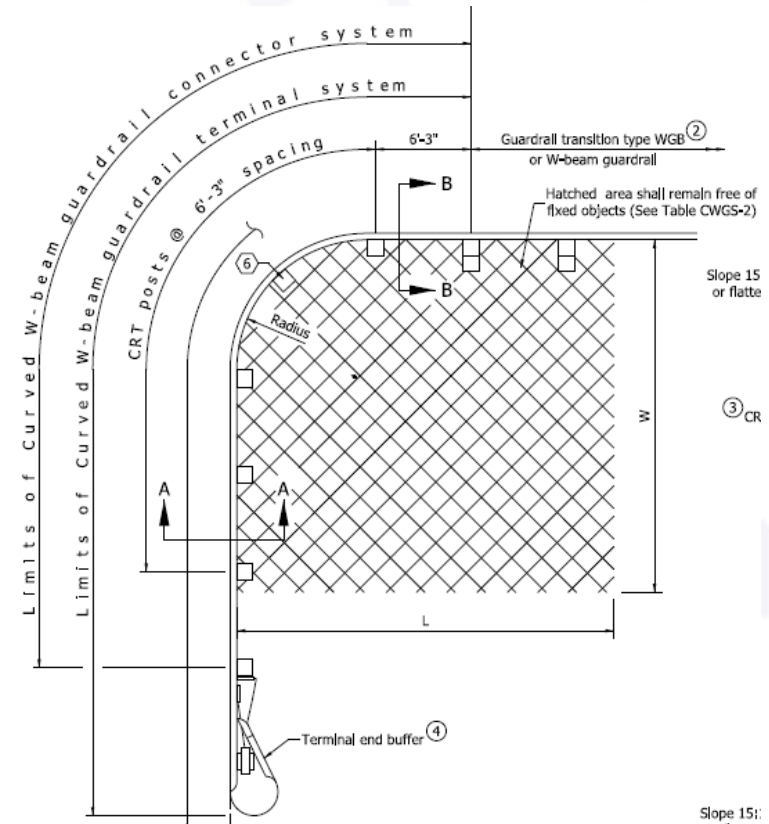
Superscript numbers will require the designer to check the existing rail height, coordinate with the District to determine the existing condition, etc.



# Curved Guardrail System (Std Dwg. 601-CWGS)

- Curved guardrail consists of W-beam and controlled released terminal (CRT) posts
- Currently no MASH-compliant equivalent
- Design Options
  - Transition MGS to W-beam. Use MGS Height Transition and Curved Guardrail System Standard.
  - Where there is limited space, it may be necessary to install NCHRP 350 compliant devices in a quadrant that requires curved w-beam guardrail. Coordination with Standards and Policy is required.

Update: There is currently an active NCHRP Report, NCHRP 15-53, that is working on a curve end treatment with a rail height of 31 inches. The completion date is set for March 2020.



# Driveway or Approach Close to a Bridge Railing

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List is in order of preference:

1. Place a MGS Transition and MSG Height Transition Prior to the Curved Guardrail System (this may included relocating a driveway or approach)
2. Placing a Guardrail Transition Type TGB then a Curved Railing System
3. Placing the Concrete Railing Transition on the Bridge and the use a Guardrail Transition Type TGB then a Curved Railing System
4. Placing an impact attenuator
5. If you have a more challenging location submit an inquiry

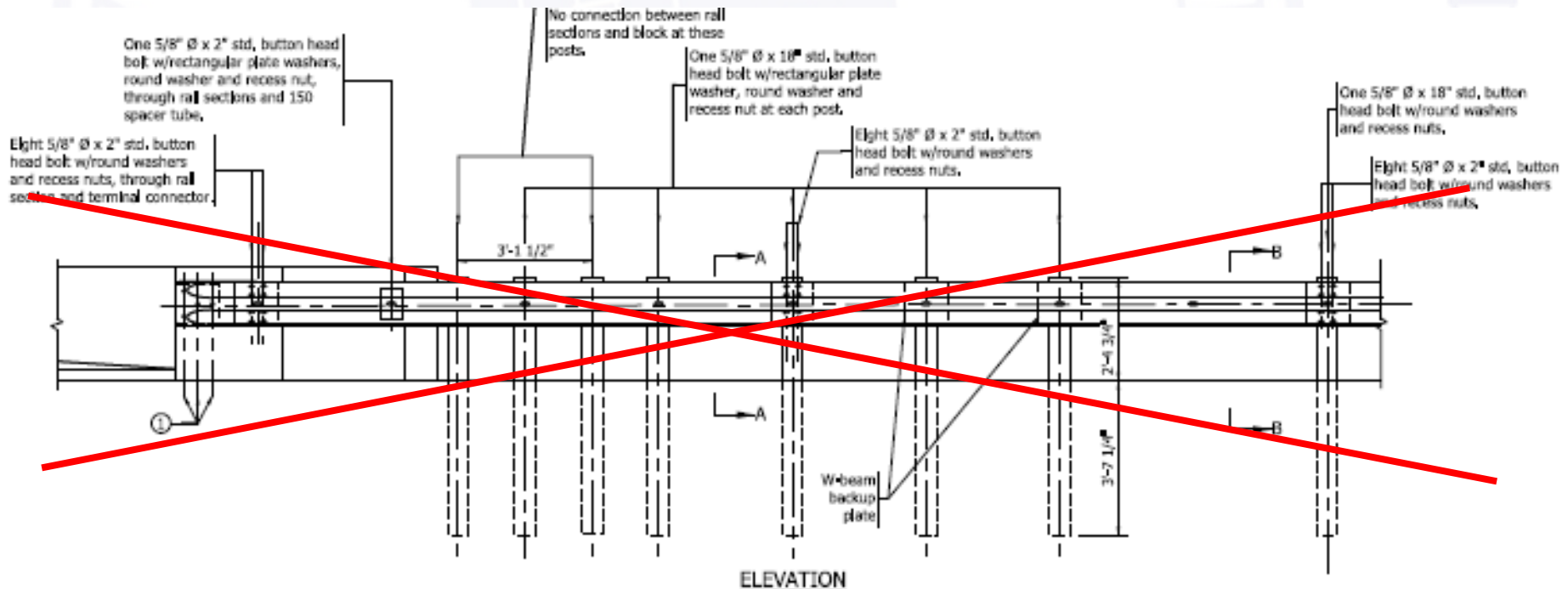
**Remember: Define the hazard you are protecting.**

# Guardrail Transition Type WGB

- The Guardrail Transition WGB should not be used on projects, as of September 1, 2019.
- Standard Drawing E601-TWGB has been **deleted**.

E 601-TWGB

Guardrail Transition Type WGB (del. 09/01/19)



# MGS W-Beam Half-Post and Quarter-Post Spacing

- Index Sheet of Standard Drawing Series E601-RHPG will help you navigate to the correct layout of half-post and quarter-post spacing.
  - Roadway Type
  - Working Width
- The Index Sheet also shows what layouts will use MGS w-beam or w-beam, this is based on the working width.

Treat Undivided Multi-Lane Roadways as Two-Way Roadways.

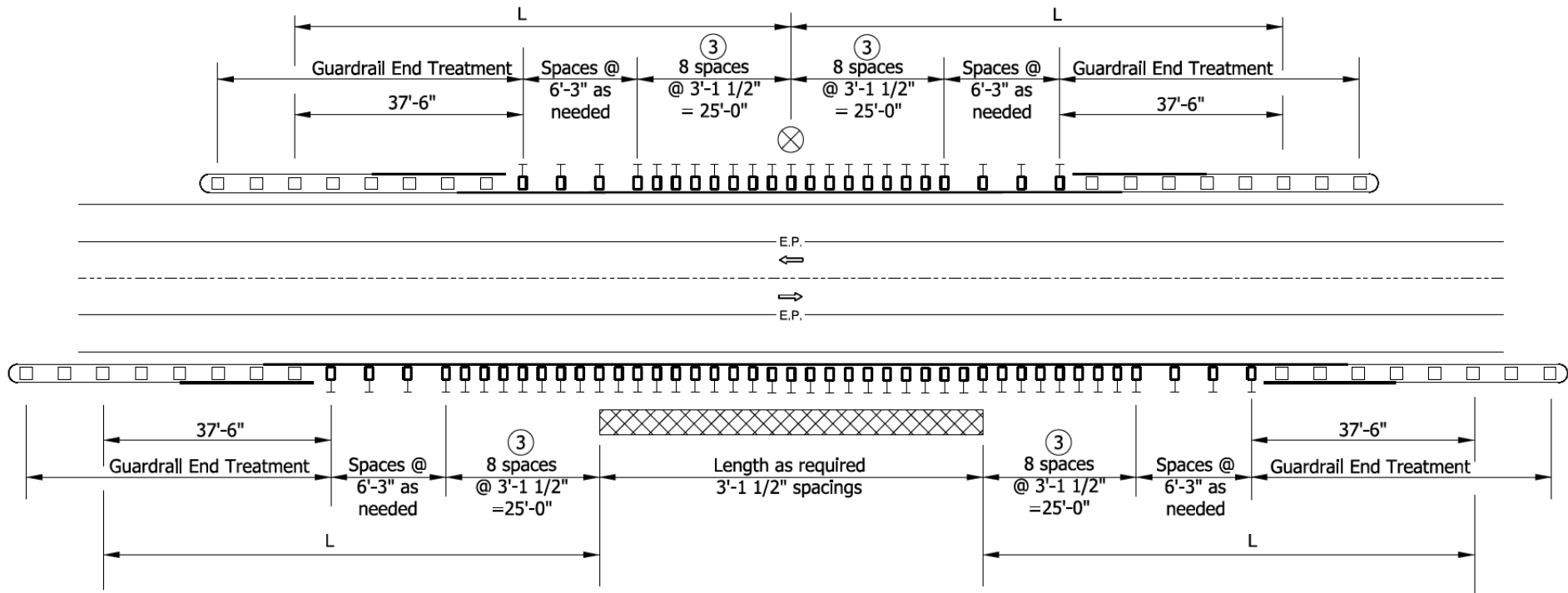
There will be some cases where the working width will be less than 4 ft. W-beam placement may still be required.

INDEX	
SHEET NO.	SUBJECT
1	Roadside Obstruction Protection Guardrail Index and General Notes
2	W-Beam Guardrail, Multi-Lane Divided Roadway, Working Width $\geq 2' - 9"$ and $< 3' - 3"$
3	W-Beam Guardrail, Multi-Lane Divided Roadway, Working Width $\geq 3' - 3"$ and $< 4' - 0"$
4	W-Beam Guardrail, Two-Lane Two-Way Roadway, Working Width $\geq 2' - 9"$ and $< 3' - 3"$
5	W-Beam Guardrail, Two-Lane Two-Way Roadway, Working Width $\geq 3' - 3"$ and $< 4' - 0"$
6	MGS W-Beam Guardrail, Multi-Lane Divided Roadway, Working Width $\geq 4' - 0"$ and $< 4' - 5"$
7	MGS W-Beam Guardrail, Multi-Lane Divided Roadway, Working Width $\geq 4' - 5"$ and $< 5' - 0"$
8	MGS W-Beam Guardrail, Two-Lane Two-Way Roadway, Working Width $\geq 4' - 0"$ and $< 4' - 5"$
9	MGS W-Beam Guardrail, Two-Lane Two-Way Roadway, Working Width $\geq 4' - 5"$ and $< 5' - 0"$

Where possible we still prefer the use of MGS w-beam.

# MGS W-Beam Half-Post and Quarter-Post Spacing

- See Standard Drawing E601-RHPG-09 for placing of MGS w-beam half-post and quarter-post spacing.
  - Place 25 ft of half-post spacing on the approach and departure end of the obstruction. (The departure end would not be required for divided highways)

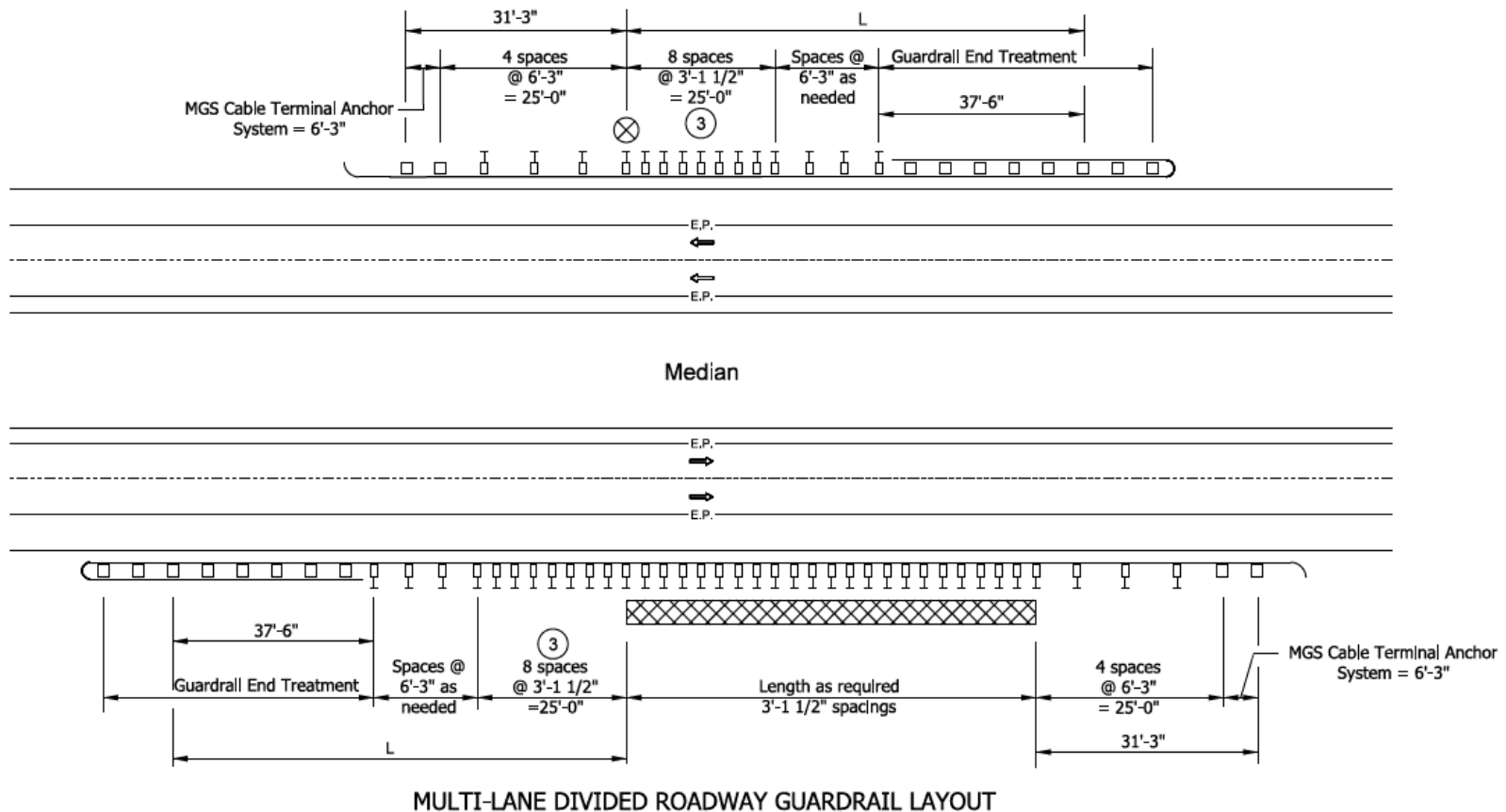


TWO-LANE TWO-WAY ROADWAY GUARDRAIL LAYOUT



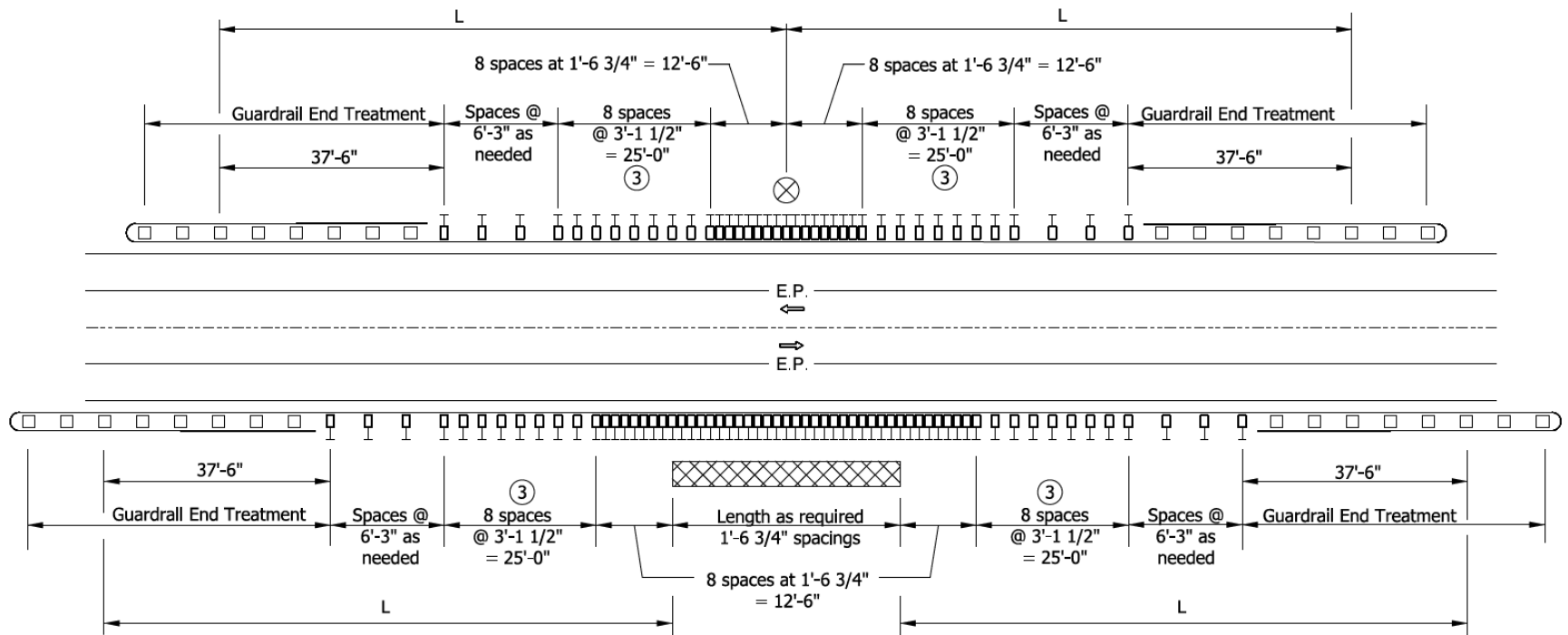
# MGS W-Beam Half-Post and Quarter-Post Spacing

- See Standard Drawing E601-RHPG-09 for placing of MGS w-beam half-post and quarter-post spacing.
  - Place 25 ft of half-post spacing on the approach to the obstruction for divided highways.



# MGS W-Beam Half-Post and Quarter-Post Spacing

- See Standard Drawing E601-RHPG-08 for placing of MGS w-beam half-post and quarter-post spacing.
  - Place 25 ft of half-post spacing on the approach and departure end of quarter-post spacing. (The departure end would not be required for divided highways)
  - Place 12.5 ft of quarter-post spacing on the approach and departure end of the obstruction. (The departure end would not be required for divided highways)



TWO-LANE TWO-WAY ROADWAY GUARDRAIL LAYOUT

# Clear Zone for Roadways with Vertical Curbs

- The clear zone for roadways with vertical curbs should be calculated per IDM 49-2.01 and 49-2.02, designer should not just assume 10 ft.

## ~~49-2.03(03) Roadway with Vertical Curbs~~

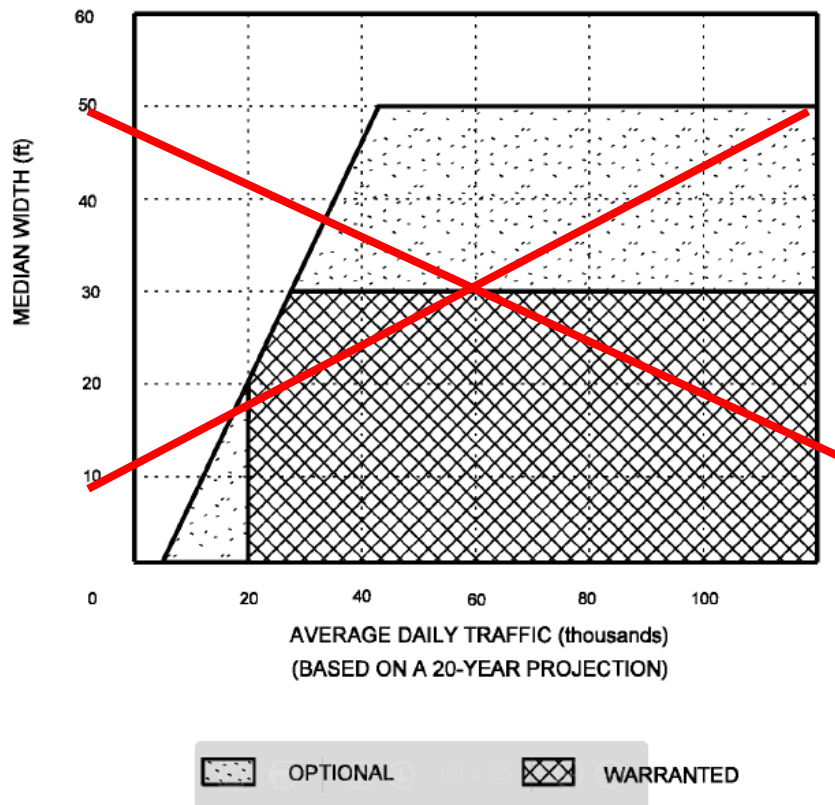
~~For an urban arterial, collector, or local street with vertical curbs at either the edge of the travel lane or the edge of shoulder, the minimum clear-zone width is 10 ft from the edge of the travel lane or to the right-of-way line, whichever is less.~~

- Curbs are not barriers, AASHTO Roadside Design Guide Section 3.4.1
  - Curbs do not have significant redirection capability
  - In restricted project locations obstructions should be located as far from the travelway as practical but in no case closer than the suggested lateral offset.
    - Lateral offset is not equivalent to clear zone
    - Minimum lateral offset distances (face of curb to the obstruction)
      - At an intersection or driveway is 3 ft
      - Anywhere else is 1.5 ft

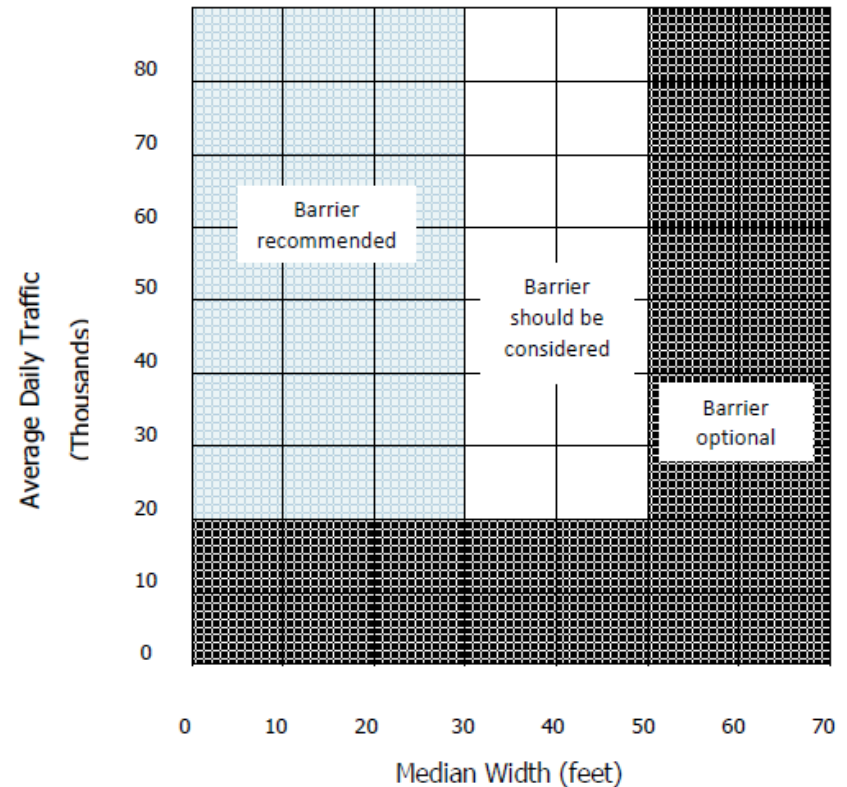
Lateral Offset = Appurtenances Free

# Median Barriers

- Figure 49-6A will be updated to match AASHTO Roadside Design Guide, Figure 6-1



IDM Figure 49-6A



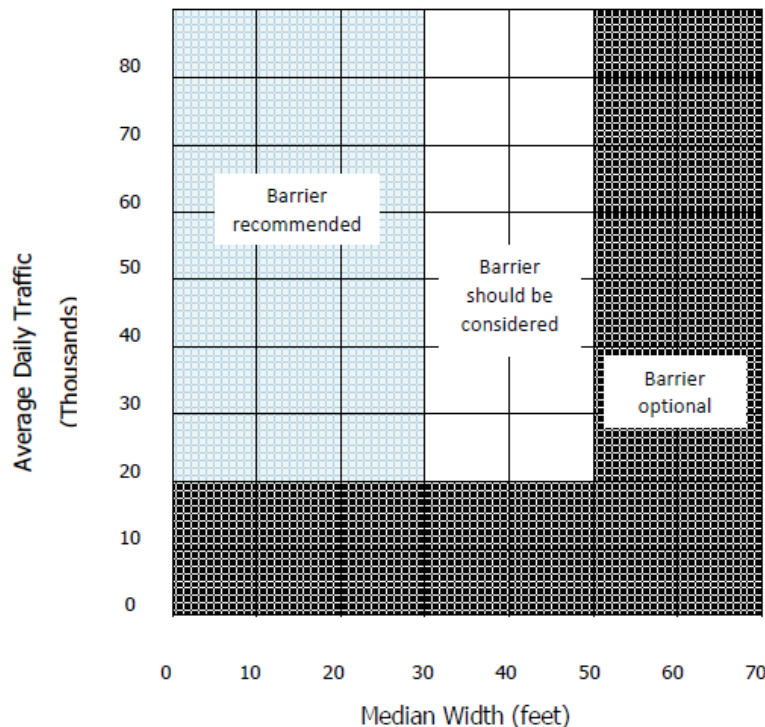
Source: AASHTO Roadside Design Guide, 2011, Figure 6-1

AASHTO Roadside Design Guide, Figure 6-1



# Median Barriers

- AASHTO Roadside Design Guide, Figure 6-1, to determine if roadside safety hardware for medians with a Freeway or Interstate (Full Limited Access) is recommended.
- Double-face MGS w-beam guardrail is MASH TL-3 tested and may be considered for placement within a median where:
  - The median barrier is determined to be “Optional”,
  - The cross section of the ditch is a maximum of 1V:10H, 1V:10H, and
  - The section of Roadway is on a tangent.



INDOT has placed a lot of w-beam along several medians in the last few years, however make sure it is appropriate. Do not place it just because it has been placed in the past.



# Median Barriers

- Where a median ditch is not 1V:10H, 1V:10H, e.g. 1V:9H, 1V:10H or within a horizontal curve, Double-face MGS w-beam guardrail should not be used. Single-face MGS w-beam guardrail should be placed along both sides of the median instead. Or look at closing the median with a concrete barrier.

Given how narrow the median is and the steep backslope behind the guardrail post, INDOT should have considered closing the median in this location. The truck count should have also been considered.



# Median Barriers

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- Where double-face or single-face MGS w-beam guardrail is placed within a median, there are a few ways to address a median bridge pier or other median obstruction:
  - The guardrail could be transitioned to a double-face MGS Transition
    - There is not a standard yet
    - The double-face MGS transition would need to be detailed in the plans
    - Part of the detail should included an epoxy anchor or through bolt option.
    - The concrete barrier may need to be transitioned to accept the double-face MGS transition.
    - The blockouts within the double-face MGS w-beam would need to be transitioned from 8" to 12" blockouts.
    - The existing pier foundation should be checked to ensure all the post can be driven within the MGS transition.

Contact us if you need additional guidance.

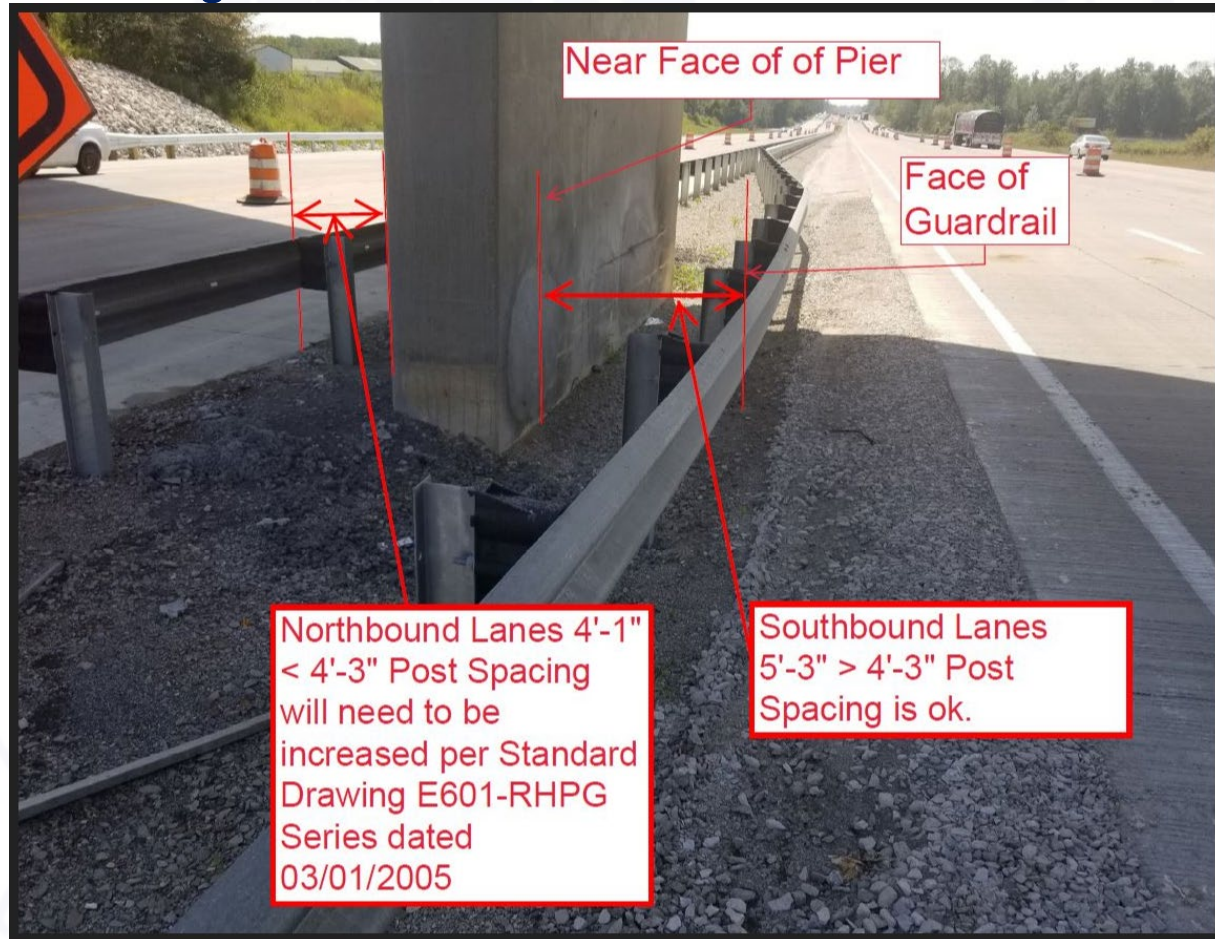
FYI, There was a set of plans where the designer called for the double-face MGS transition to attached to the bridge piers, however, the contractor chose to split the double-face guardrail into single-face guardrail and go around both sides of the pier.



# Median Barriers

- The guardrail could be split and go around the median pier
  - Check your working width
  - Utilize half-post and quarter post spacing as shown in Std. Dwg. Series E601-RHPG where needed
  - Use the correct guardrail flare rate

This may be the better option if an existing pier is being protected.



# Median Barriers

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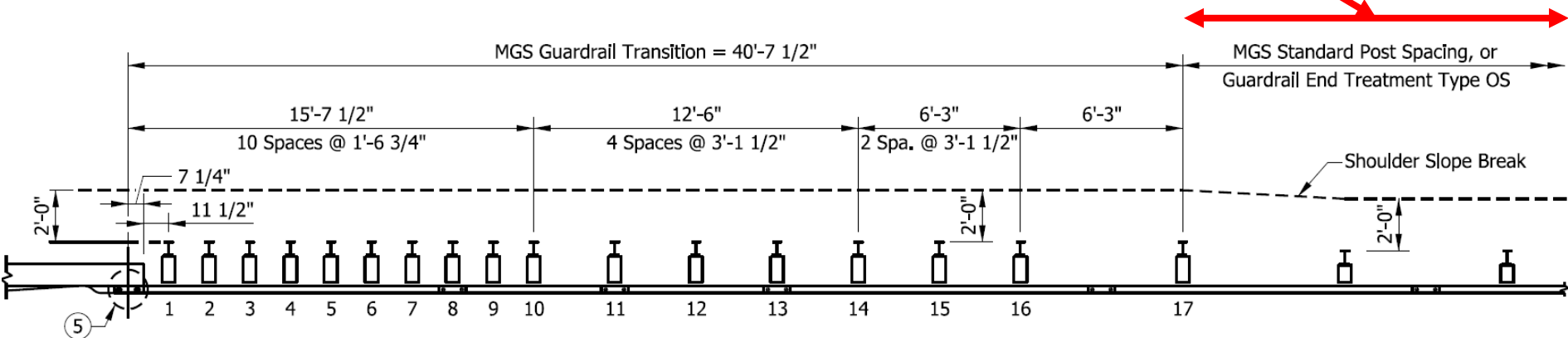
- An additional run of guardrail could be placed.
  - Check your working width
  - Utilize half-post and quarter post spacing as shown in Std. Dwg. Series E601-RHPG where needed



# MGS Transitions and Minimum Guardrail Lengths

- When placing a MGS Transition there is a minimum length of guardrail required in advance or beyond the MGS Transition post 17, 37'-6".
  - An OS end treatment (50 ft assume) meets this criteria.
  - A cable terminal anchor (6'-3"), used beyond a bridge on a divided highway, would not.

Min. MGS W-Beam Guardrail, 37'-6"



Not in the Standard Drawing as of Yet.



# Reminders

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The following slides contain some designer reminders.



# Sunset Dates For 27 ¾" OS End Treatments

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As of June 30, 2018: the 27 ¾" OS End Treatment should not longer be used.

- All MASH approved end treatments have a 31" top rail height.
- If site limitations prevent the placement of both a MGS Height Transition and a 31" OS End Treatment, send in an inquiry for your the project.

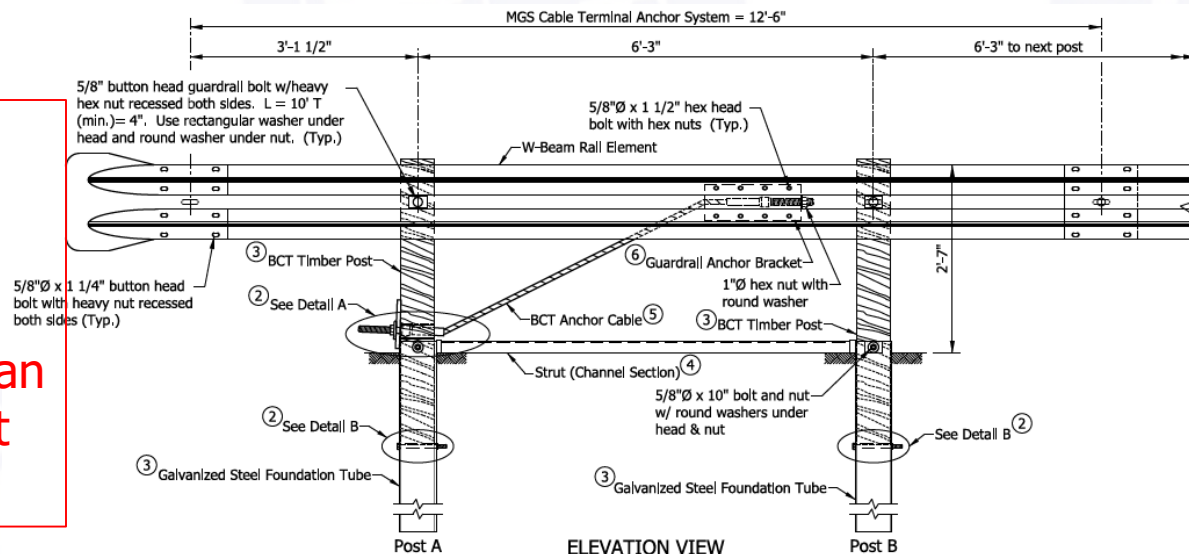
Provide the following with your inquiry:

- Project Des Number
- Construction plans
- Plan details should show the standard guardrail system that will not fit your location and why
- Approach AADT
- Crash history at the intersection

# When to Use a Cable Terminal Anchor System

- A cable terminal anchor system is meant to be used on the outgoing end along a divided highway (a guardrail end that is not exposed to oncoming traffic)
- We do not encourage placement of a cable terminal anchor on a two-way roadway, even where the guardrail terminal is outside of the clear zone for opposing traffic
- A cable terminal anchor system may not be substituted with 25 ft of W-Beam or MGS W-Beam guardrail
- Where cable terminal anchors are placed, consider offsetting the rail at 25:1 away from the roadway
- If you have a location that requires special consideration, you should submit an inquiry

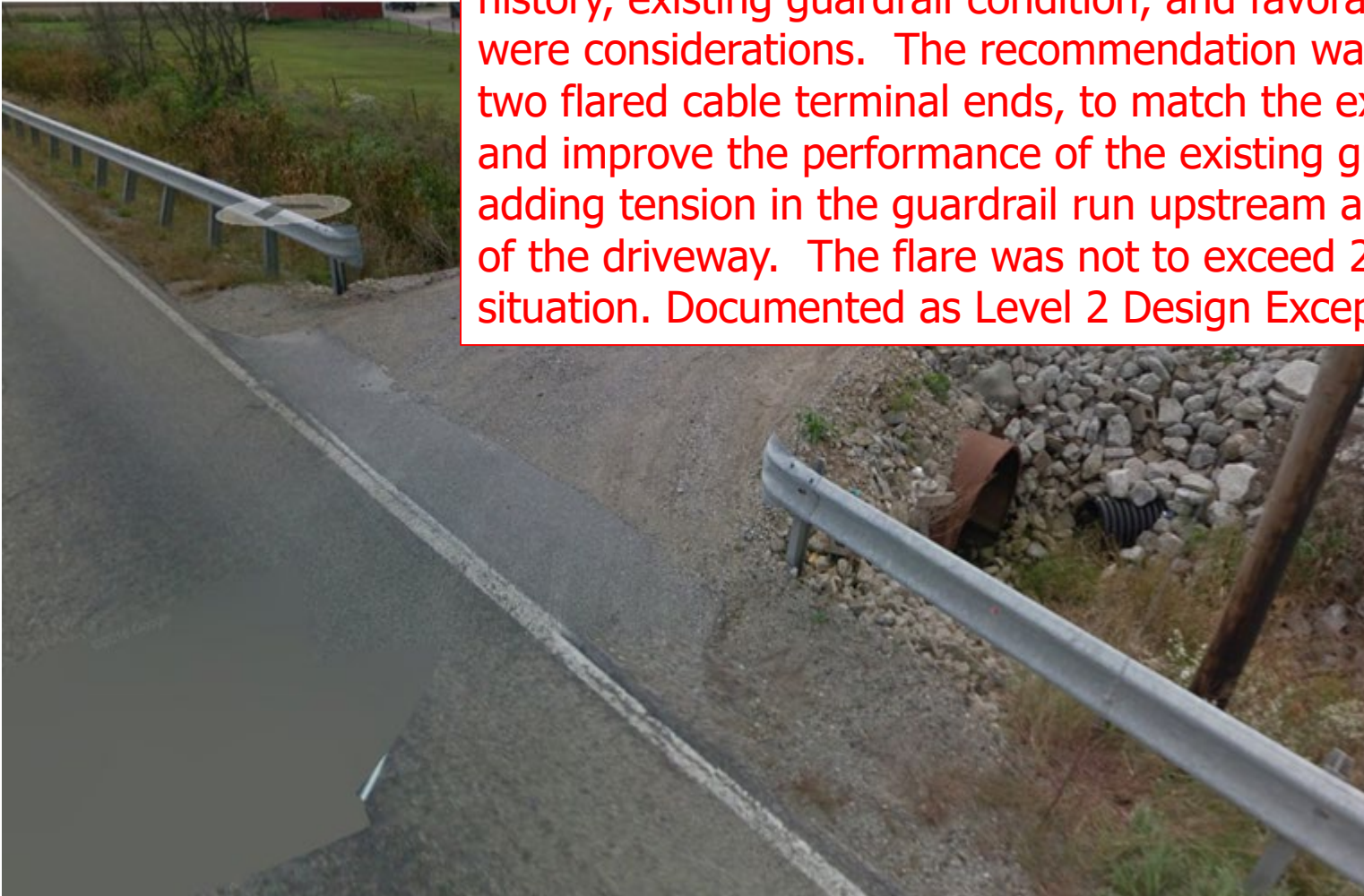
OS End  
Treatments are  
Tangent End  
Treatments,  
however they can  
also be offset at  
a rate of 25:1



# When to Use a Cable Terminal Anchor System

- Example of a location that required special consideration

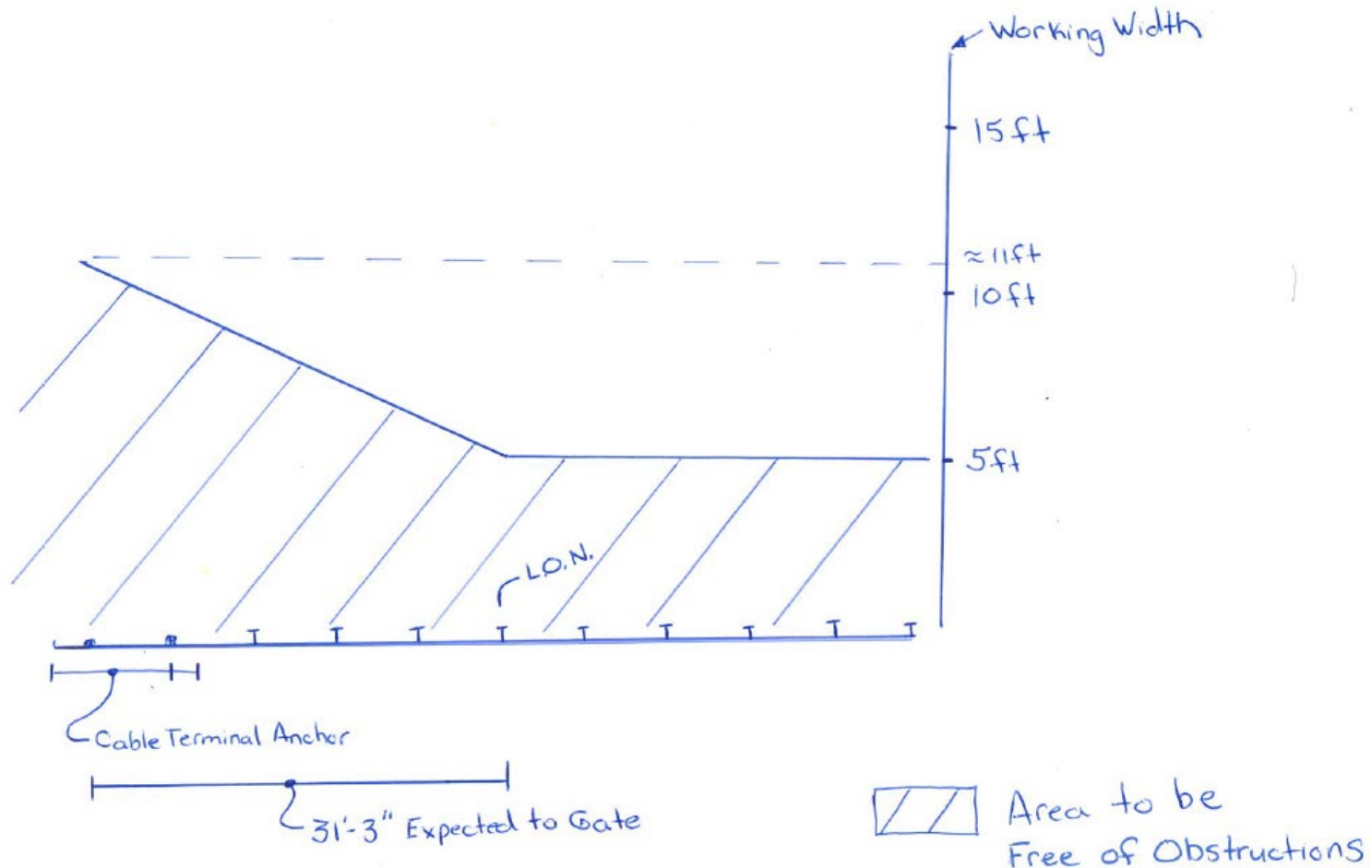
This was a resurface project, no right-of-way acquisition, and existing right-of-way was not much past the EOP. The crash history, existing guardrail condition, and favorable geometrics were considerations. The recommendation was to provide two flared cable terminal ends, to match the existing condition and improve the performance of the existing guardrail by adding tension in the guardrail run upstream and downstream of the driveway. The flare was not to exceed 25:1 for this situation. Documented as Level 2 Design Exception.





# Working Width of the Cable Terminal Anchor

What is the assumed working width when 31'-3" of MGS w-beam guardrail with a cable terminal anchor is placed on a divided highway?





# When to Use a Cable Terminal Anchor System

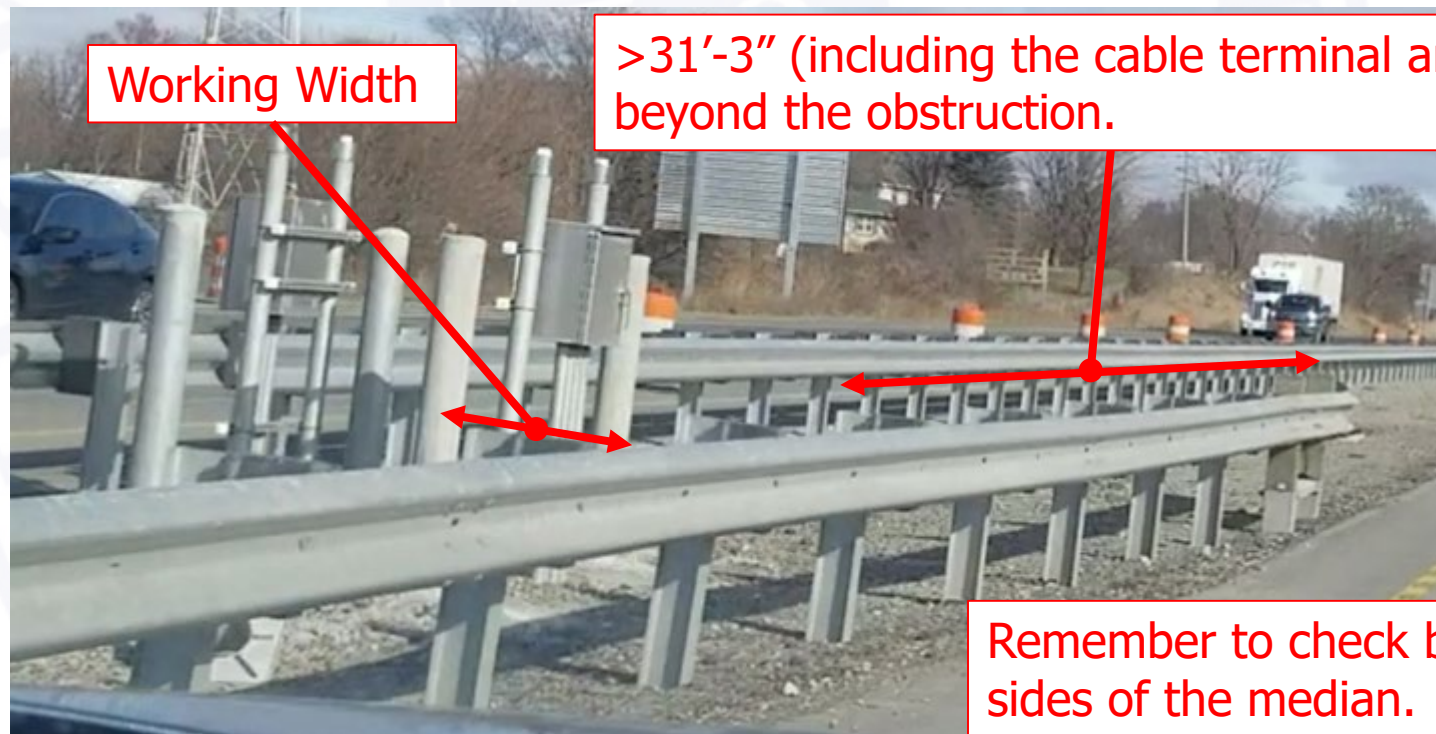
- When placing a cable terminal anchor system extend 31'-3" beyond the length of need. The length of 31'-3" includes the length of the cable terminal anchor. See Design Memo 17-10.



# When to Use a Cable Terminal Anchor System

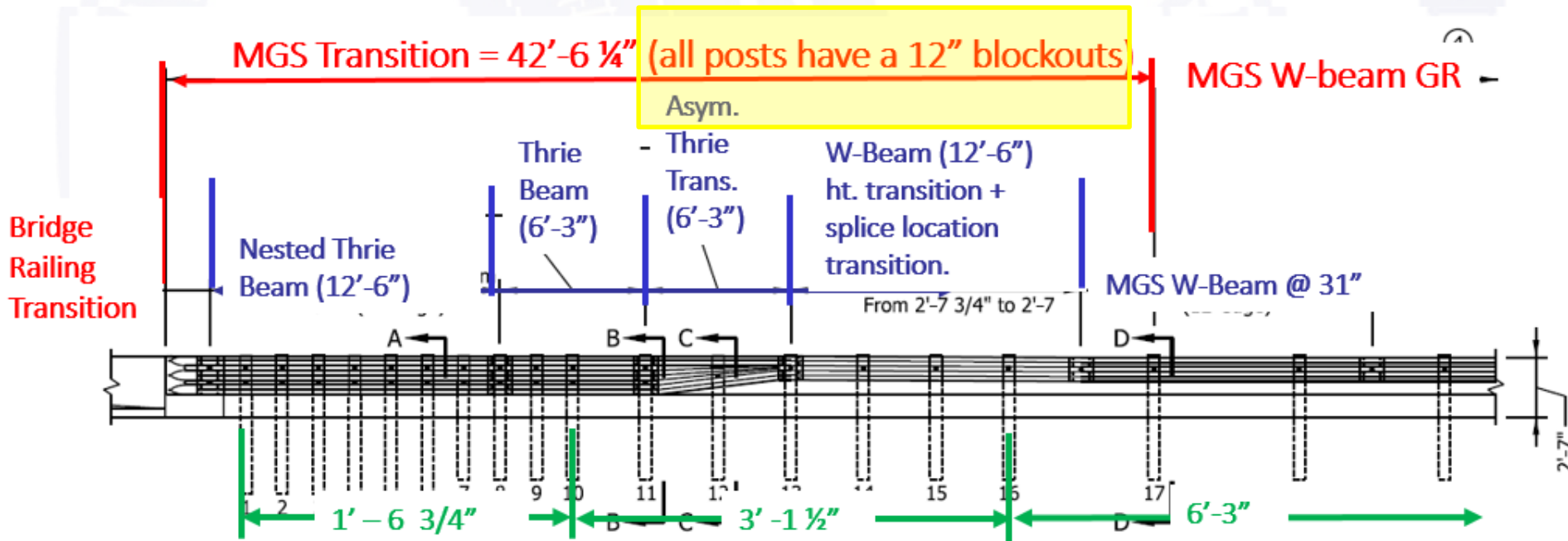
- Other obstructions within the median that may require shielding, if they can not be relocated
  - Remember to taking into account the working width, and
  - The LON beyond the obstruction

It appears the working width is good and the minimum LON has been provided beyond the obstruction, 31'-3" (including the cable terminal anchor). DM 17-10



# Midwest Guardrail System (MGS) Reminders

- The MGS Transition and MGS Long Span require the use of 12-in. deep blockouts.



MGS Transition

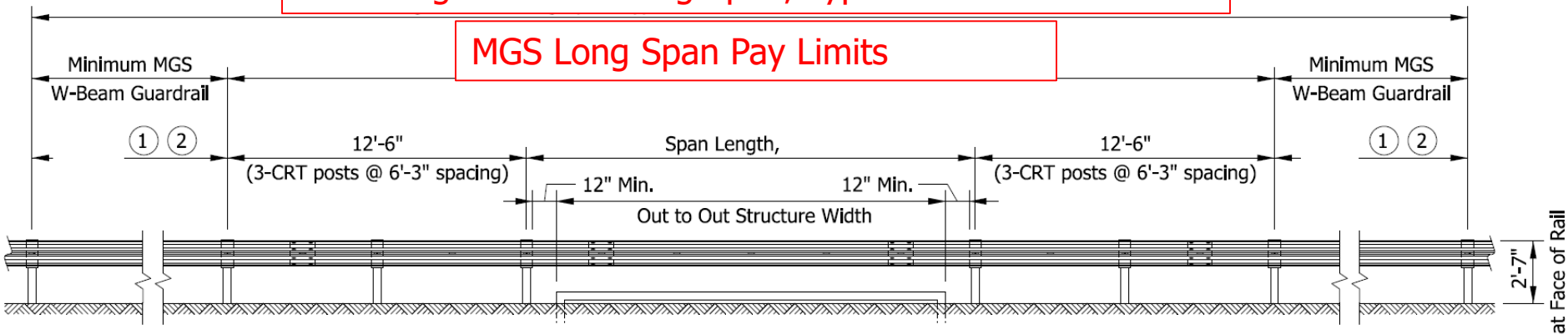


# Midwest Guardrail System (MGS) Reminders

- The MGS Transition and MGS Long Span require the use of 12-in. deep blockouts.

Min. Length of MGS Long Span, Type 1 or 2

MGS Long Span Pay Limits



ELEVATION VIEW

INSTALLATION TYPE 1  
(2 POSTS OMITTED)

FYI: The W-Beam Nested Guardrail System used two 8" blockouts, a total of 16" at each CRT post

Each CRT Post has a 12" blockout

Each CRT Post has a 12" blockout

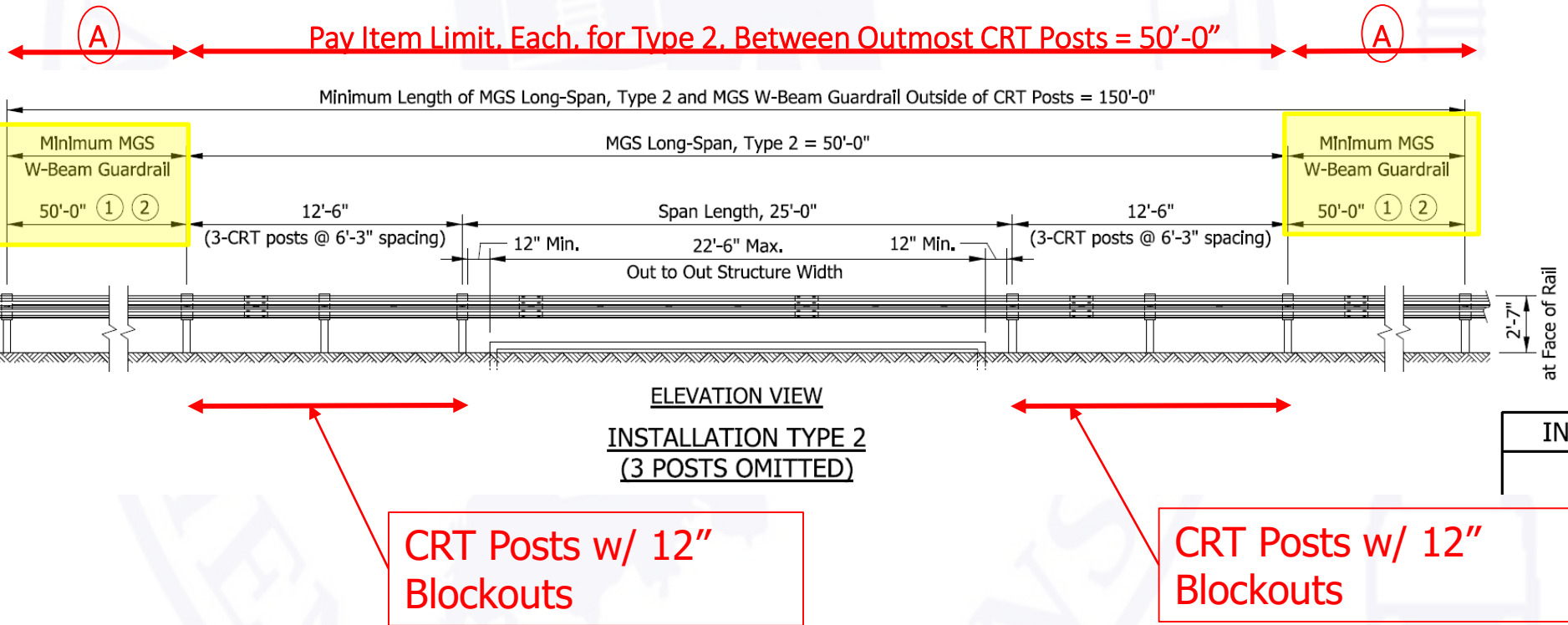
MGS Long Span



# MGS Long Span Pay Items

- Pay Item unit “Each” includes distance between outmost CRT posts
- Additional length required each end.

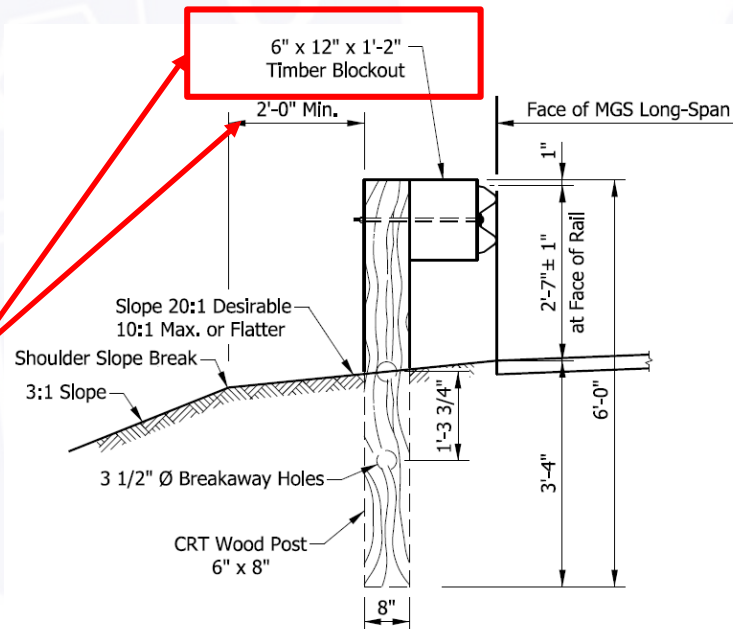
A This length is required upstream and downstream of the outmost CRT post. It may contain, MGS W-Beam Guardrail, MGS Transition, MGS End Treatment, or Terminal End Anchor. These items are paid for separately from the MGS, Long Span, Type 2.



# Midwest Guardrail System (MGS) Reminders

- Provide 2 ft of embankment behind the back of post. Where limitations within the project prevent the 2 ft of embankment from being placed:
  - Standard MGS W-Beam Guardrail (6'-3" post spacing) can eliminate the 2 ft of embankment.
    - File a level two design exception, no inquiry required
    - Do not eliminate just to save right-of-way
  - For all other MGS W-Beam Guardrail Systems, a project specific inquiry will be required. The approved inquiry should be filed with a level two design exception.

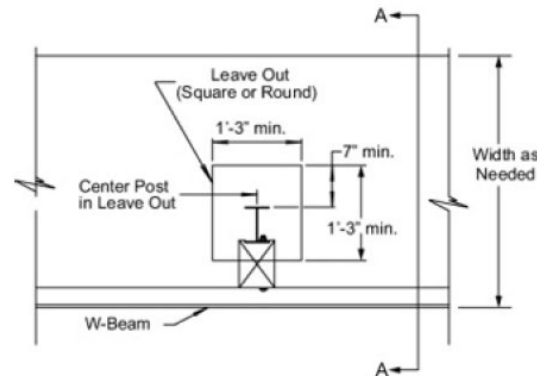
Example MGS Long Span: Make sure to take into account the 12 inch blockout and 2 ft embankment width behind the post when laying out your typical section



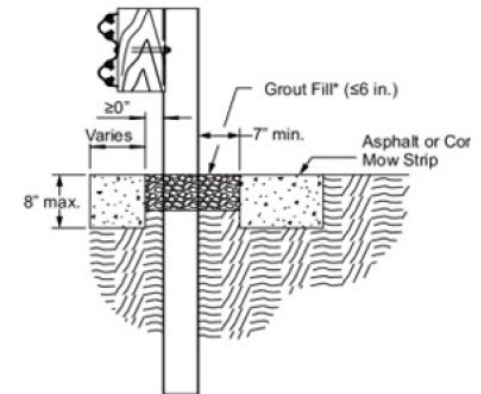
TYPICAL SECTION AT CRT POST

# Do Not Place Posts in HMA or Concrete

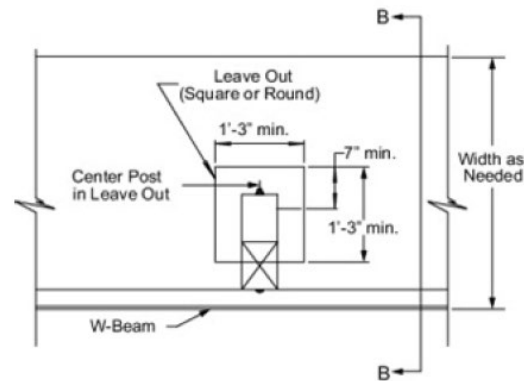
Post should not be encased in HMA or concrete pavement (Standard Drawing E601-MGSA-02, note #5). A leave-out detail and the leave-out locations should be included in the plans. The leave-out detail is a hole (square or circle) in the HMA or Concrete, capped with Structure Backfill Type 4. Structure Backfill Type 4 is removal and has a compressive strength of approximately 120 psi which allows the post to move. Movement of the post allows the system to preform as tested.



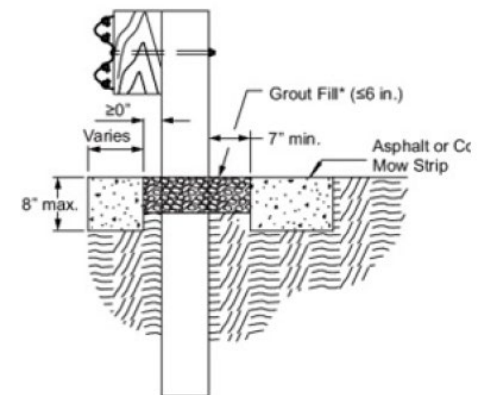
Steel Post Detail



Section A-A



Wood Post Detail



Section B-B

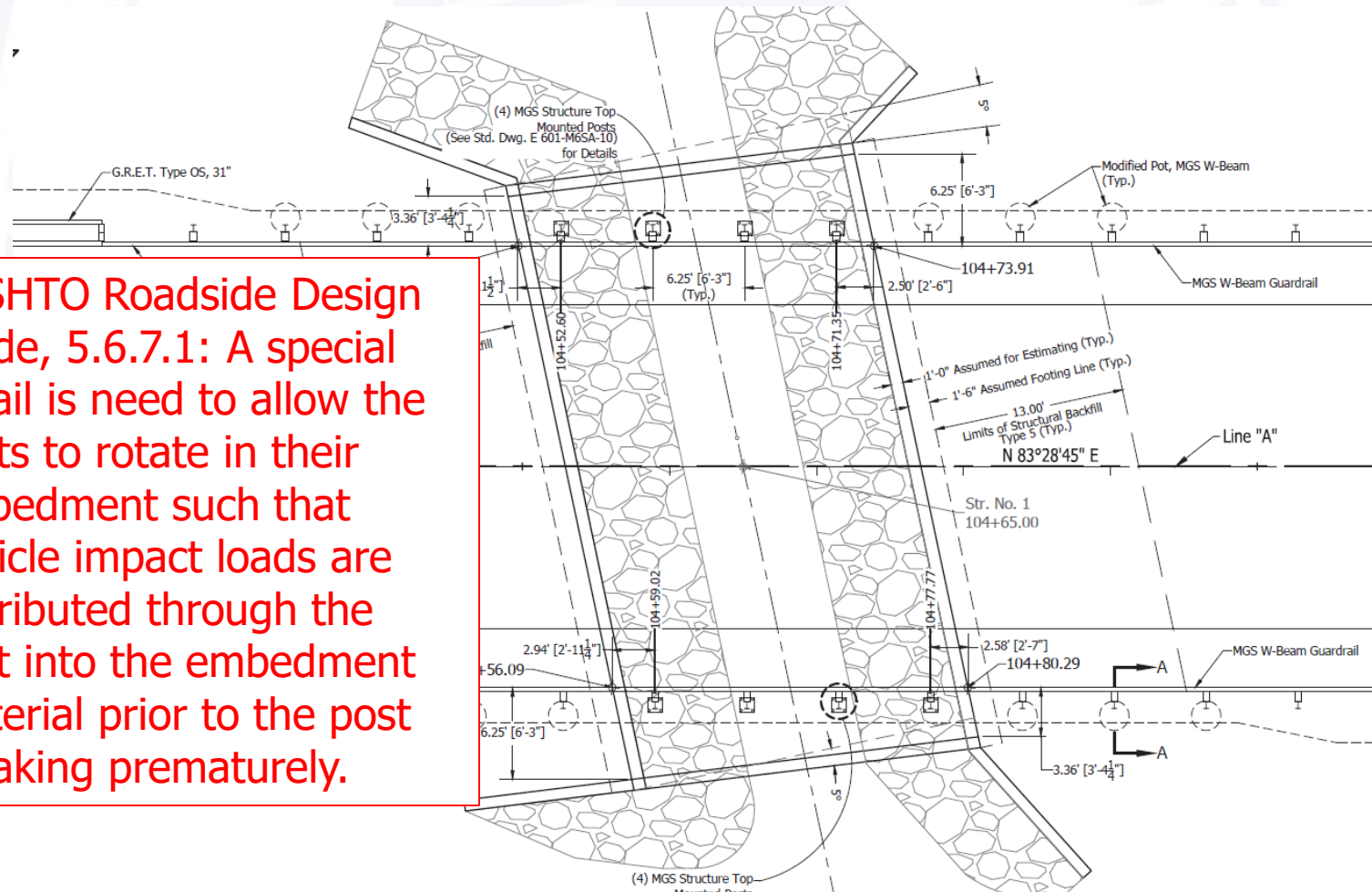
\*Grout fill material has a 28-day compressive strength of 120 psi or less.

AASHTO Roadside Design Guide, 5.6.7.2 and Figure 5-52b

# Do Not Place Posts in Structure Backfill Type 5

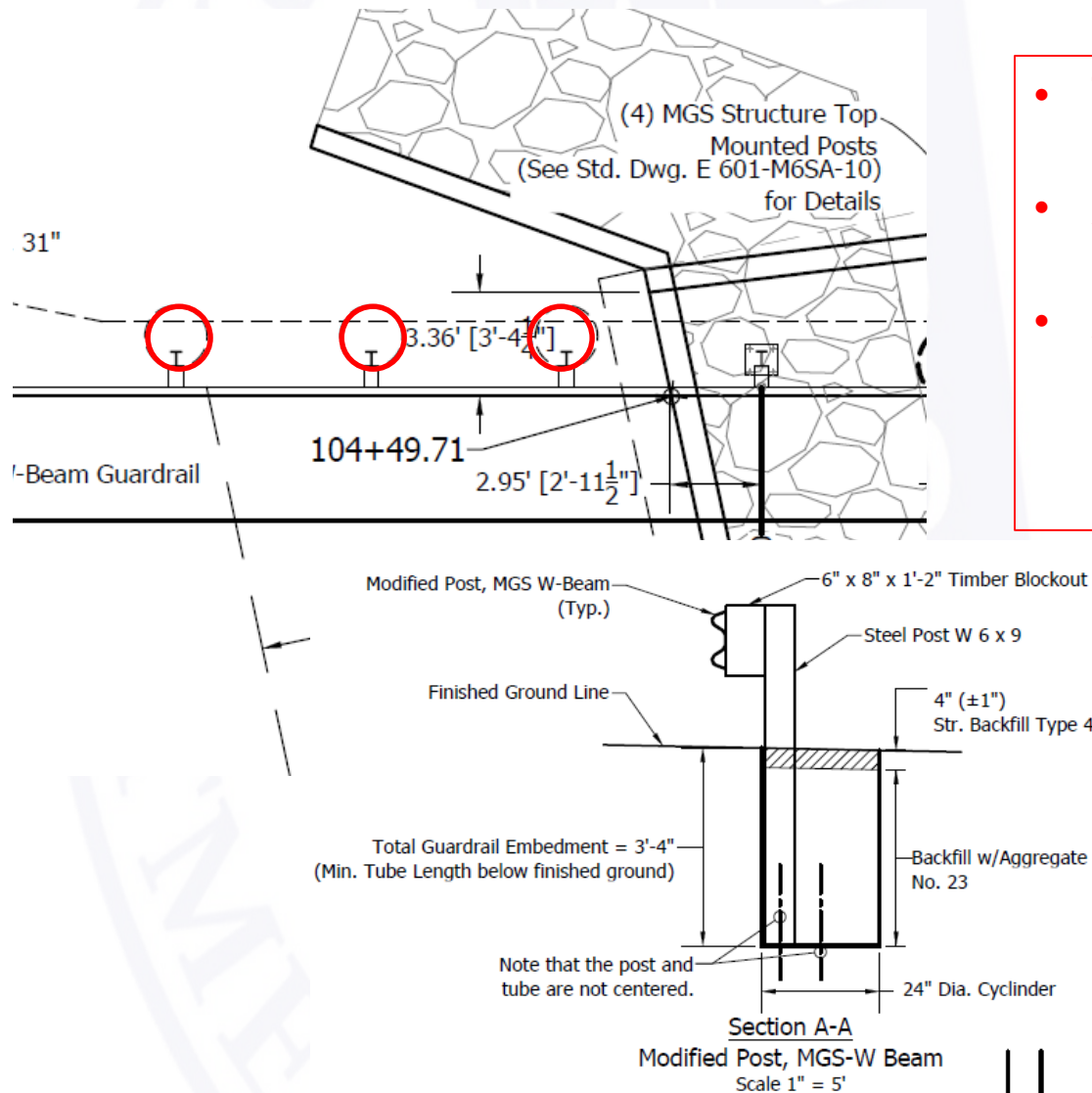
Some times a project may call for structure backfill type 5, if your guardrail posts fall within the limits of the structure backfill type 5 a special detail will be needed. To allow the guardrail posts to rotate.

**AASHTO Roadside Design Guide, 5.6.7.1:** A special detail is need to allow the posts to rotate in their embedment such that vehicle impact loads are distributed through the post into the embedment material prior to the post breaking prematurely.

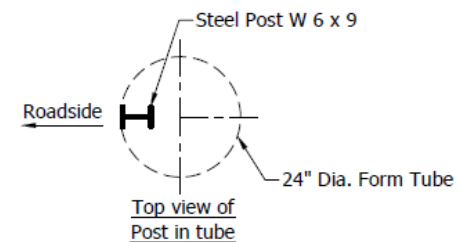




# Do Not Place Posts in Structure Backfill Type 5



- The location of the Modified Posts is shown in the plans
- A detail of the Leave-Out Tubes is detailed in the plans
- A USP is included in the contract to describe the construction requirement ( we have an example when needed)



# Elimination of Guardrail

If a structure is extended beyond the clear zone or slightly farther, keep a visual consistency to best delineate the roadway.

The extended aggregate shoulder was viewed as being part of the roadway.





# Elimination of Guardrail

If a structure is extended beyond the clear zone or slightly farther, to eliminate guardrail, keep visual consistency. Visual consistency is the best way to delineate the roadway.

Adding the grass and object markers better delineates where the driver should proceed. In addition, not visible in the picture, a rumble strip was added for further delineation.





# Elimination of Guardrail



Added grass  
visually directs the  
driver toward the  
roadway.





# Elimination of Guardrail

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Range of Treatments IDM Chapter 46 section 49-3.01(01) for roadside hazards:

- Remove or redesign so that it can be safely traversed
- Relocate outside of the clear zone to a point where it is less likely to be hit
- Make breakaway to reduce impact severity
- Shield with a traffic barrier or impact attenuator
- Delineate if the above treatment are not practical

← Placement of a Barrier, #4

# Guardrail Recommendations Given in 2019

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The following slides will show some guardrail recommendations that our office gave this year. These recommendation were a product of an inquiry.

# Terminating Median Barrier

## Roadway Reconstruction Project Question:

- Median barrier will be removed for a crossover.
- Once the crossover is removed, can we replace the guardrail by placing a double-face cable terminal anchor?

The answer was, No.

- The cable terminal anchor has not been crash tested for a double-face application. It is thought that both rail faces would need to be anchored.
- The anchor system could gate 6 posts from the end of the anchor allow a vehicle to cross into head on traffic or hit the blunt end of the existing concrete barrier.



# Terminating Median Barrier

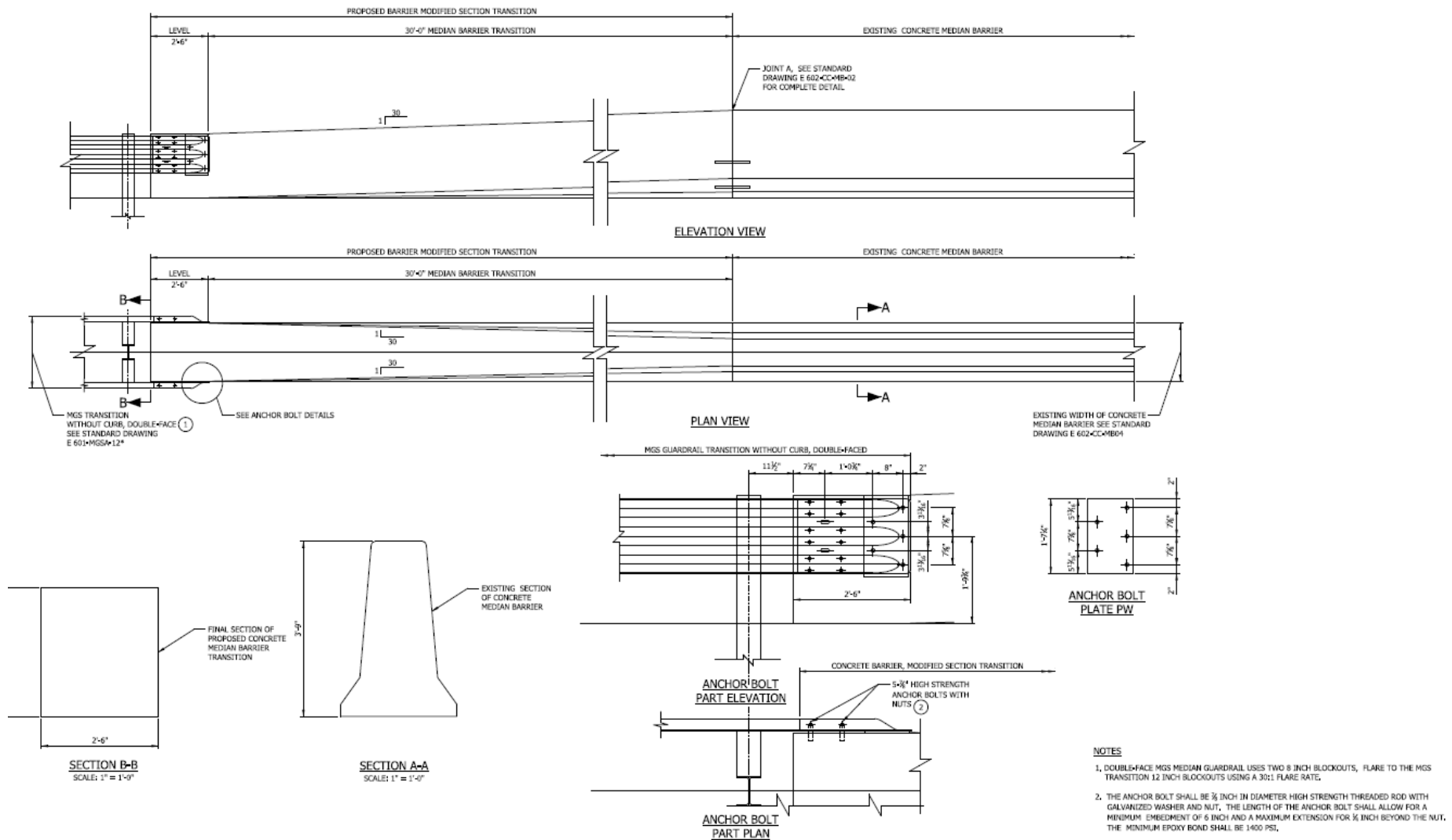
The guardrail recommendation:

- Attached double-face MGS w-beam guardrail to the concrete median barrier.
  - Use double-face MGS transition
  - Transition concrete barrier to match the width of the double-face MGS transition (2-12" blockouts).
  - Use anchor bolts to attached double-face transition. (If needed to offset the anchor bolts by 6'-3" so they do not conflict.)
- Use 12" blockout for double-face MGS w-beam guardrail.
- Connect double-face MGS transition to the existing pier at the opposite end.



# Terminating Median Barrier

Final detail that was used:



# Adjust the Rail Height for 36,208 ft of Guardrail?

Preventative Maintenance Project called for the 36,208 ft of guardrail height adjustment.

- The question was, is this really needed?

## Project Information Gathered:

- The average height of the existing guardrail was 27". There were 9 locations scattered though out that length that measure below 27", the lowest measurement being 26.4".
- The proposed overlay would not raise the existing grade.
- The existing guardrail has steel blockouts, some had the extra holes needed to raise the rail 3".
- The existing guardrail does not have rubrail.
- There are some damaged locations within the guardrail runs.
- The roadway is relatively tangent.



# Adjust the Rail Height for 36,208 ft of Guardrail?

## Final Guardrail Recommendation:

- Do not adjust the guardrail height because:
  - According to FAQ document by FHWA, the top rail height can be as low as 26.5 inches.
  - According to FAQ document by FHWA, when the 30 inch maximum rail height is exceeded for w-beam guardrail it becomes a different system. It was not recommended to exceed a 30" top rail height for w-beam guardrail.
  - One supplier noted if the guardrail is 10 to 15 years old it may be difficult to remove the bolts and if some of the blockouts do not have the predrilled holes, that would increase time and cost.



**Make informed decisions  
and document your  
reasons for those  
decisions.**



# Should All the Guardrail Be Replaced

## District Intersection Improvement Project (Turning Radii Improvement)

- The existing guardrail is w-beam guardrail, NCHRP-350 TL-3
- The existing guardrail extends well past the guardrail limits along the mainline roadway.

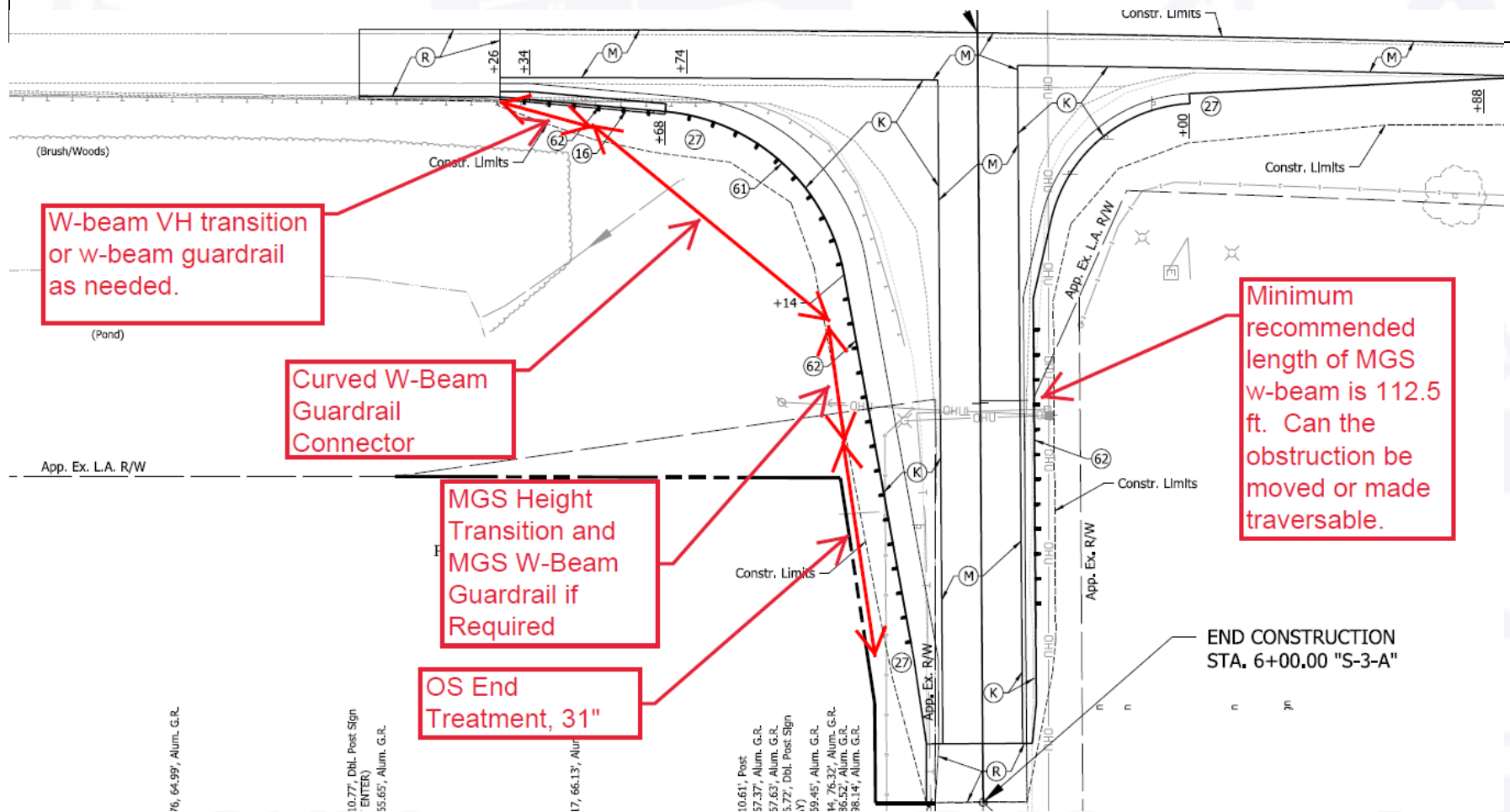




# Should All the Guardrail Be Replaced

The existing guardrail could remain in place along the mainline because the guardrail is NCHRP-350 tested and this marginally passed MASH TL-3 Criteria.

The guardrail recommendation given is summarized below:



# Should the Impact Attenuator be Reset

Pavement Reconstruction Project, 4R Non-Freeway, the Impact Attenuators were not going to be disturbed.



# Should the Impact Attenuator be Replaced

Pavement Reconstruction Project, 4R Non-Freeway, the Impact Attenuators were not going to be disturbed.

**Desirable:** the units should be upgraded to the current standard.

**Minimum:** If the unit is NCHRP-350 TL-3 tested and does not need to be removed, the system could remain in place if INDOT Maintenance Management verifies the system is still supported by the manufacture.

For this project we confirmed with INDOT Maintenance Management that the existing impact attenuators are:

- G.R.E.A.T systems, NCHRP-230 TL-3 tested (the standard prior to NCHRP-350) and
- This system is longer supported by the manufacture.

The final recommendation was to upgrade the impact attenuators to the current standard.





# Example of Replacing End Treatments

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Scope: HMA Preventative Maintenance Project that included Replacement of the Type 1 End Treatments



# Example of Replacing End Treatments

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Scope: HMA Preventative Maintenance Project that included Replacement of the Type 1 End Treatments

# Example of Replacing End Treatments

Scope: HMA Preventative Maintenance Project that included Replacement of the Type 1 End Treatments (District was being pro-active)

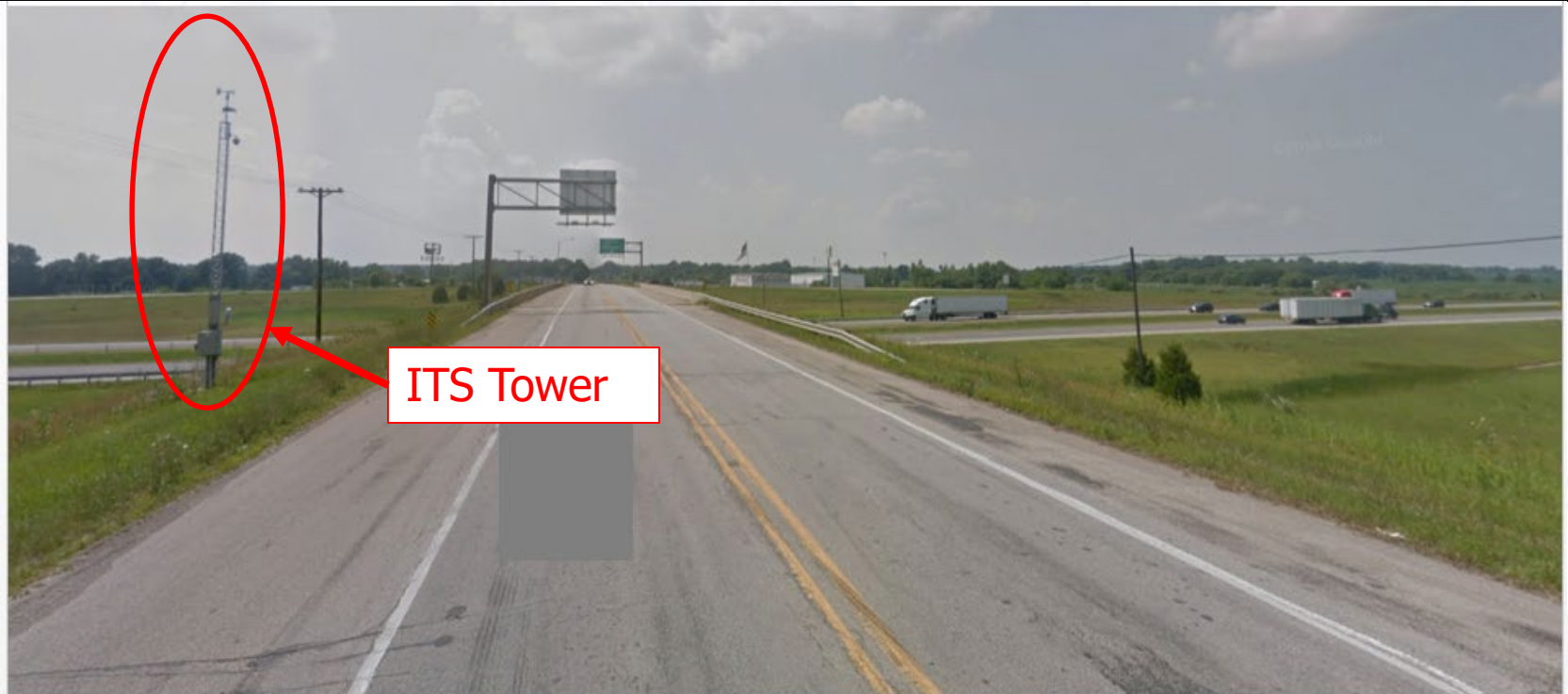
Recommendation for replacing the type 1 end treatments:

- Check the existing guardrail top rail height is not less than 27"
  - If the top rail height will be less than 27", it may be the appropriate time to:
    - check the length of need and
    - upgrade all the guardrail.
  - If the top rail height will be 27" or greater
    - Check the length of need
      - Add guardrail if required,
      - Remove existing guardrail for MGS height transition.
    - Two quadrants have thrie beam guardrail past the cantilevered sign structures:
      - Check the top rail height of the existing thrie-beam.
      - Determine if a thrie-beam to w-beam transition is needed.
      - Modify the MGS height transition as needed.
- Check the grading in the area of the proposed OS End Treatment, the grading should follow Standard Drawing E601-GRET-06.

# Example of Replacing End Treatments

Some additional items that were addressed:

- The proposed guardrail extended past the ITS tower, we contacted the INDOT division to make sure this was ok.
- The guardrail deflection was checked at the cantilever sign structures.
- OS end treatments were proposed in all four quadrants because:
  - This is a two-lane roadway
  - The interchanges north and south of the this interchange used OS end treatments in all four quadrants.





# Example of When Guardrail May Not be Needed

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# Example of When Guardrail May Not be Needed

The existing culvert had already been extended to the one side. The runout area is very flat. Why introduce guardrail?



# Example of When Guardrail May Not be Needed

Range of Treatments IDM Chapter 46 section 49-3.01(01) for roadside hazards:

- Remove or redesign so that it can be safely traversed
- Relocate outside of the clear zone to a point where it is less likely to be hit
- Make breakaway to reduce impact severity
- Shield with a traffic barrier or impact attenuator
- Delineate if the above treatment are not practical

← Placement of a Barrier, #4

# Example of When Guardrail May Not be Needed

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Items to Consider for Maintaining the Extended Structure without Guardrail Protection:

- What needs to be protected on this project? (Concentrate on the side without existing guardrail)
  - The culvert end does not need to be shielded because:
    - The culvert can daylight outside of the Clear Zone
    - The grading prior to, over, and past the culvert are relatively flat (10:1 or less) or the ditch is traversable. The grading provides room for recovery.
    - The crash history does not lead the designer to protect the culvert end outside of the clear zone.

# Example of When Guardrail May Not be Needed

## Items to Consider for Maintaining the Extended Structure without Guardrail Protection (Cont'):

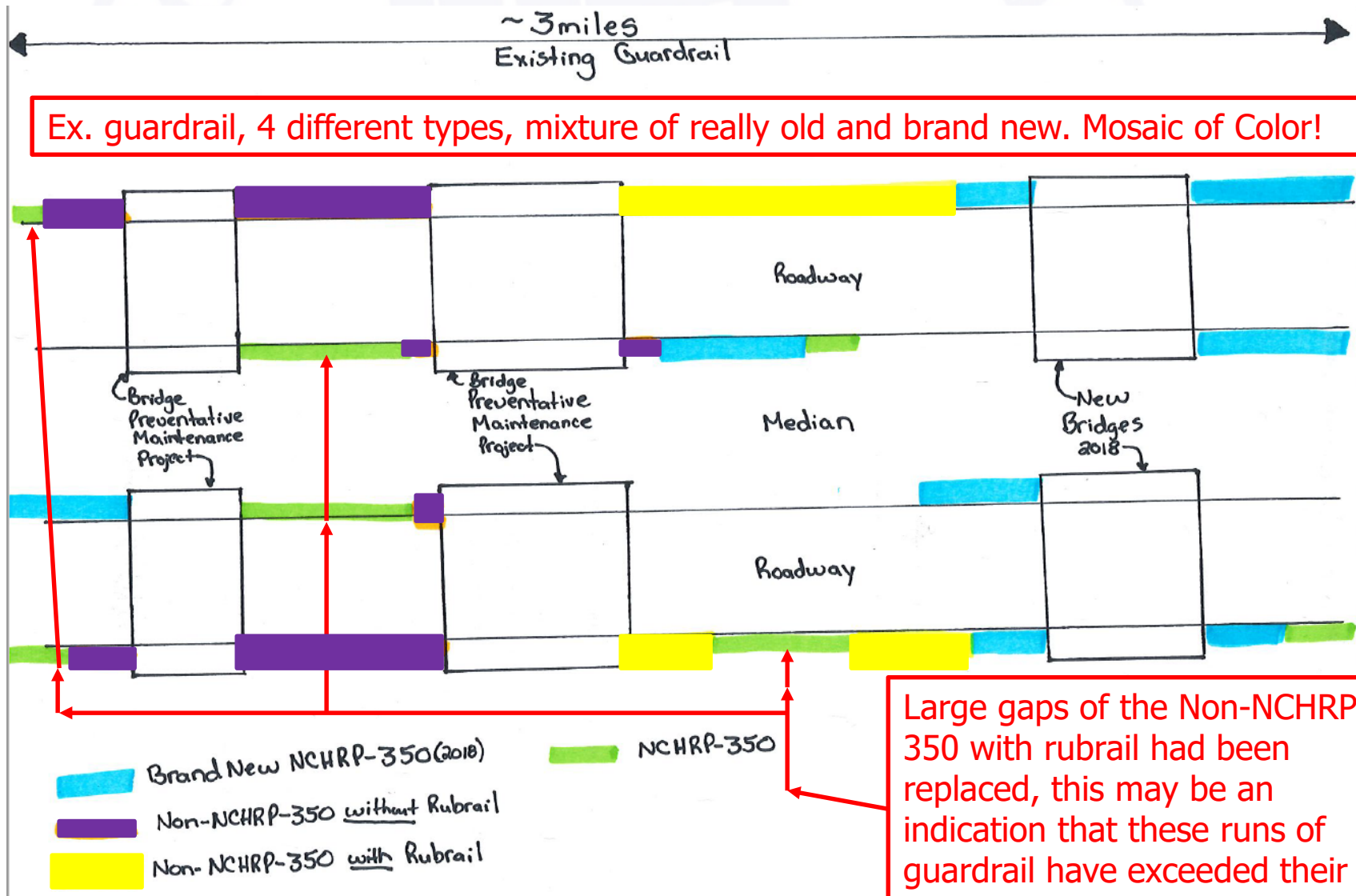
- What needs to be protected on this project? (Concentrate on the side without existing guardrail)
  - The utility pole is inside the Clear Zone but may not need to be shielded because:
    - The utility pole is in a long line of utility poles that parallel the roadway unshielded by a barrier.
    - The utility pole adjacent the culvert is not closer to the roadway than the other poles paralleling the road.
    - The utility pole does not appear to have been struck in the past.

Recommendation would be to extend the culvert end out past the clear zone, keeping the approximate existing side slope for recovery, and not place guardrail on that side of the roadway. Adding a run of guardrail may be more of a hazard than the utility pole.



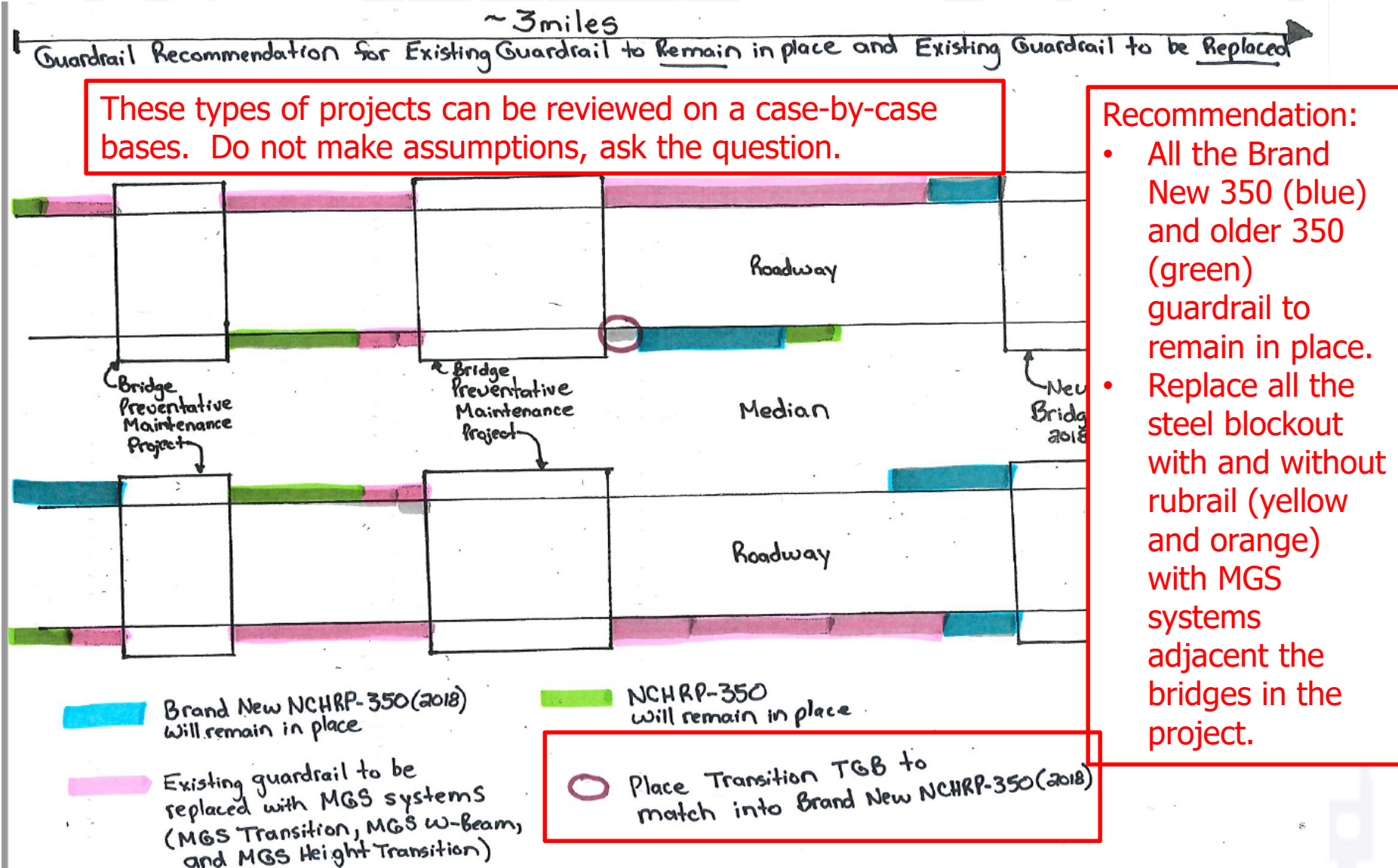
# Evaluate the Existing Guardrail Types

- Example of a location that contains multiple types of guardrail



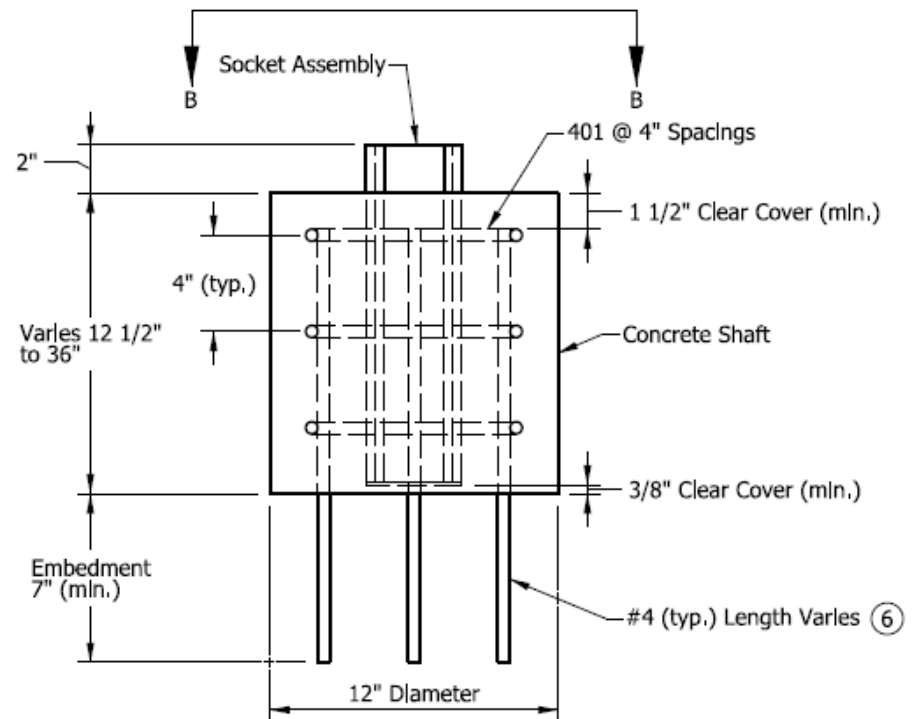
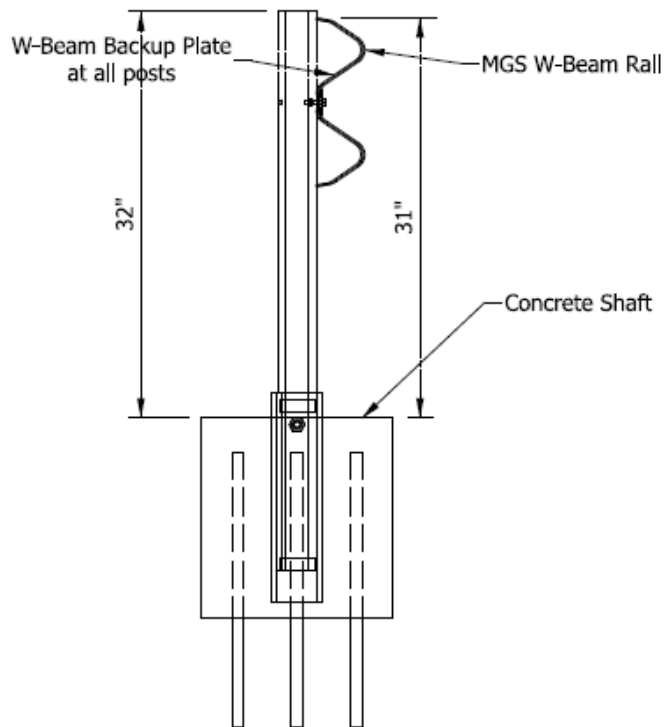
# Evaluate the Existing Guardrail Types

- Example of a location that contains multiple types of guardrail



# MGS Weak-Post Assembly Option are Coming

## Socketed Weak Post



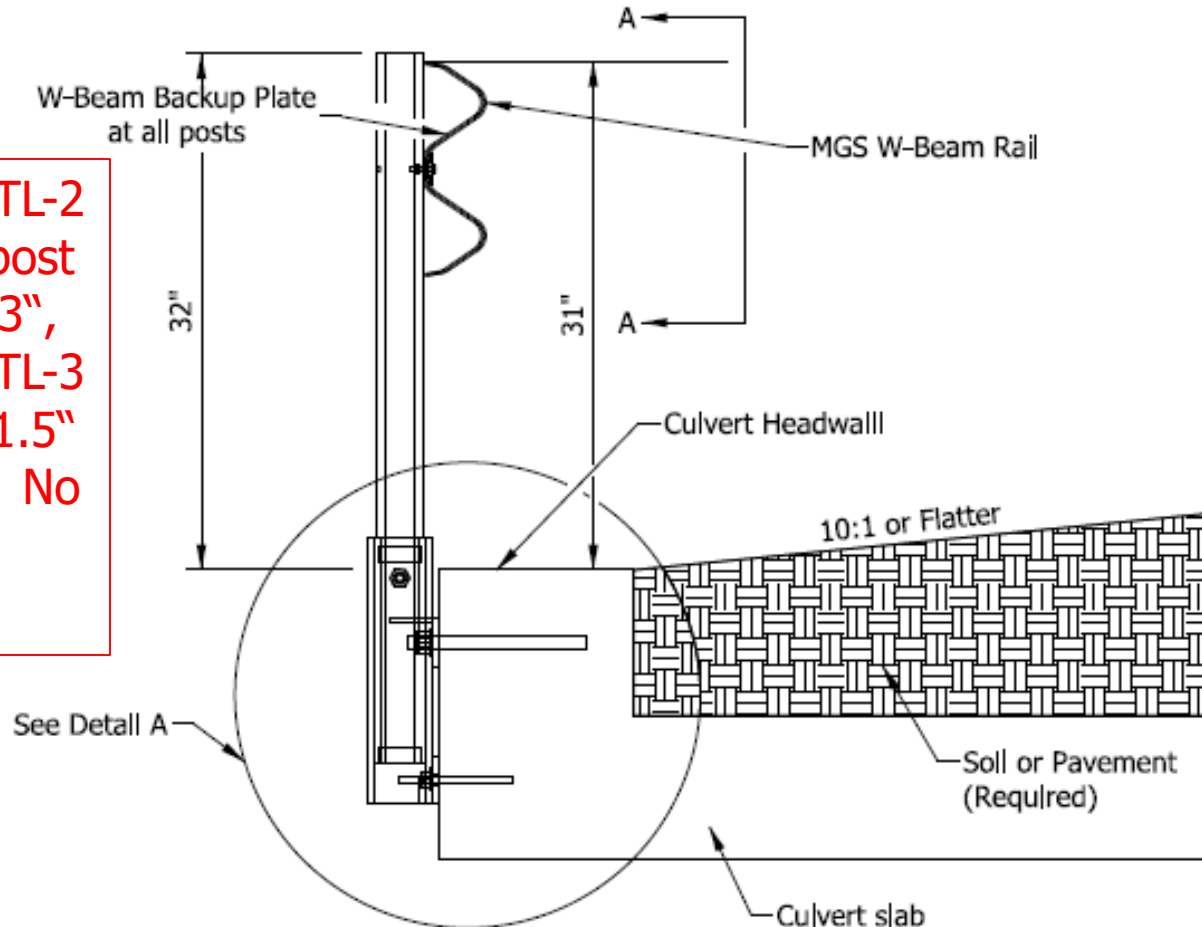
DETAIL A

Meets MASH TL-2 Criteria with post spacing at 6'-3", Meets MASH TL-3 Criteria at 3'-1.5" post spacing. No Transition needed.

# MGS Weak-Post Assembly Option are Coming

## Headwall Side Mounted Weak Post

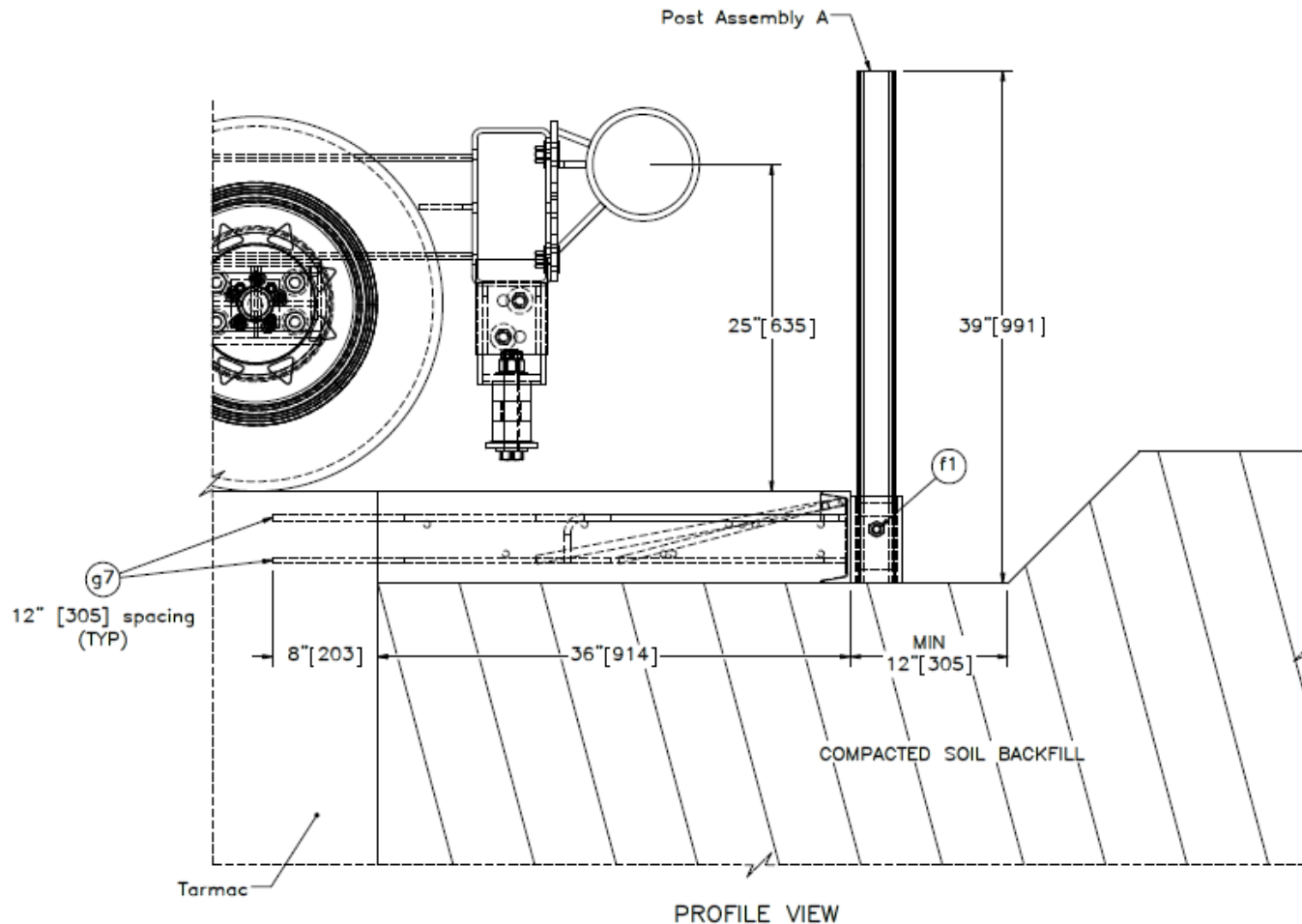
Meets MASH TL-2 Criteria with post spacing at 6'-3", Meets MASH TL-3 Criteria at 3'-1.5" post spacing. No Transition needed.





# MGS Weak-Post Assembly Option are Coming

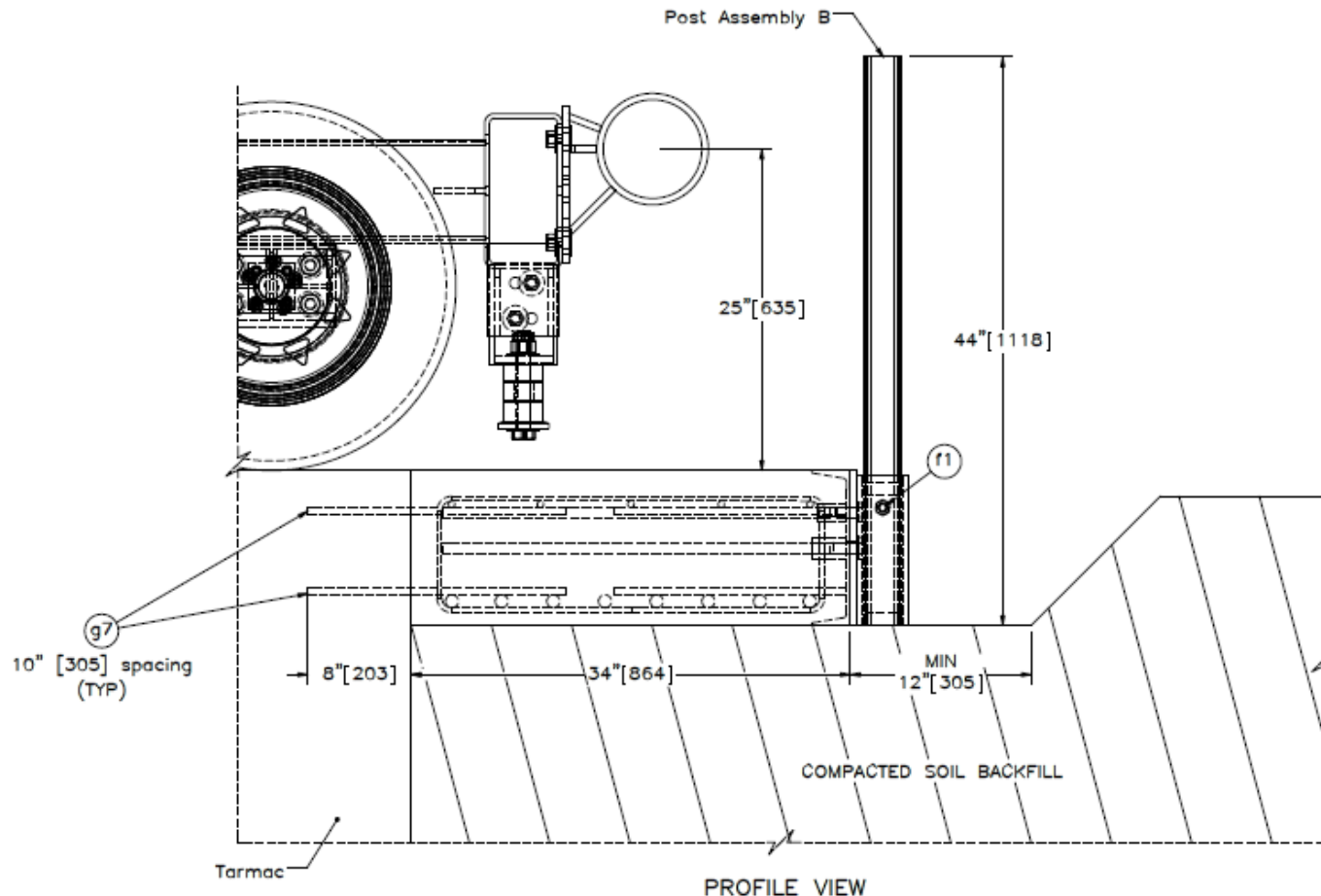
Alternate method to cross a bridge along the edge of the deck (Minimum Deck Depth 7"), Deck Side Mounted Weak Post.



Deck depth equal to or greater than 7" and less than 12". Meets MASH TL-2 Criteria with post spacing at 6'-3", Meets MASH TL-3 Criteria at 3'-1.5" post spacing. Will required special edge beam reinforcement.

# MGS Weak-Post Assembly Option are Coming

Alternate method to cross a bridge along the edge of the deck (Minimum Deck Depth 12"), Deck Side Mounted Weak Post.



Deck depth equal to or greater than 12". Meets MASH TL-2 Criteria with post spacing at 6'-3", Meets MASH TL-3 Criteria at 3'-1.5" post spacing. Will required special edge beam reinforcement.

# MGS Weak Post Bridge Rail TL-2 or TL-3

<https://mwrsf.unl.edu/researchhub/files/Report53/mgsbr1aos3.wmv>

<https://mwrsf.unl.edu/researchhub/files/Report53/mgsbr1aos4.wmv>

<https://mwrsf.unl.edu/researchhub/files/Report53/mgsbr1jvc1.wmv>



These are links to the crash test videos for Crash Test TRP-03-226-10 performed by Midwest Roadside Safety Facility. INDOT will review these rail types for incorporation into the standards.



# MGS Weak Post Bridge Rail TL-2 or TL-3





# MGS Weak Post Bridge Rail TL-2 or TL-3



# MGS Weak Post Bridge Rail TL-2 or TL-3

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# Crash Cushion = Impact Attenuator

Crash test with ramped end:

Engineering  
Judgement:  
these end  
treatments  
have there  
place, low  
speed urban  
facilities,  
not high  
speed  
facilities



## What You Should Remember?

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- MGS guardrail systems are different than w-beam guardrail systems. For design guidance on MGS w-beam guardrail refer to Design Memos 17-10 and 17-17.
- If you need to modify an MGS guardrail system, send your recommendation in for review, [DesignManualInquiries@indot.IN.gov](mailto:DesignManualInquiries@indot.IN.gov)



# QUESTIONS

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and Policy

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Using the general email  
will be the best way to  
getting a response, more  
eyes watch this inbox