MnDOT MASH Bullnose Manual

Assembly, Maintenance, and Repair

Version 1

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Disclaimer

This installation manual is for the non-proprietary bullnose system developed through the Midwest Roadside Safety Facility (MwRSF) and the Midwest Pooled Fund Program. The bullnose system was designed and crash tested as a redirective, non-gating crash cushion to meet the requirements of the American Association of State and Highway Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH) criteria Test Level 3 (TL-3). It is the responsibility of the installer to utilize a design approved by the State DOT and to follow all required State procedures and instructions in installing the thrie-beam bullnose.

These instructions are for standard assembly specified by the appropriate highway authority. In the event the specified system assembly, maintenance, or repair would require a deviation from standard assembly parameters, contact the MnDOT standards engineer.

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This material is based upon work supported by the Federal Highway Administration, U.S. Department of Transportation and the Midwest Pooled Fund Program - TPF-5(193). The contents of this manual reflect the views and opinions of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the University of Nebraska-Lincoln, state of Minnesota, nor the Federal Highway Administration, U.S. Department of Transportation. This report does not constitute a standard, specification, or regulation. Trade or manufacturers' names, which may appear in this report, are cited only because they are considered essential to the objectives of the manual. The United States (U.S.) government and the State of Nebraska and State of Minnesota do not endorse products or manufacturers.

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1 GENERAL INFORMATION

This installation manual is for the MASH TL-3 bullnose system. The bullnose is a non-proprietary, thrie-beam, median barrier system used to shield median hazards found between divided highways. A bullnose guardrail system involves wrapping a semi-rigid guardrail system completely around the hazard. When a vehicle impacts the radiused nose of a bullnose, the barrier captures the vehicle, collapses inward, and dissipates energy to safely decelerate the vehicle. Impacts along the sides of the barrier are redirected similar to standard guardrail systems. A schematic and overhead view of the bullnose system is shown in Figure 1.

The bullnose system was designed and crash tested as a non-gating, redirective crash cushion to meet the requirements of the American Association of State and Highway Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH 2016) criteria Test Level 3, which specifies impact at 62 mph. The bullnose system is eligible for Federal-aid reimbursement for use on the National Highway System. It is the responsibility of the installer to utilize a design approved by the State DOT and to follow all required State procedures and these instructions when installing the bullnose system.

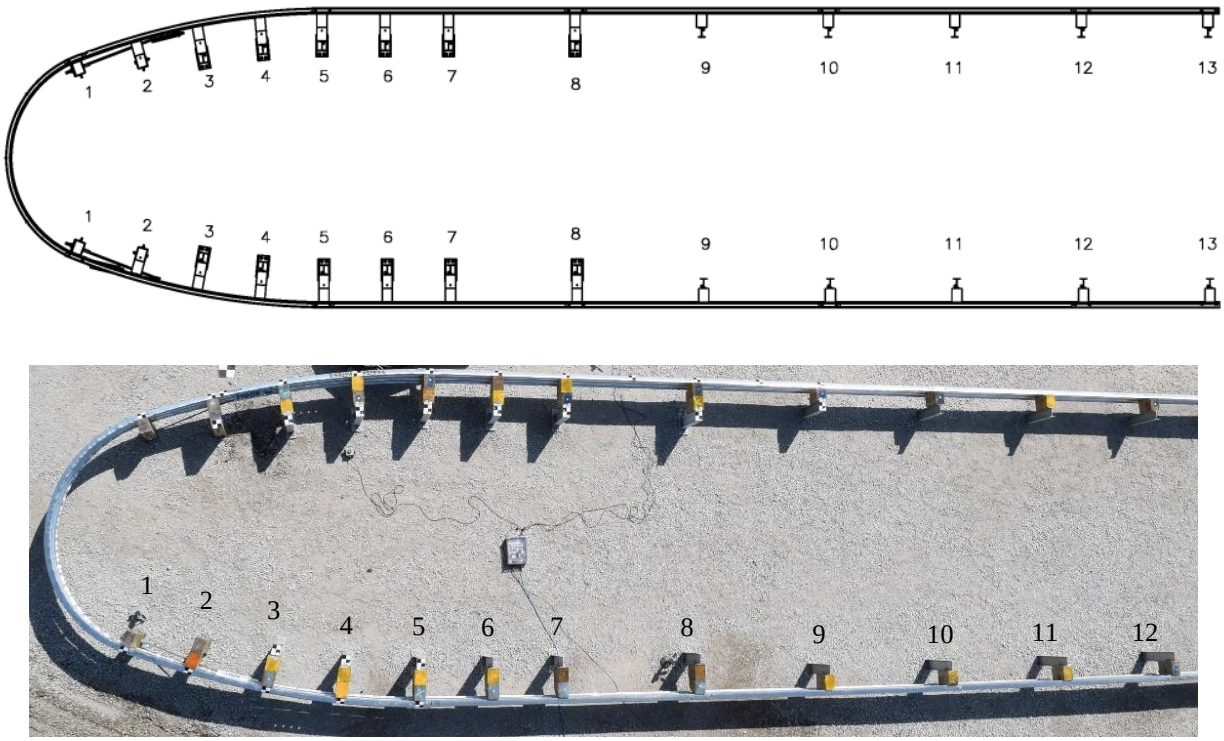


Figure 1. Bullnose System: Schematic with Post Numbers and Overhead View

The bullnose system consists of a guardrail envelope made up of thrie-beam panels mounted at a height of 31⅝ in. and supported by a series of Universal Breakaway Steel Posts (UBSPs) and W6x8.5 or W6x9 steel posts. The nose rail section and the adjacent rail section are radiused and slotted, the third section is slotted, and the fourth rail section is standard thrie beam. The combination of the radiused and slotted rail segments and the breakaway posts allows the

system to safely capture and decelerate vehicles impacting near the end or nose of the system while redirecting vehicles impacting along the side.

This manual details general information regarding the MASH TL-3 bullnose system, site preparation and grading, system parts and assemblies, installation procedures, alternative system configurations, an inspection checklist, and maintenance and repair guidance. This manual is not intended for use with older versions of the bullnose system as the design was updated to meet MASH safety requirements.

2 PARTS AND ASSEMBLIES

2.1 System Overview

The parts and assemblies for the bullnose system are detailed in this section. The pay limit for the bullnose system is defined from the nose through post 13 in the system, as shown in Figure 2. This represents a total system length of 125 ft. The standard layout includes the slotted thrie beam nose section with reinforcing nose cables, one curved and slotted thrie beam section on each side of the system, one straight and slotted thrie beam section on each side of the system, two standard thrie beam sections on each side of the system, and one asymmetric W-to-thrie transition rail section on each side of the system. Details for the individual post assemblies, guardrail sections, anchorages, and nose cables are provided in subsequent sections. The bill of materials for the bullnose system is shown in Table 1.

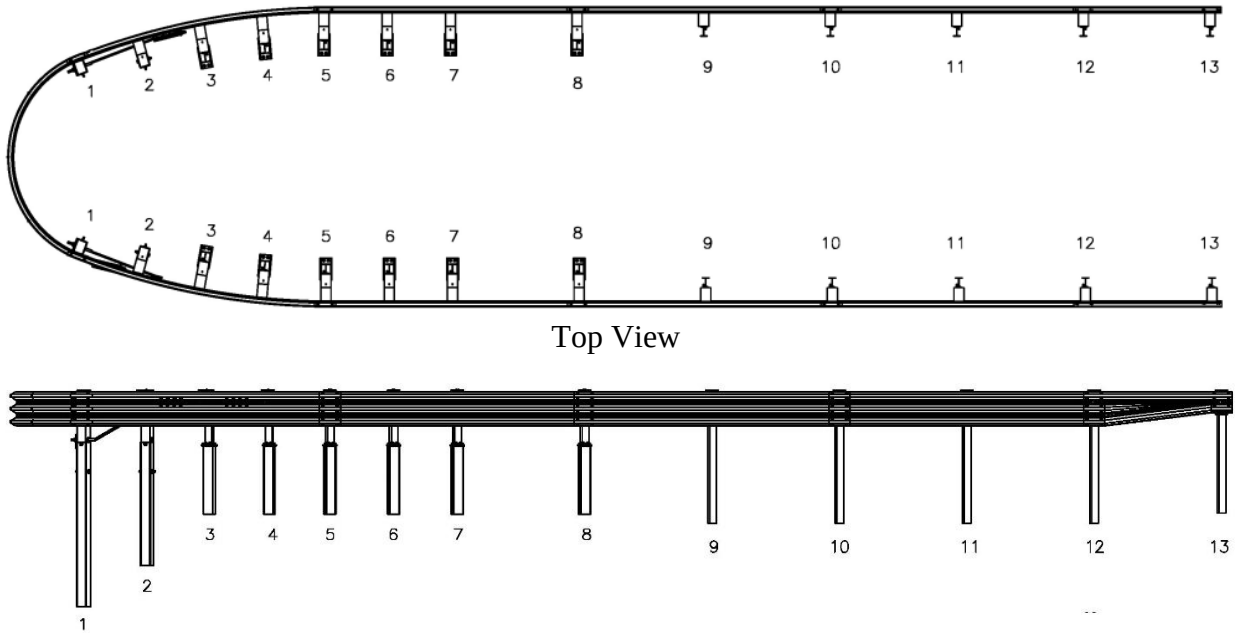


Figure 2. Thrie-Beam Bullnose System Diagram, Top View and Side View

Table 1. Thrie-Beam Bullnose System Bill of Materials

Item No.	Quantity	Description	MnDOT Part No.	Material Specification	Treatment Specification	Hardware Guide No.
a3	2	8"x8"x⅝" Anchor Bearing Plate	GR3110	ASTM A36	ASTM A123	FPB01
c3	136	⅝"-11 UNC, 1¼" Long Guardrail Bolt and Nut	Bolt- GR3126 Nut- GR3134	Bolt- ASTM A307 Gr. A Nut- ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBB01
c4	16	⅝"-11 UNC, 1½" Long Hex Head Bolt and Nut	Bolt- GR3127 Nut- GR3133	Bolt- ASTM A307 Gr. A Nut- ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBX16a
c9	2	1" Dia. Hex Nut	GR3139	ASTM A563A	AASHTO M232 (ASTM A153) for Class C or AASHTO M298 (ASTM B695) for Class 50	FNX24a
d1	1	12'-6" 12 gauge Bent Thrie Beam Section Nose	GR3107	AASHTO M180	ASTM A123 or A653	RTM07a
d2	1	12'-6" 12 gauge Bent Thrie Beam Section Side A	GR3106	AASHTO M180	ASTM A123 or A653	RTM07d
d3	1	12'-6" 12 gauge Bent Thrie Beam Section Side B	GR3106	AASHTO M180	ASTM A653	RTM07d
d4	2	12'-6" 12-gauge Thrie Beam Section	GR3105	AASHTO M180	ASTM A123 or A653	RTM07e
d5	4	12'-6" 12-gauge Thrie Beam Section	GR3103	AASHTO M180	ASTM A123 or A653	RTM02a
e2	32	⅝" Dia. Plain Round Washer	GR3132	ASTM F844	ASTM A153 or B695 Class 55 or F2329	FWC16a
f5	9	2¼"x¾" 11-gauge U-Bolt Plate Washer	-	ASTM A1011 CS Type B	ASTM A123	FWR10
g1	2	BCT Cable Anchor Assembly	GR3144	-	-	FCA01
g2	1	2⅜" O.D. x 6" Long BCT Post Sleeve	GR3113	ASTM A53 Gr. B Schedule 40	ASTM A123	FMM02
g3	3	⅝" Dia. x 14'-6" Long Cable and Swage Button	GR3114	"Cold Tuff" Button, S-409 Size No. 12 SB, Stock No. 1040395 for 5/8" Dia. (6x19) wire rope (or any similarly sized swage-grip button ferrules)	Wire Rope - Class A Coating	RCM02
g4	6	12⅝"x5 13/16"x3/16" Nose Cable Anchor Plate	GR3112	ASTM A36	ASTM A123	FPA04
g6	9	U-Bolt ¼ X 2-½ Nut and Washer	GR3124	U-Bolt - ASTM A307 Gr. A Nut - ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBU01
h2	2	Anchor Bracket Assembly	GR3109	ASTM A36	ASTM A123	FPA01
k1	1	7'-3.5" 10-gauge W-Beam to Thrie-Beam Asymmetric Transition Section	GR3108	AASHTO M180	ASTM A123 or A653	RWT02
k2	1	7'-3.5" 10-gauge W-Beam to Thrie-Beam Asymmetric Transition Section	GR3108	AASHTO M180	ASTM A653	RWT02
p1	2	Post Assembly 1	-	-	-	-
p2	2	Post Assembly 2	-	-	-	-
p3	12	Post Assembly 3-8	-	-	-	-
p9	8	Post Assembly 9-12	-	-	-	-
p13	2	Post Assembly 13	-	-	-	-

2.2 Parts and Assemblies

The bullnose system is made up of four main components/assemblies:

- Posts and blockouts
- System anchorage
- Guardrail
- Nose cables

2.2.1 Posts and Blockouts

The bullnose system is constructed with twenty-six posts. The bullnose system utilizes Breakaway Cable Terminal (BCT) posts for post nos. 1 and 2. Posts 3 through 8 are Universal Breakaway Steel Posts (UBSPs), posts 9 through 12 are thrie-beam guardrail steel posts, and posts 13 and on are standard W-beam guardrail posts.

Breakaway Cable Terminal (BCT) Posts

Post 1 and 2 are breakaway cable terminal (BCT) posts. Post 1 does not use a blockout. The bill of materials for post 1 is shown in Table 2 and diagrams of post 1 are shown in Figure 3 and Figure 5. Post 2 uses a tapered 6x8x14¼-in. timber blockout. The bill of materials for post 2 is shown in Table 3, and diagrams of post 2 are shown in Figure 4 and Figure 6. A photograph of posts 1 and 2 installed in the final system is shown in Figure 7.

Table 2. Bill of Materials for Post 1

Item No.	Quantity	Description	MnDOT Part No.	Material Specification	Treatment Specification	Hardware Guide No.
a1	1	TS8"x6"x3/16", 96" Long Foundation Tube	GR3116	ASTM A500 Gr. B	ASTM A123	PTE07
c2	1	⅝"-11 UNC, 10" Long Hex Head Bolt and Nut	Bolt- Nut- GR3133	Bolt- ASTM A307 Gr. A Nut- ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBX16a
c6	1	⅞"-9 UNC, 8" Long Hex Head Bolt and Nut	-	Bolt- ASTM A307 Gr. A Nut- ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBX22b
c7	2	⅝"-11 UNC, 10" Long Guardrail Bolt and Nut	Bolt- GR3129 Nut- GR3134	Bolt- ASTM A307 Gr. A Nut- ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBB03
e2	4	⅝" Dia. Plain Round Washer	GR3132	ASTM F844	ASTM A153 or B695 Class 55 or F2329	FWC16a
f1	1	BCT Timber Post for Thrie-Beam Bullnose End Terminal	GR3118	SYP Grade No. 1 or better (No knots +/- 18" from ground on tension face)	-	PDF04
f2	2	⅞" Dia. Plain Round Washer	-	ASTM F844	ASTM A153 or B695 Class 55 or F2329	FWC20a

Table 3. Bill of Materials for Post 2

Item No.	Quantity	Description	MnDOT Part No.	Material Specification	Treatment Specification	Hardware Guide No.
a2	1	TS8"x6"x3/16", 72" Long Foundation Tube	GR3115	ASTM A500 Gr. B	ASTM A123	PTE06
a4	1	6"x8"x14¼" Tapered Timber Blockout - Post 2	GR3122	SYP Grade No. 1 or better	-	PDB12
c2	1	⅝"-11 UNC, 10" Long Hex Head Bolt and Nut	Bolt- Nut- GR3133	Bolt-ASTM A307 Gr. A Nut- ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBX16a
c5	1	⅝"-11 UNC, 18" Long Guardrail Bolt and Nut	Bolt- GR3130 Nut- GR3134	Bolt- ASTM A307 Gr. A Nut- ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBB04
c6	1	⅞"-9 UNC, 8" Long Hex Head Bolt and Nut	-	Bolt ASTM A307 Gr. A Nut- ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBX22b
c8	1	16D Double Head Nail	-	-	-	-
e2	3	⅝" Dia. Plain Round Washer	GR3132	ASTM F844	ASTM A153 or B695 Class 55 or F2329	FWC16a
f1	1	BCT Timber Post for Thrie-Beam Bullnose End Terminal	GR3118	SYP Grade No. 1 or better (No knots +/- 18" from ground on tension face)	-	PDF04
f2	2	⅞" Dia. Plain Round Washer	-	ASTM F844	ASTM A153 or B695 Class 55 or F2329	FWC20a

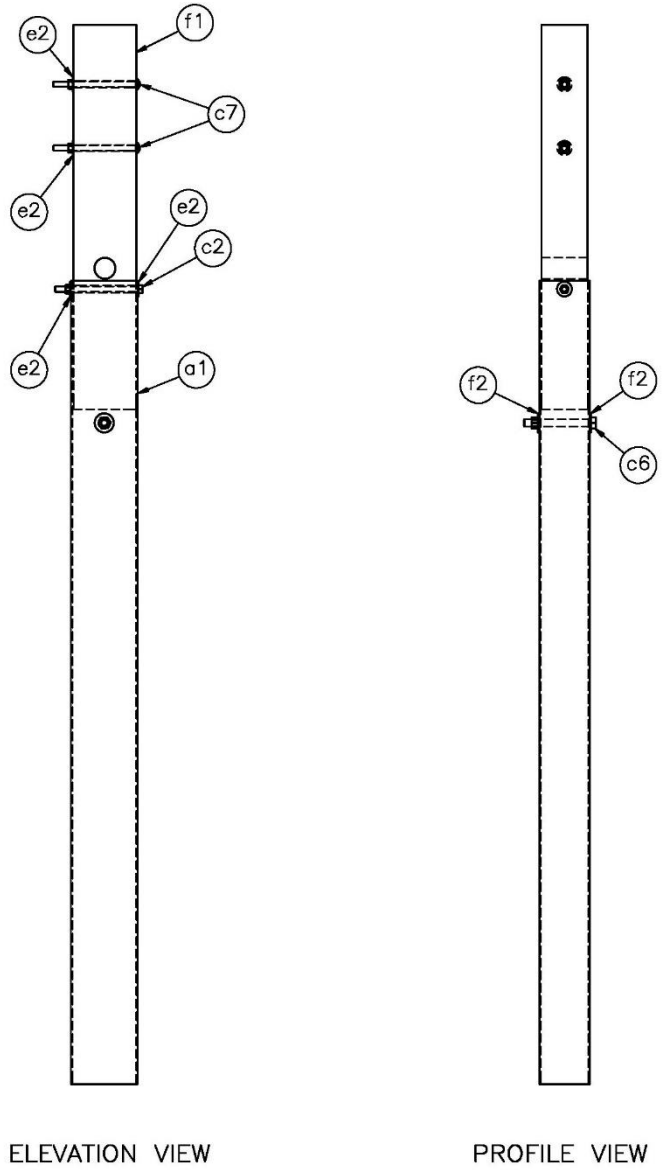


Figure 3. Post 1 – Diagram (Rail Not Shown)

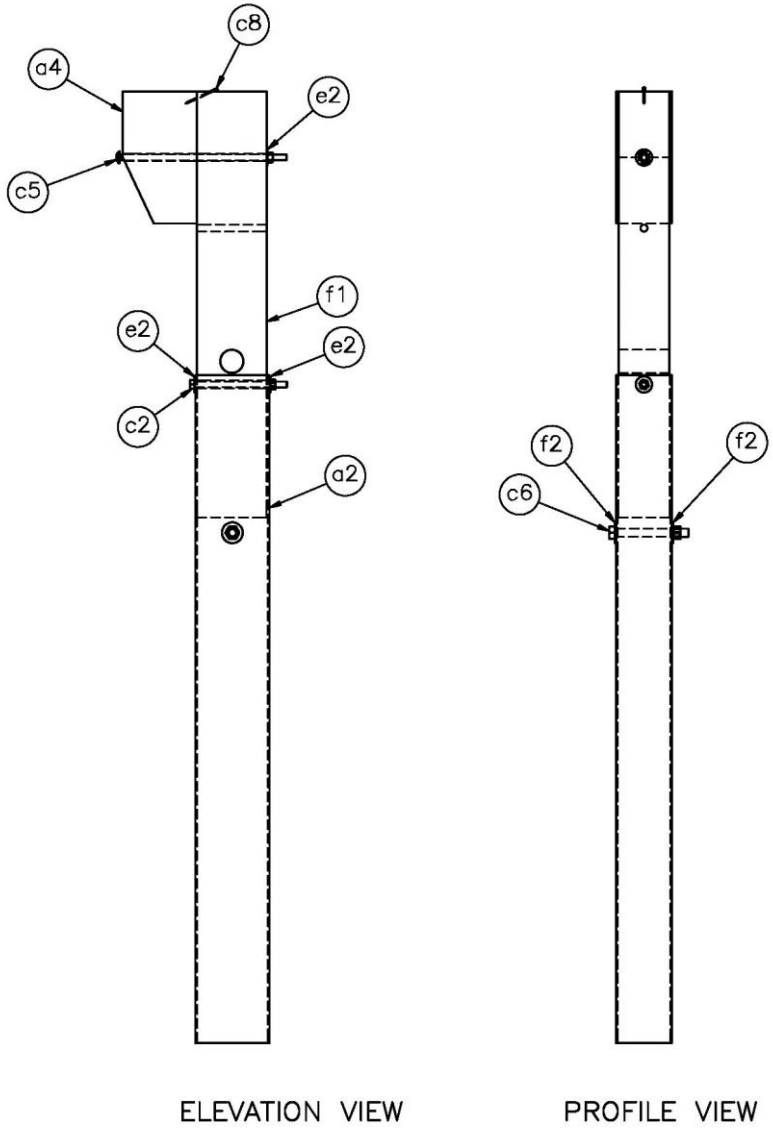


Figure 4. Post 2 – Diagram (Rail Not Shown)

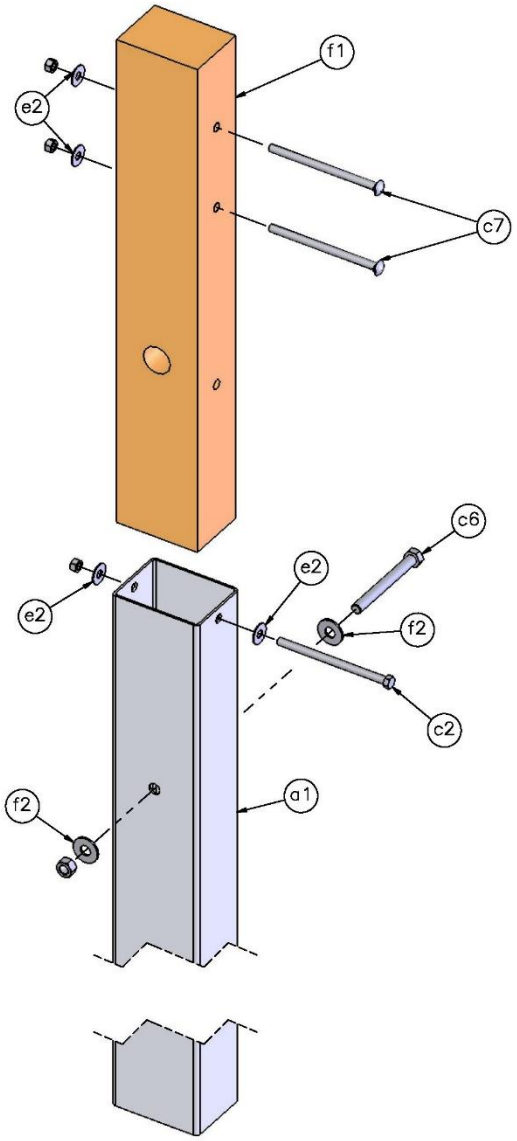


Figure 5. Post 1 – Exploded View (Rail Not Shown)

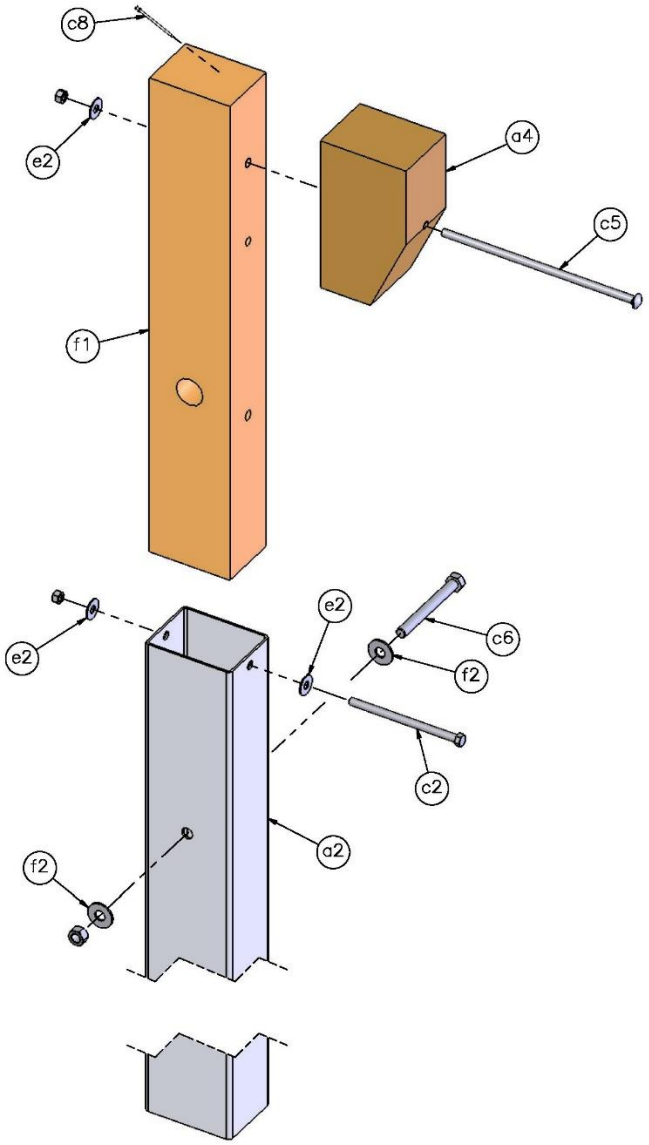


Figure 6. Post 2 – Exploded View (Rail Not Shown)

Figure 7. Posts 1 and 2 Installed in System

Universal Breakaway Steel Posts (UBSPs)

Posts 3 through 8 are UBSPs. The lower portion of the UBSP consists of a foundation tube with a lower base plate. The upper portion of the UBSP consists of a post with an upper base plate. The upper and lower halves of the UBSP are connected with a series of four bolts. UBSPs use dual blockouts, with one rectangular 6x8x14¼-in. blockout and one tapered 6x8x14¼-in. blockout. The bill of materials for posts 3 through 8 is shown in Table 4 and diagrams of posts 3 through 8 are shown in Figure 8 and Figure 9. Photographs of assembled UBSPs shown in Figure 10.

Table 4. Bill of Materials for Posts 3 through 8

Item No.	Quantity	Description	MnDOT Part No.	Material Specification	Treatment Specification	Hardware Guide No.
a4	1	Lower UBSP Assembly	-	Plate- ASTM A36 Tube- ASTM A500 Gr. B	ASTM A123	PTE08
a5	1	Upper UBSP Assembly	-	Plate- ASTM A36 Post- ASTM A992	ASTM A123	-
a6	1	6"x8"x14¼" Timber Blockout	GR3121	SYP Grade No. 1 or better	-	PDB09
a7	1	6"x8"x14¼" Tapered Timber Blockout – Posts 3-8	GR3122	SYP Grade No. 1 or better	-	PDB20
c1	4	7/16" [11] Dia. UNC, 2¼" [57] Long Heavy Hex Bolt and Nut	-	Bolt - ASTM A449 Nut - ASTM A563DH	ASTM A153 or B695 Class 55 or F2329	FBX12b
c5	1	⅝"-11 UNC, 18" Long Guardrail Bolt and Nut	Bolt- GR3130 Nut- GR3134	Bolt- ASTM A307 Gr. A Nut- ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBB04
c8	2	16D Double Head Nail	-	-	-	-
e1	16	7/16" [11] Dia. Plain Round Washer	-	ASTM F844	ASTM A153 or B695 Class 55 or F2329	FWC12a

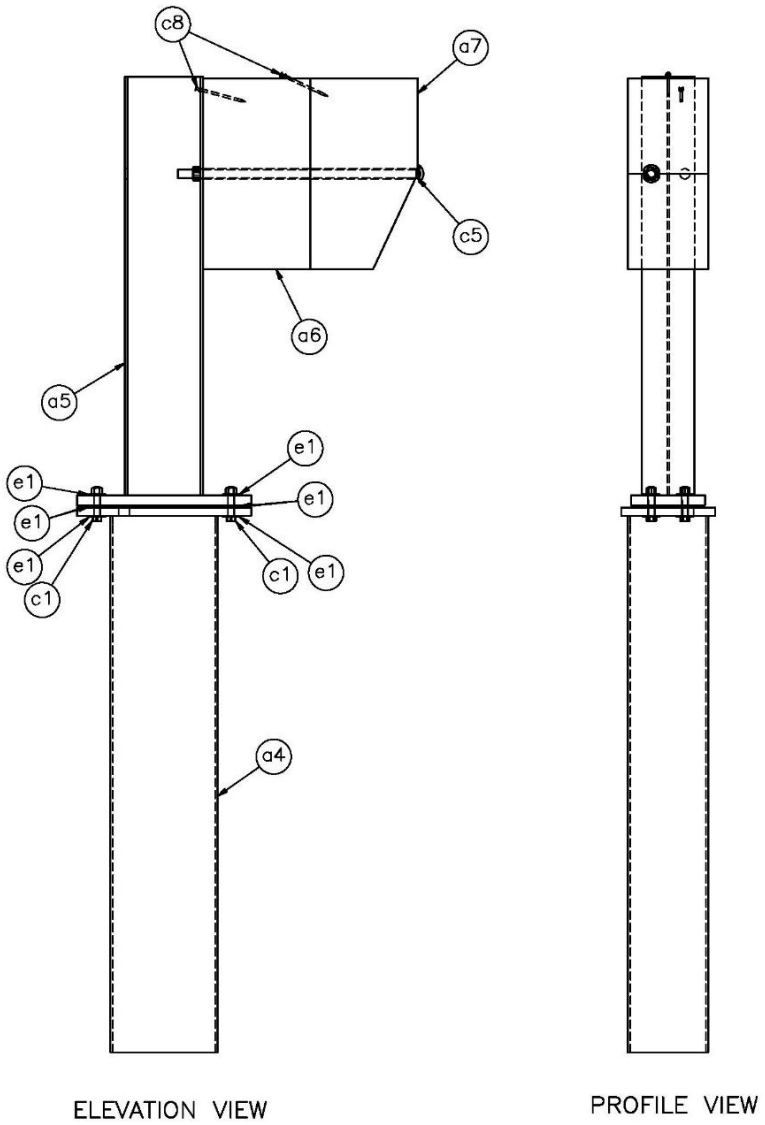


Figure 8. Posts 3 through 8 – Diagram (Rail Not Shown)

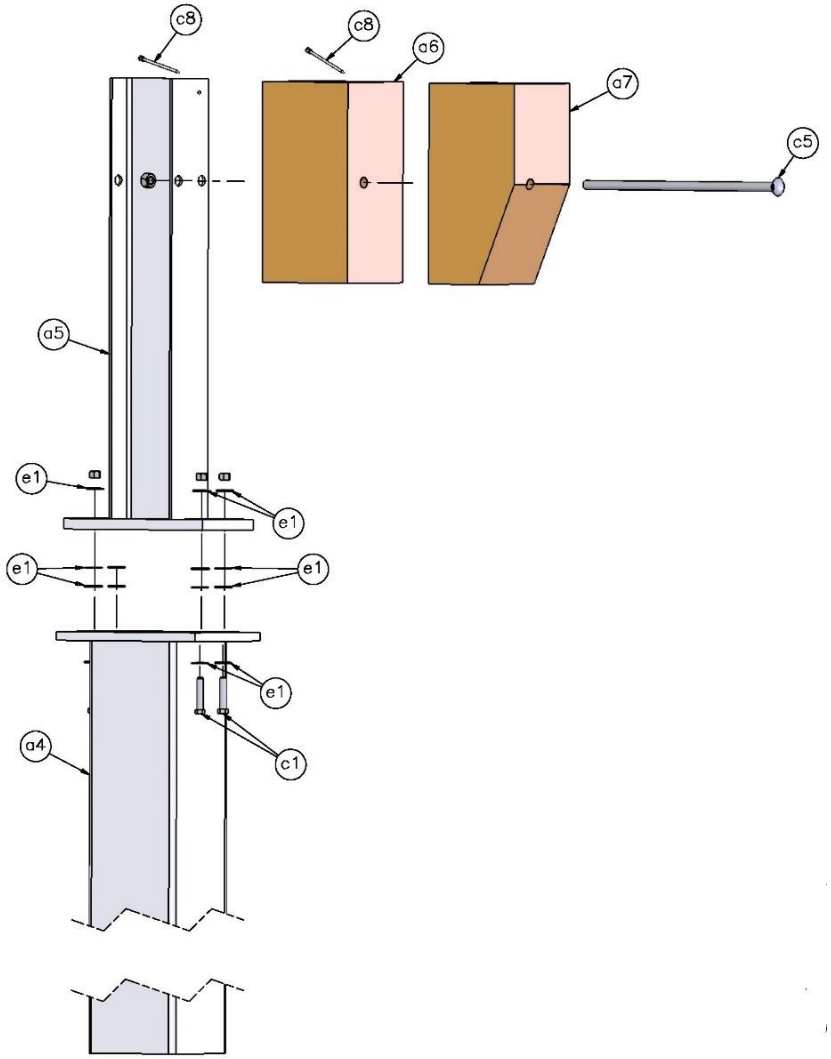


Figure 9. Posts 3 through 8 – Exploded View (Rail Not Shown)

Figure 10. Assembled (top) and Installed (middle, bottom) UBSPs

Thrie-Beam Guardrail Posts

Posts 9 through 12 are 78-in. long thrie-beam guardrail steel posts. These posts use 6x8x14¼-in. blockouts. The bill of materials for posts 9 through 12 is shown in Table 5, and diagrams of posts 9 through 12 are shown in Figure 11 and Figure 12.

Table 5. Bill of Materials for Posts 9 through 12

Item No.	Quantity	Description	MnDOT Part No.	Material Specification	Treatment Specification	Hardware Guide No.
a6	1	6"x8"x14 1/4" Timber Blockout	GR3121	SYP Grade No. 1 or better	-	PDB09
c7	1	5/8"-11 UNC, 10" Long Guardrail Bolt and Nut	Bolt- GR3129 Nut- GR3134	Bolt- ASTM A307 Gr. A Nut- ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBB03
c8	1	16D Double Head Nail	-	-	-	-
b1	1	W6x8.5 or W6x9, 78" Long Steel Post	GR3152	ASTM A992	ASTM A123	-

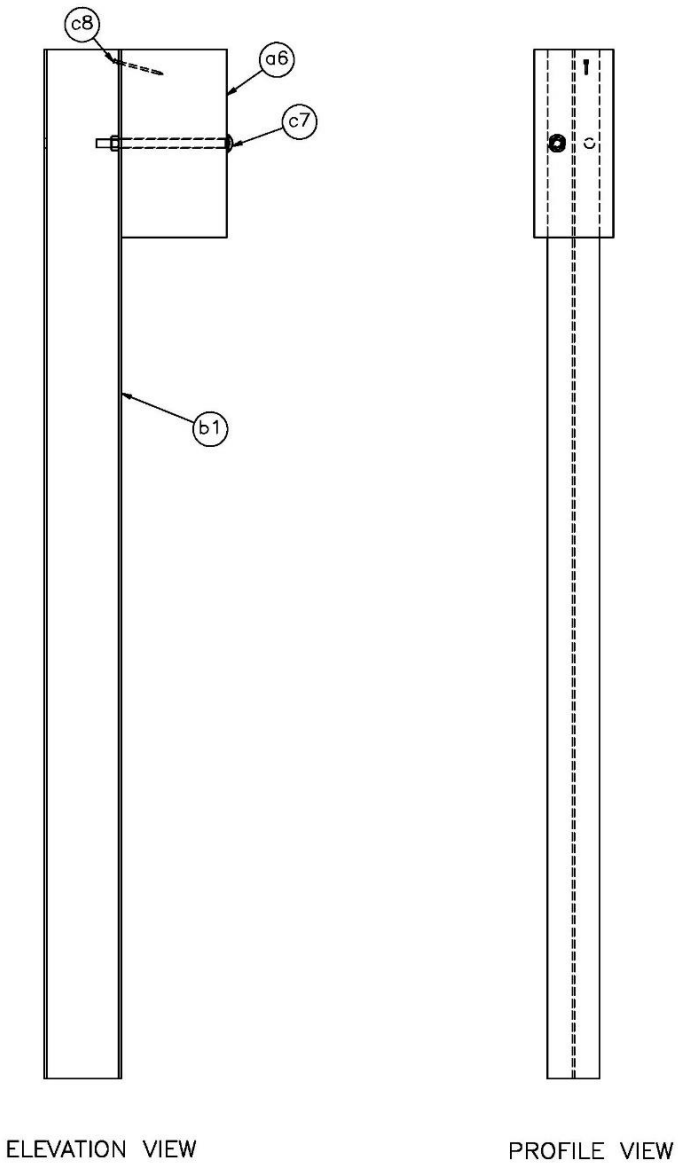


Figure 11. Posts 9 through 12 – Diagram (Rail Not Shown)

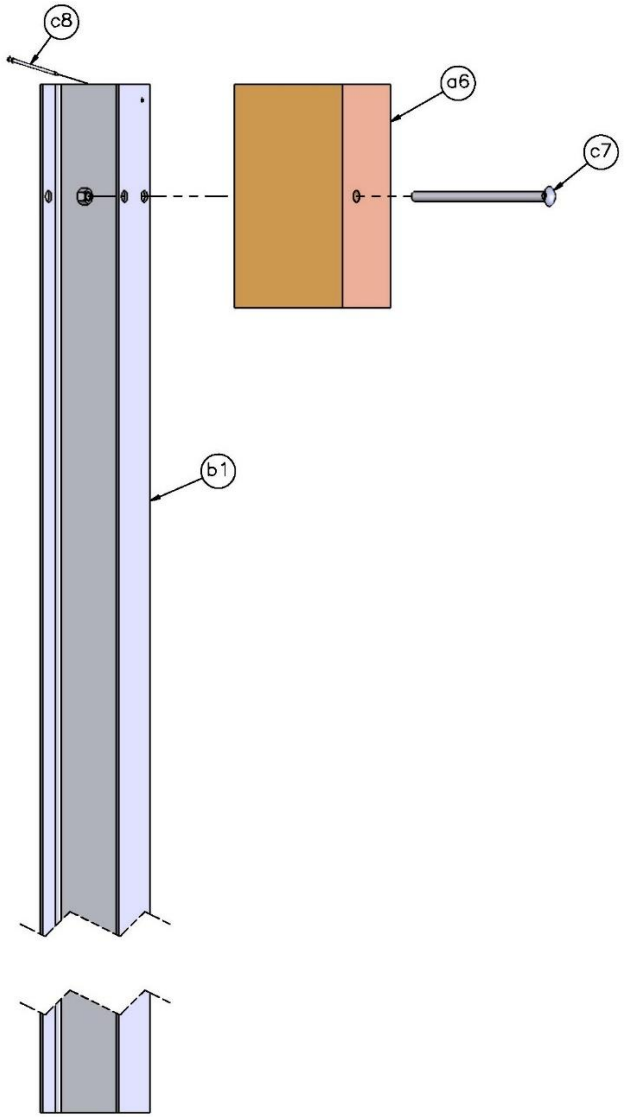


Figure 12. Posts 9 through 12 – Exploded View (Rail Not Shown)

Standard W-Beam Guardrail Posts

Post 13 is a standard 72-in. long W-beam guardrail steel posts. These posts use standard 6x8x14¼-in. blockouts. The bill of materials for post 13 is shown in Table 6, and diagrams of post 13 are shown in Figure 13 and Figure 14.

Table 6. Bill of Materials for Post 13

Item No.	Quantity	Description	MnDOT Part No.	Material Specification	Treatment Specification	Hardware Guide No.
a6	1	6"x8"x14 1/4" Timber Blockout	GR3121	SYP Grade No. 1 or better	-	PDB09
c7	1	5/8"-11 UNC, 10" Long Guardrail Bolt and Nut	Bolt - GR3129 Nut- GR3134	Bolt- ASTM A307 Gr. A Nut- ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBB03
c8	1	16D Double Head Nail	-	-	-	-
f3	1	W6x8.5 [W152x12.6] or W6x9 [W152x13.4], 72" Long Steel Post	GR3151	ASTM A992	ASTM A123	-

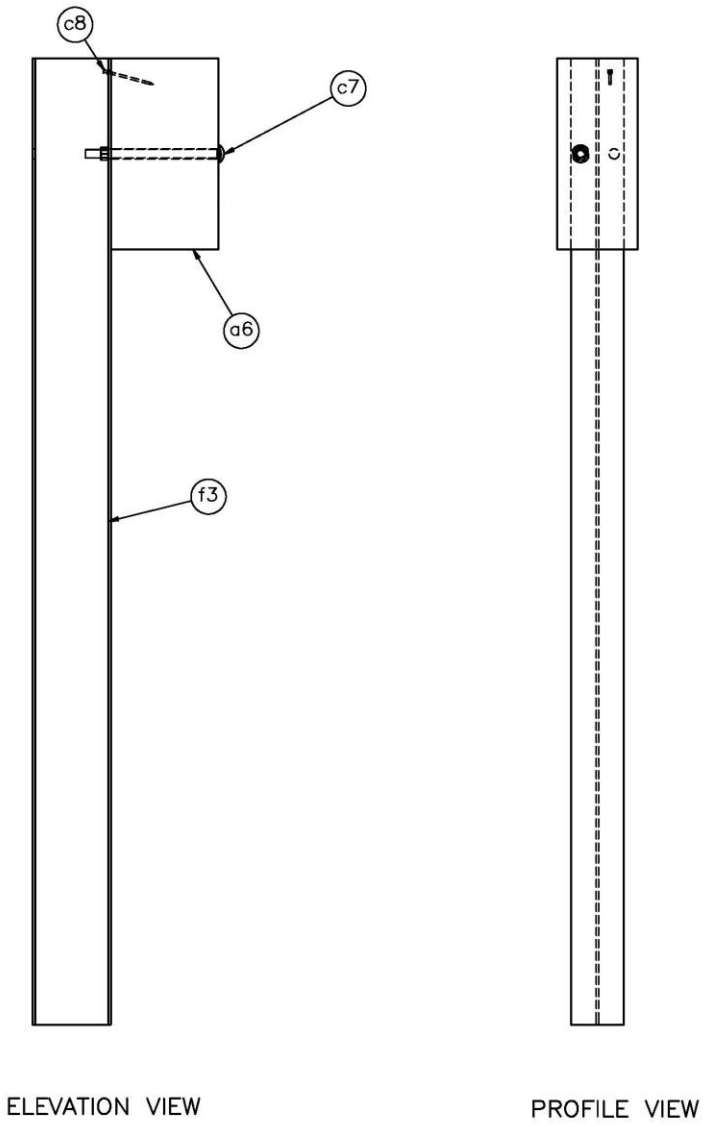


Figure 13. Post 13 – Diagram (Rail Not Shown)

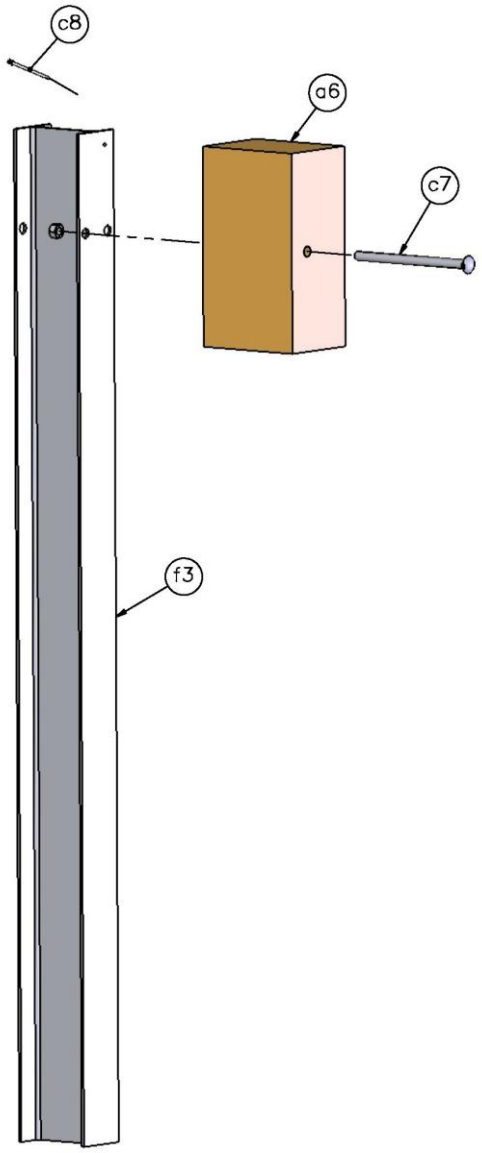


Figure 14. Post 13 – Exploded View (Rail Not Shown)

2.2.1 System Anchorage

The bullnose system anchorage consists of two BCT posts (posts 1 and 2) and the anchorage components, as shown in Figure 15 and Figure 16. Diagrams of the anchorage are shown in Figure 17 and Figure 18. The anchor cable and cable plate along with their assembly at post 1 are shown in Figure 19 and Figure 20.

Figure 15. Photograph of Anchorage

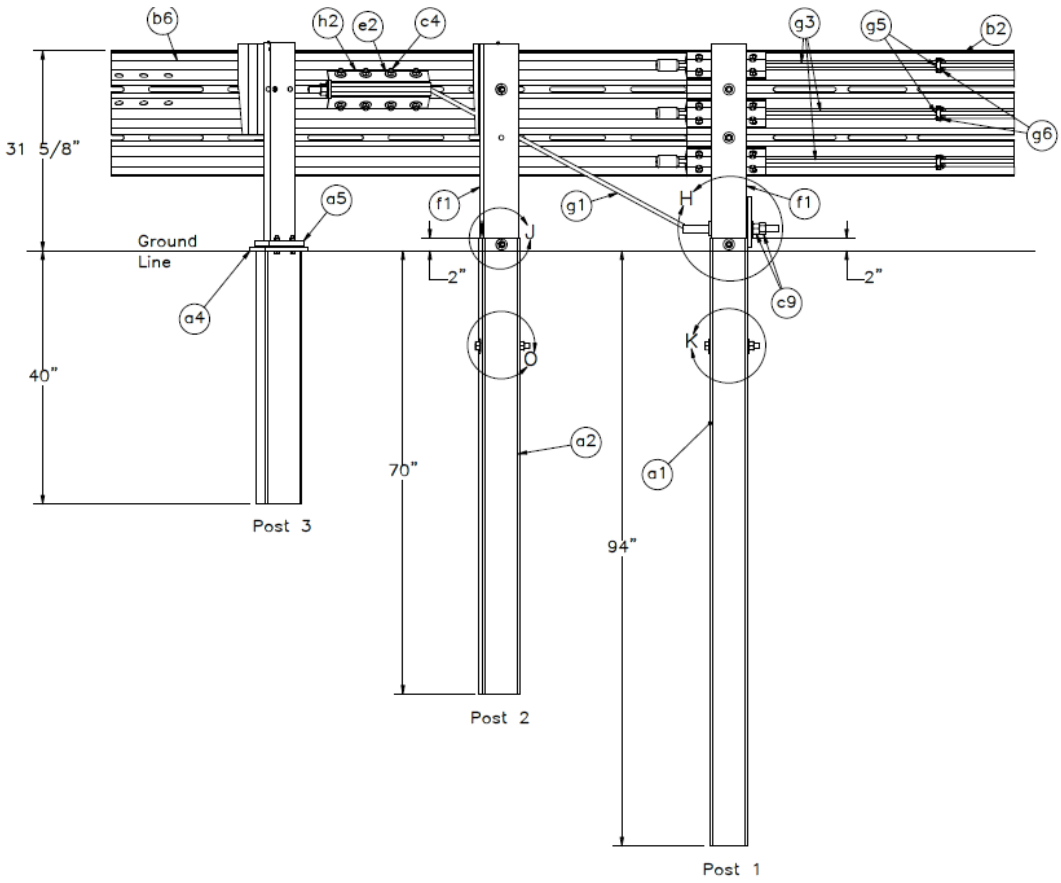


Figure 16. Diagram of Posts 1 through 3 and Anchorage

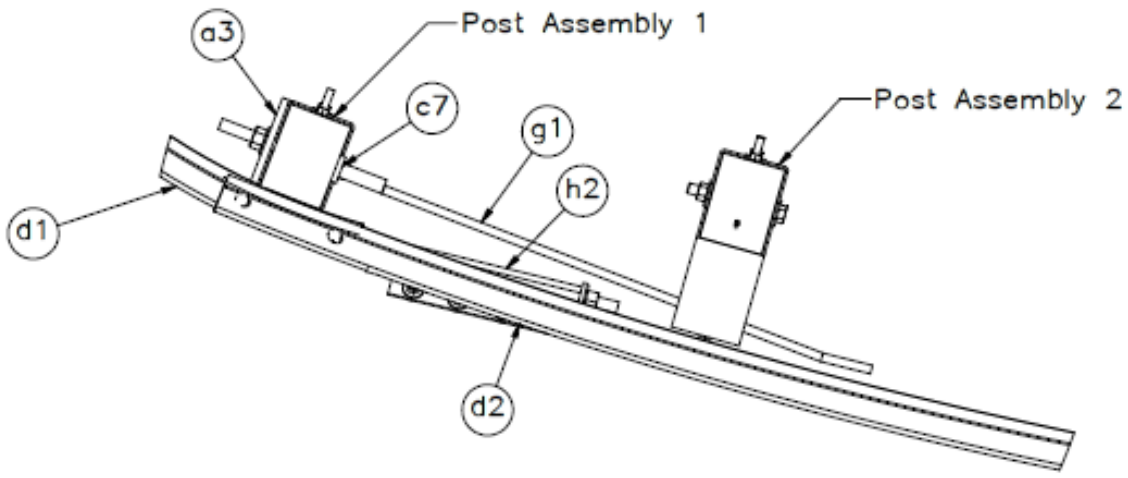


Figure 17. Diagram of Front Anchorage – Top View

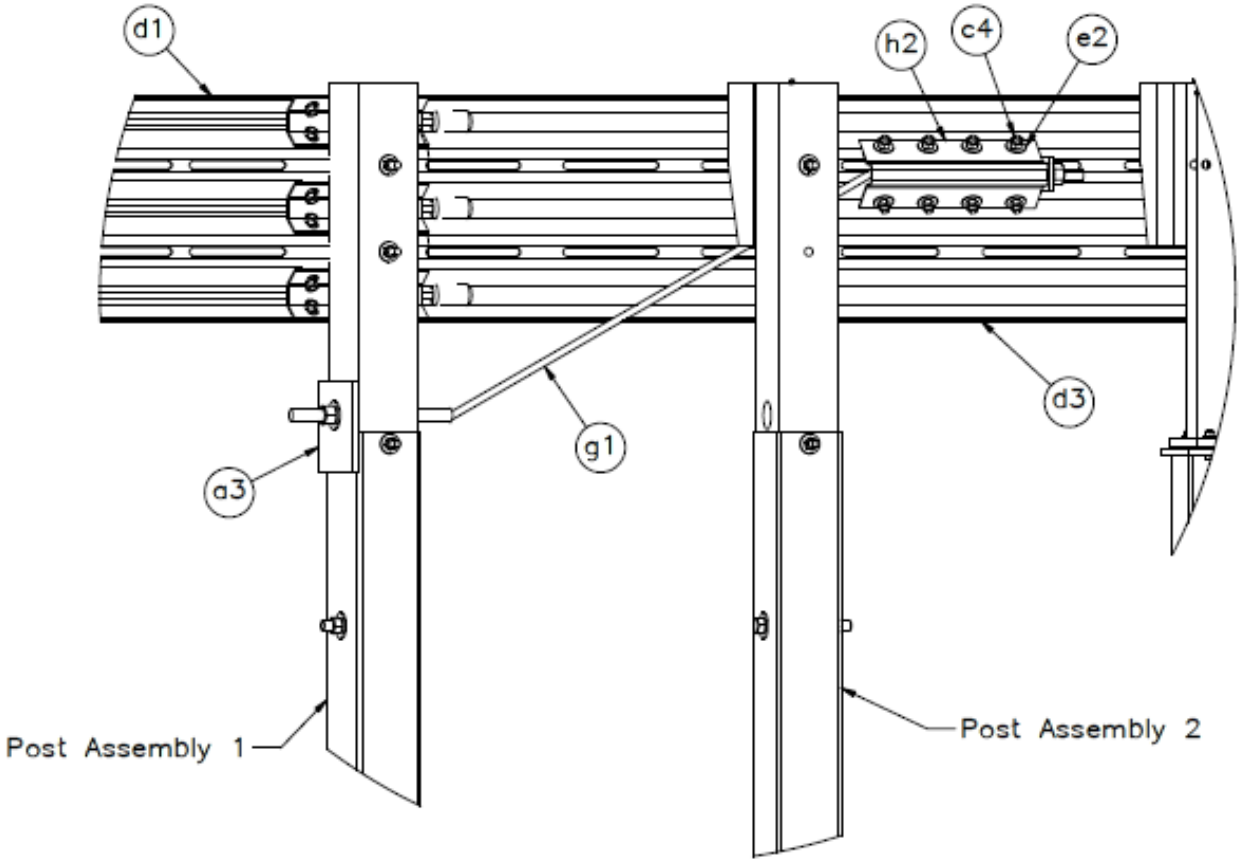


Figure 18. Diagram of Front Anchorage

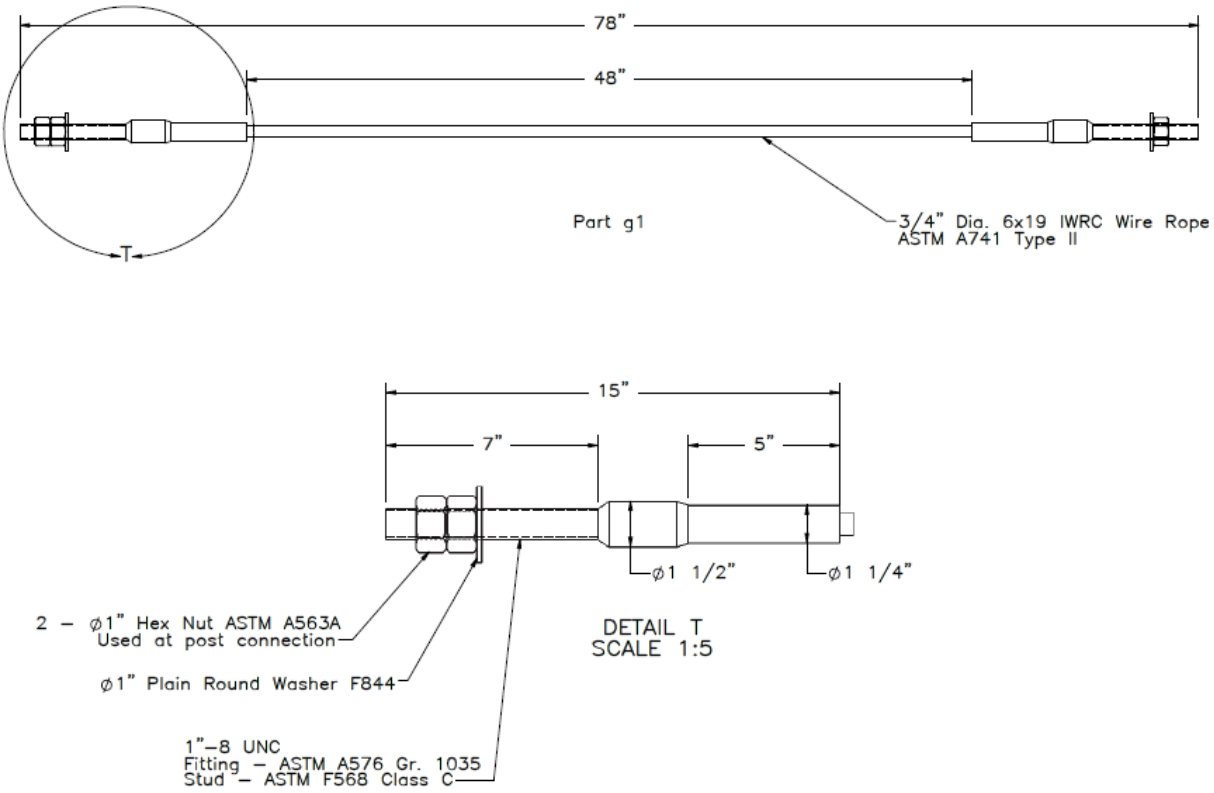


Figure 19. BCT Anchor Cable

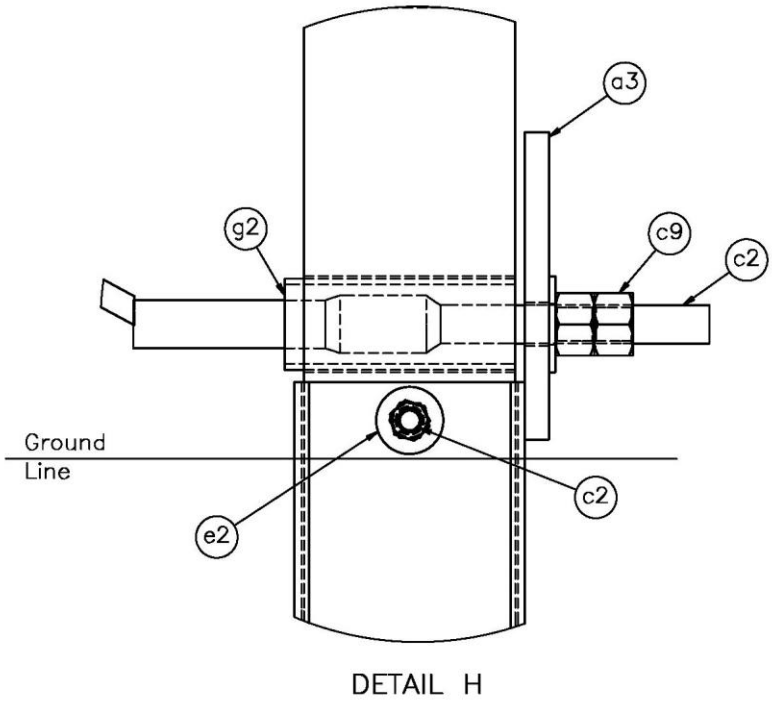


Figure 20. Post 1 Cable and Post Assembly

2.2.2 Guardrail

Four thrie-beam sections and one W-to-thrie transition section make up the bullnose system. The first three rail sections are cut with slots in the valleys of the rail to aid in energy dissipation and manage rail deformation and kinking during impact. All thrie beam rail sections used in the bullnose barrier consist of 12-gauge steel thrie beam. The W-to-thrie transition section is 10-gauge material. The rail segments are spliced together with standard lap splices.

Guardrail Section 1

This rail section makes up the nose of the system and consists of a 12-ft 6-in. long section bent into a $62^{3}/_{16}$-in. radius. This guardrail has 3 slots measuring 27½ in. and is shown in Figure 21.

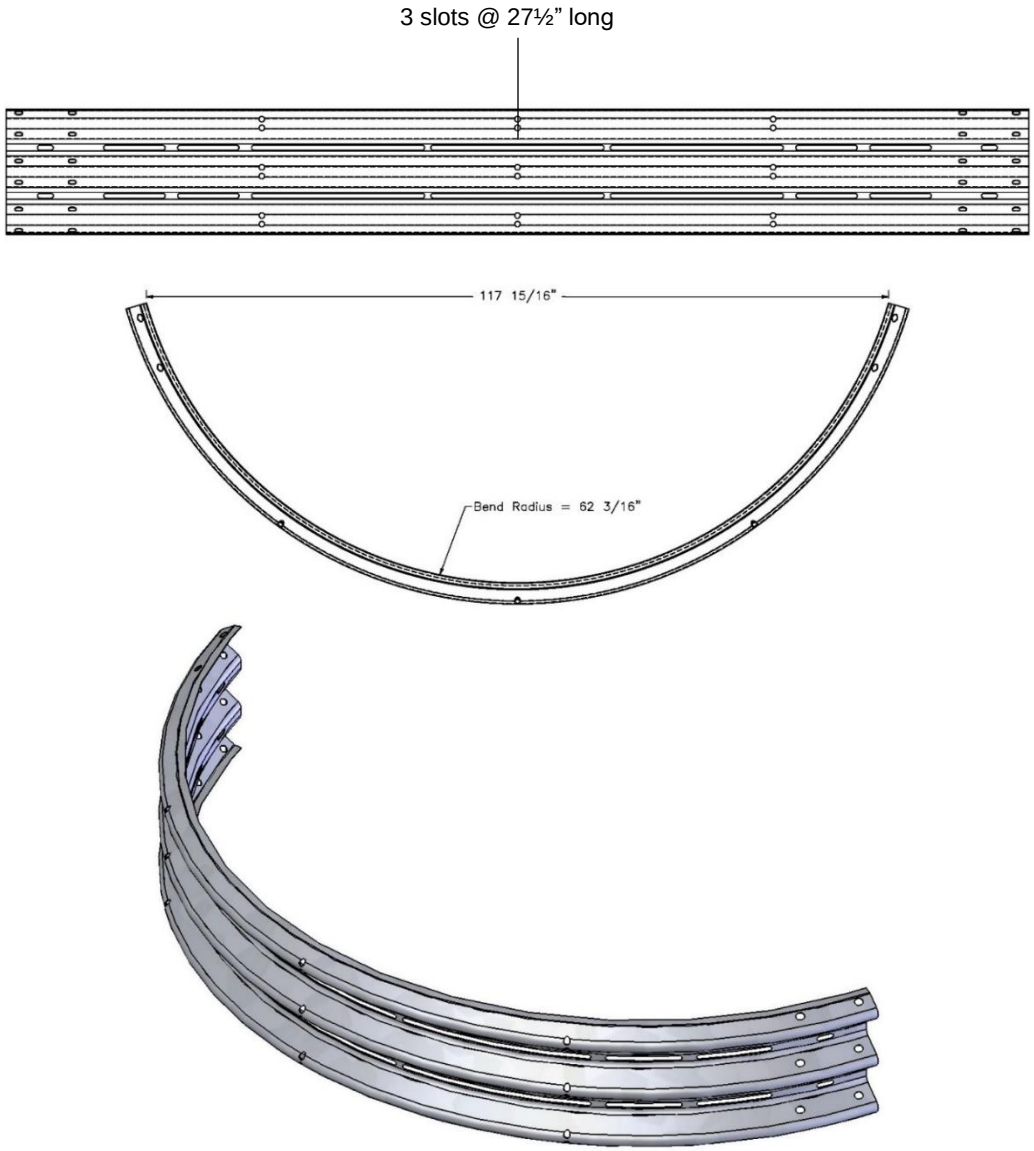


Figure 21. Guardrail Section 1

Guardrail Section 2

The second rail section, which extends from post 1 to post 5 on each side of the bullnose system, is bent to form a $409^{7}/_{16}$-in. radius curve and has 11 slots at ¾ x 8⅞ in., as shown in Figure 22. Note that MnDOT standards allow the use of an asymmetrical bullnose system for median widths greater than 24 ft, as described in Section 6.5. For this type of installation, the second rail section on side of the bullnose opposite oncoming traffic is straight rather than curved, but the rail slot pattern is unchanged.

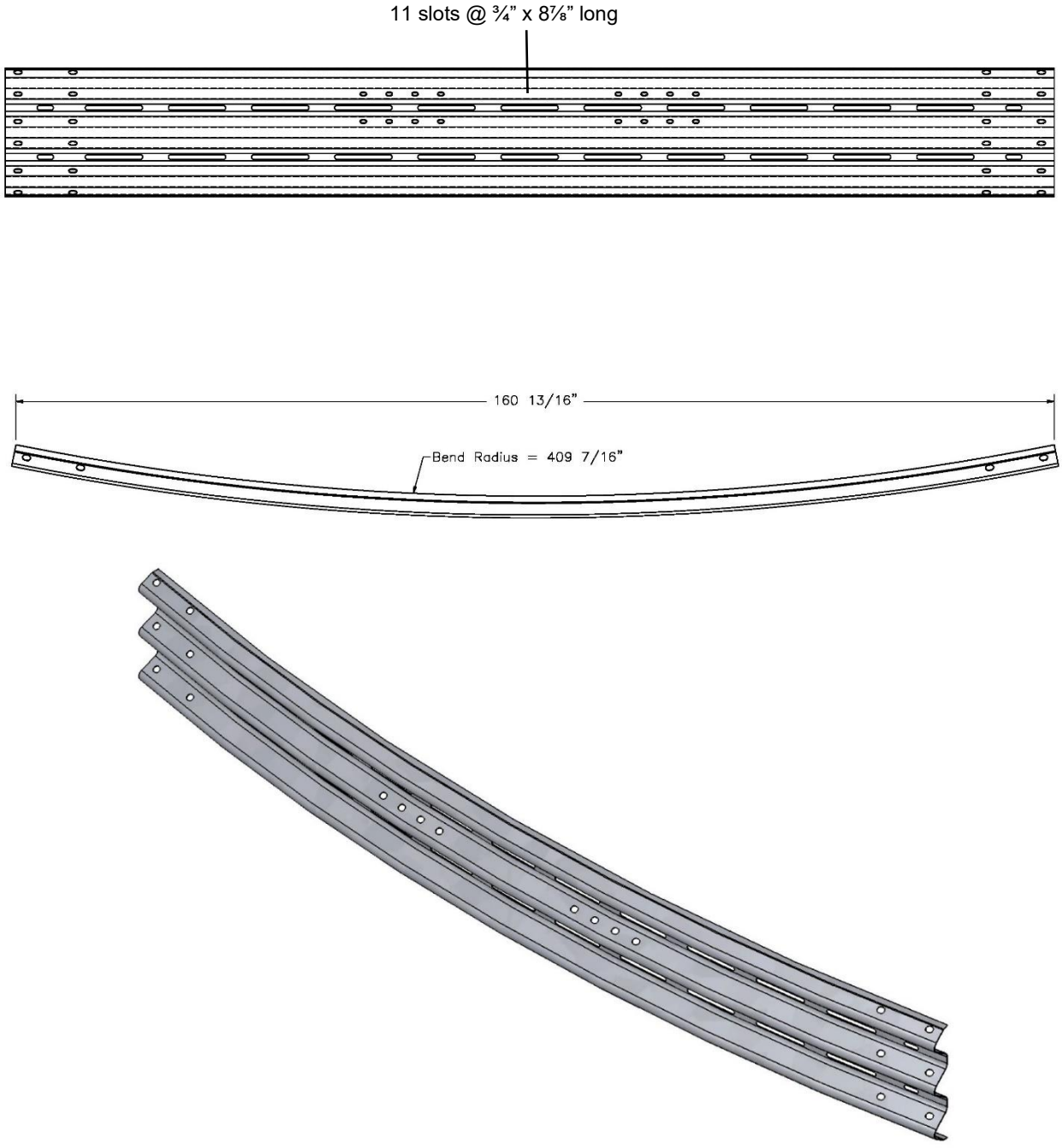


Figure 22. Guardrail Section 2

Guardrail Section 3

The third rail section, which extends from post 5 to post 8 on each side of the system, consists of a 12-ft 6-in. long guardrail section with 6 slots measuring ¾ x 11¾-in. long., shown in Figure 23.

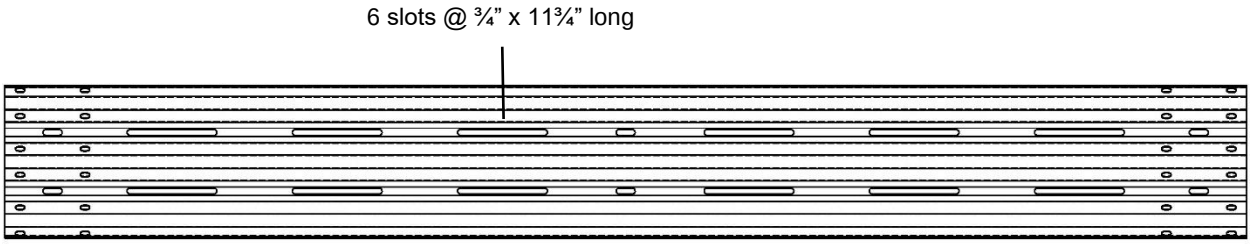


Figure 23. Guardrail in Section 3

Guardrail Section 4

The fourth rail section, which extends from post 8 to post 12 on each side of the system, consists of standard, 12-ft 6-in. long, thrie-beam guardrail section with no slots, as shown in Figure 24.

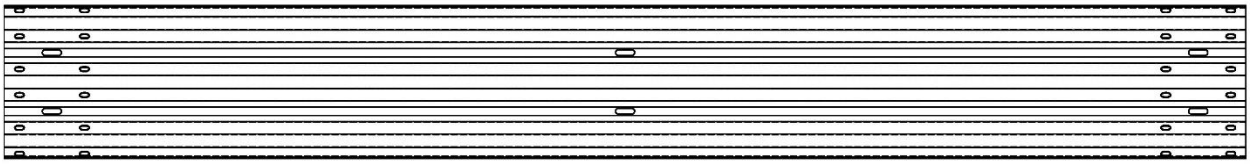


Figure 24. Guardrail in Section 4

The four thrie beam guardrail sections are shown in an installed system in Figure 25.

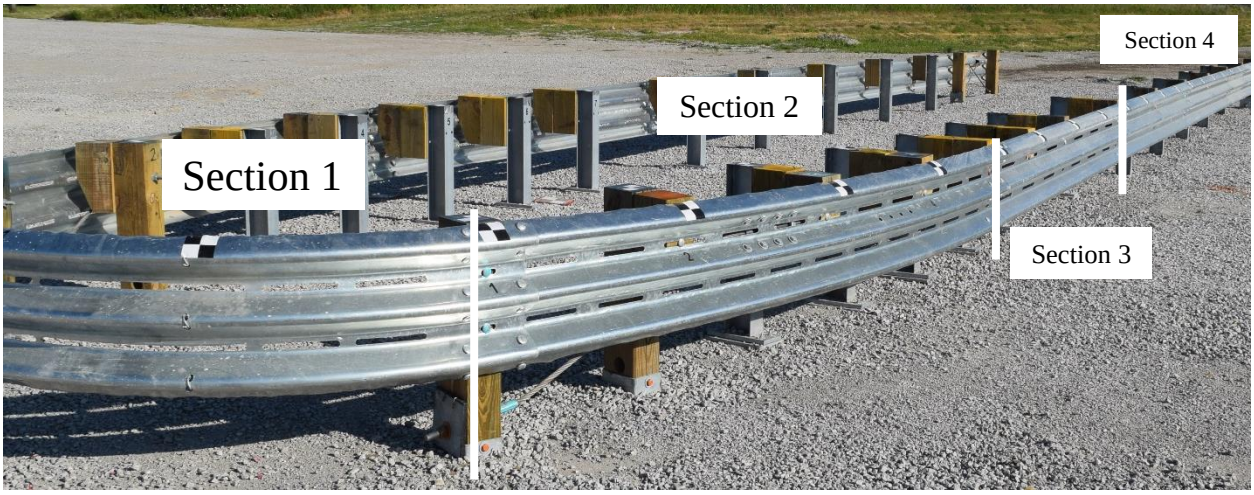


Figure 25. Installed Guardrail Sections 1 through 4

Asymmetric W-to-Thrie Transition Section

The final rail section in the bullnose is the 10-gauge, asymmetric W-to-thrie transition section used to connect the bullnose to the Midwest Guardrail System (MGS). The asymmetrical W-to-thrie transition section is added at the end of rail section 5 or post 12, as shown in Figure 26.

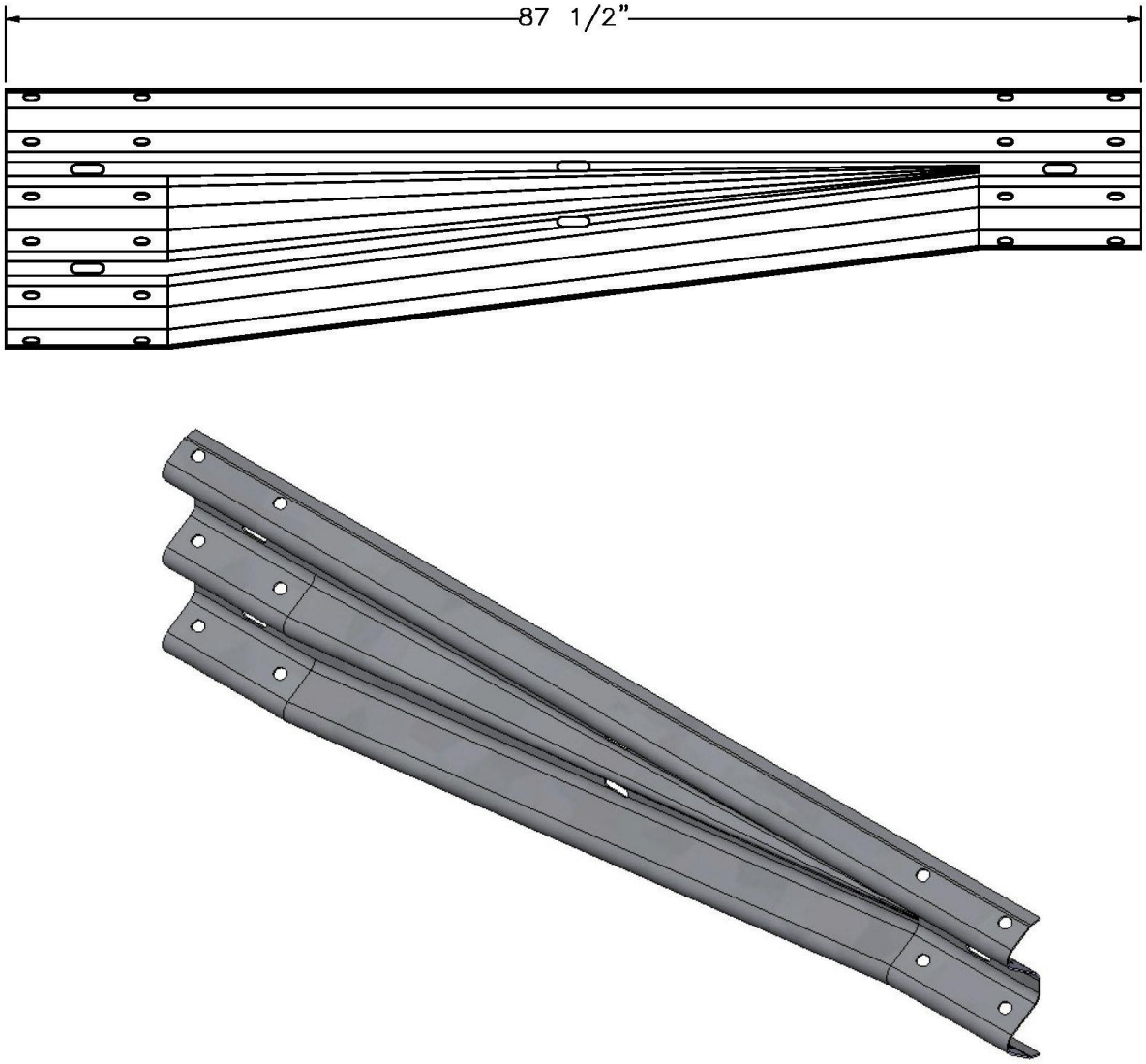


Figure 26. Asymmetric W-to-Thrie Beam Transition Section

2.2.3 Nose Cables

A set of three steel cable retention devices located behind the system nose is necessary to contain impacting vehicles in the event of rail fracture. A 14-ft 6-in. long by ⅝-in. diameter, 6x19 XIPS IWRC cable should be used behind the top, middle, and lower humps of the nose section of thrie-beam rail. A schematic is shown in Figure 27, with photographs of the installed cables shown in Figure 28 and Figure 29. A diagram of the nose cable attachment at post 1 is shown in Figure 30 and an exploded view of the nose assembly is shown in Figure 31.

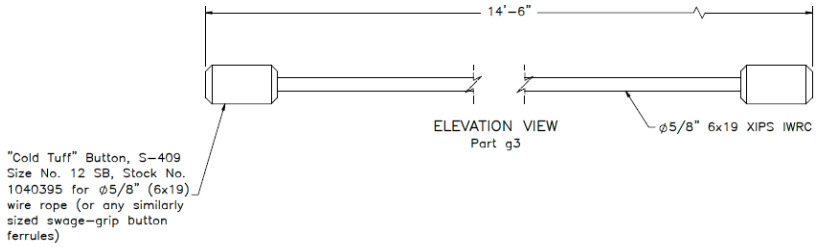


Figure 27. Cable Diagram

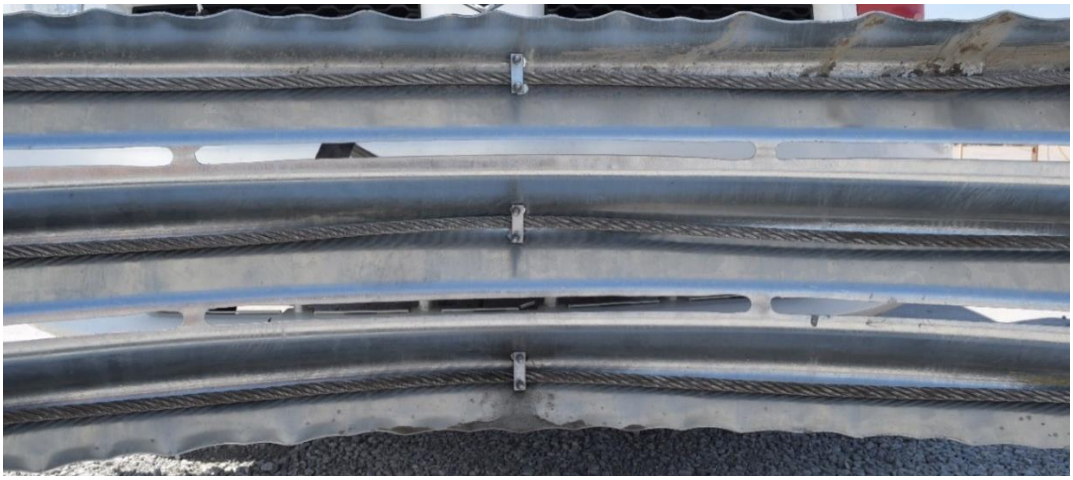


Figure 28. Cables Lining System Nose (Back View)

Figure 29. Nose Cable Attachment at Post 1

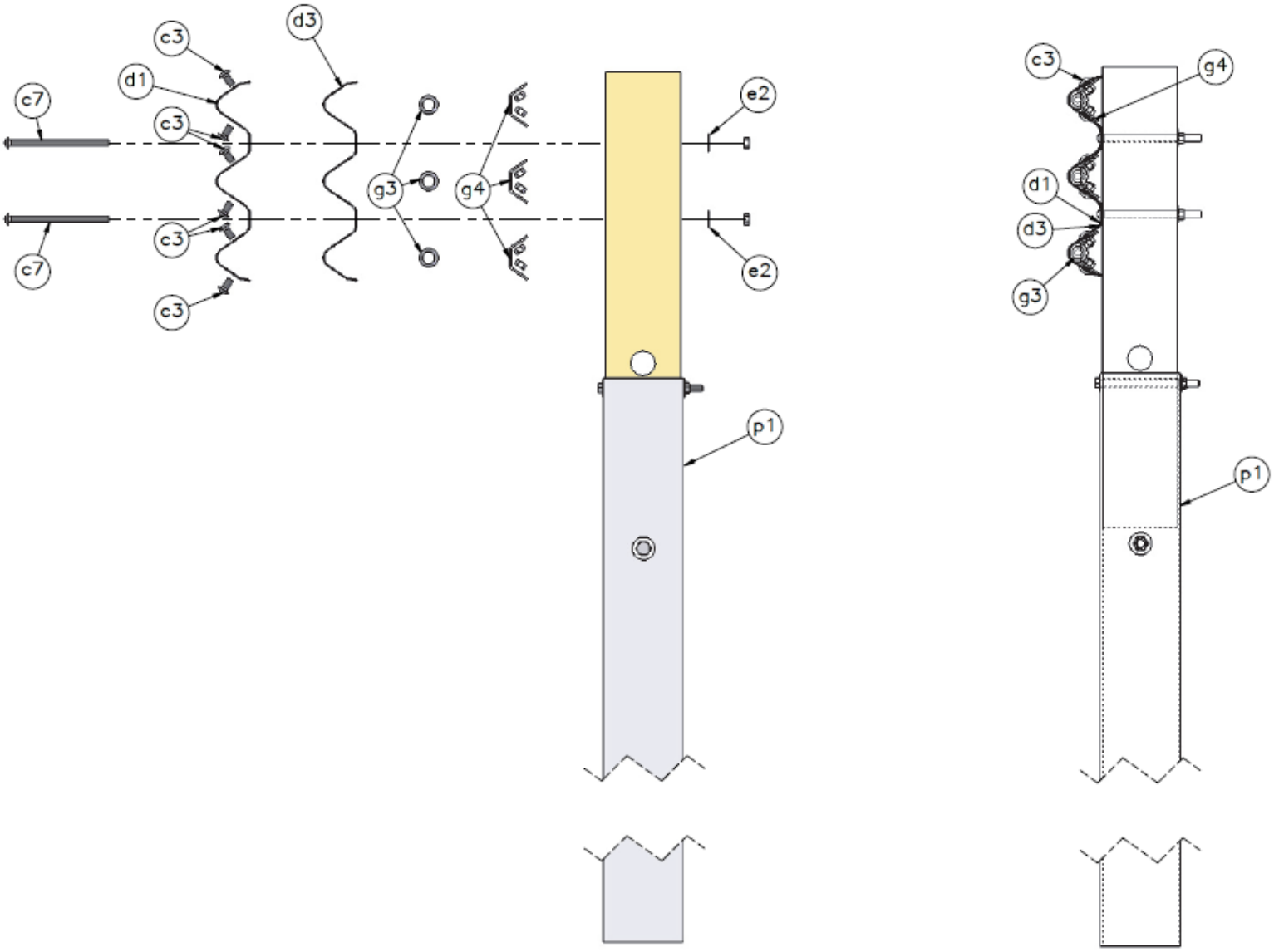


Figure 30. Post 1 – Exploded View and Detail

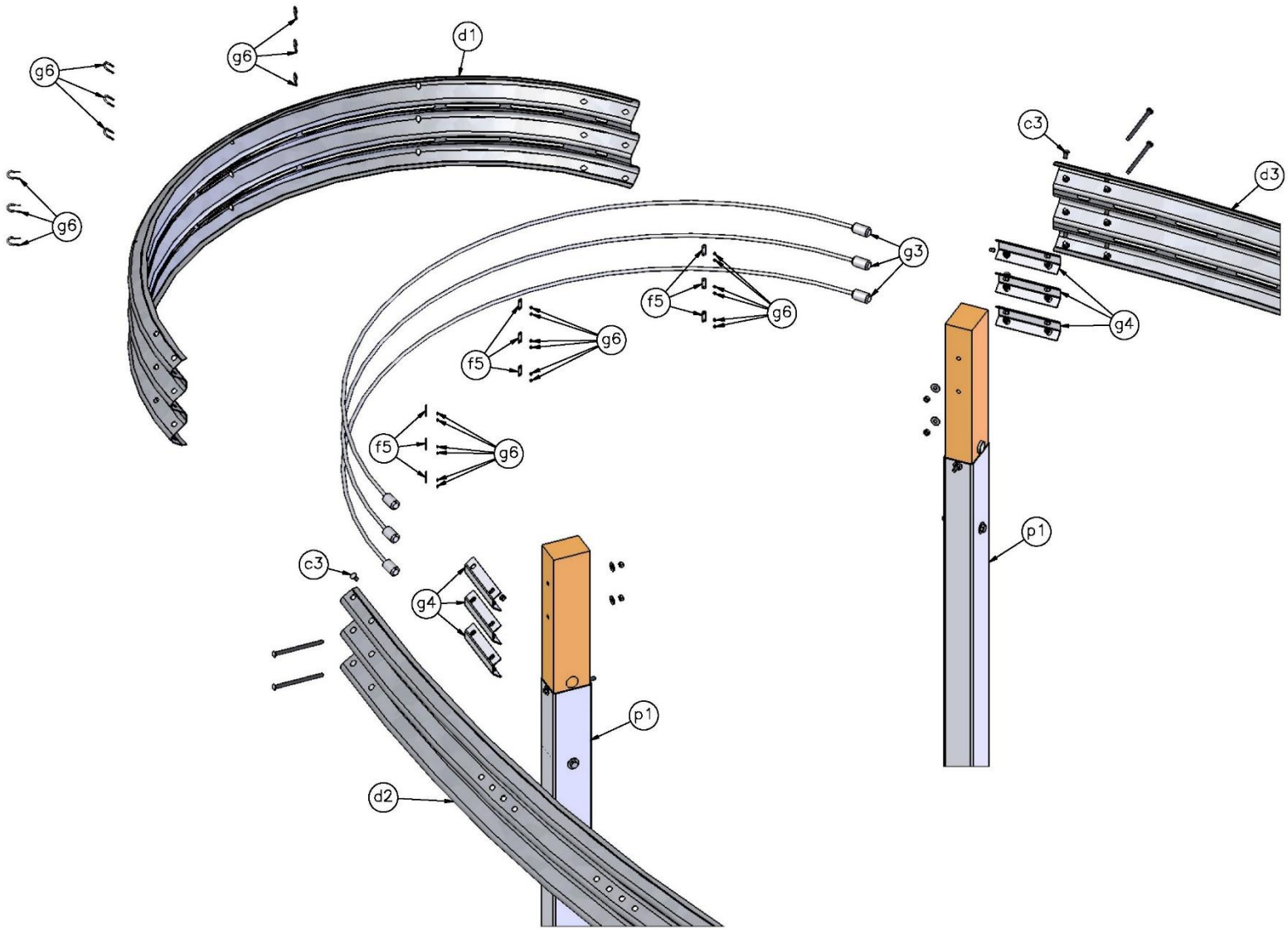


Figure 31. Nose Details – Exploded View

3 SITE PREPARATION/GRADING

As with any barrier system, grading of the terrain adjacent to the bullnose system is an important aspect of installation to ensure proper function of the system. The bullnose system should be installed on a maximum grade of 10H:1V. This grade applies to cross slopes and V- and flat-bottomed ditches. It is also recommended that the 10H:1V slope area be applied for at least 60 ft in front of the nose of the bullnose system to provide sufficient space to improve stable tracking of errant vehicles prior to impact.

For the longitudinal slopes prior to the 10H:1V grading directly adjacent to the nose of the system, several grading configurations have been developed for transitioning from 4H:1V ditch configurations to the 10H:1V required adjacent to the bullnose system. The recommended slope transitions recommend transitioning from the 4H:1V ditch to a 10H:1V slope using slopes between 8H:1V to 10H:1V. These grading transition recommendations would also be extended to sloped ditches shallower than 4H:1V. MnDOT standard grading guidance is shown schematically in Figure 32. Additional grading transition options are provided in Appendix C.

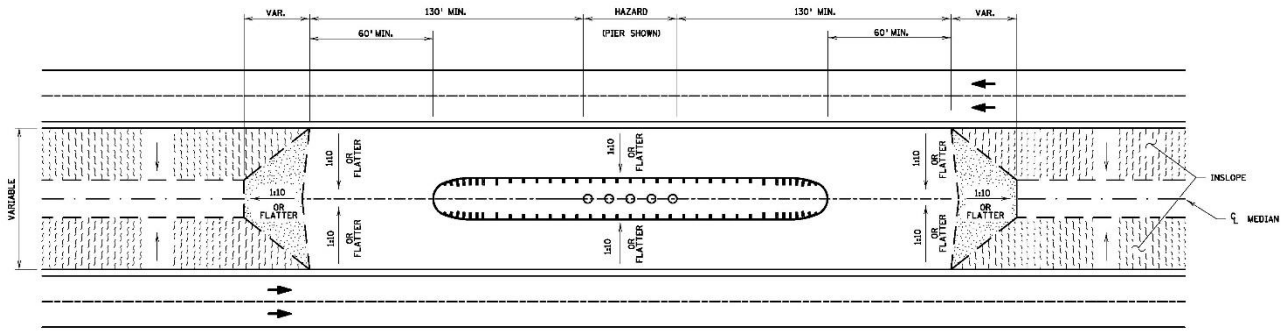


Figure 32. MnDOT Grading Diagram

Site preparation for the bullnose systems should also consider appropriate working widths and distances from the barrier system relative to the hazard or other roadway elements. In order to prevent contact with the shielded hazard during head-on impacts with the bullnose, a minimum longitudinal distance of 50-ft from post 5 or four sections of guardrail downstream from post 5 of the system, is recommended in front of any hazard, as shown in Figure 33. This is equivalent to 66 ft - 1¾ in. measured longitudinally from the center of the nose of the system.

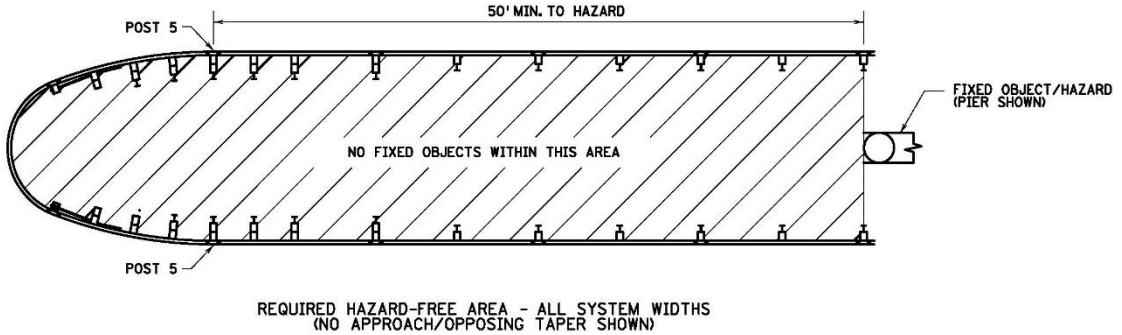


Figure 33. MnDOT Distance to Hazard Diagram

During full-scale crash testing of angled impacts on the end of the bullnose, the far side of the bullnose system extended outward from the system for a distance of 14 ft – 6 in. laterally, which resulted in a working width of 29 ft – 2 in. relative the oncoming traffic side of the system. This distance should serve as the lateral working width on one or both sides of the system depending on the direction of traffic flow. For example, if the bullnose system is installed in a median with opposing traffic, then the lateral working width would only be applied relative to the oncoming traffic side of the system. For a gore installation, the lateral working width would need to be considered relative to both sides of the system.

An additional consideration for the application of the bullnose barrier to a narrow median hazard situation is the lateral clearance between the tangent segments of the bullnose barrier system and the face of a hazard. For thrie-beam bullnose systems transitioning to the MGS or an approved thrie-beam guardrail system, the working widths for those systems should be used to establish the lateral barrier offset to the hazard.

General foundation soil conditions for the bullnose installation should follow MnDOT standard guidance and specifications for the roadway, shoulder, and medians.

Some end users may wish to install the bullnose in an asphalt or concrete median. Because the presence of asphalt or concrete paving can limit the post rotation and energy absorption, leave-outs are required for bullnose installations in paved areas. Note that the leave-out recommendations are based on existing research and our engineering analysis and judgment as the bullnose has not been crash tested with leave-outs. For standard longitudinal barrier posts, current leave-out guidance is shown in Figure 34 and requires at least 7 in. from the back of the post to the edge of the leave-out to allow for proper rotation of the post and energy absorption from the soil. The parallel sides of the bullnose which utilize standard guardrail posts function as a longitudinal barrier should perform acceptably when using current leave-out guidance. This would be posts 9 and above (or downstream) on the bullnose.

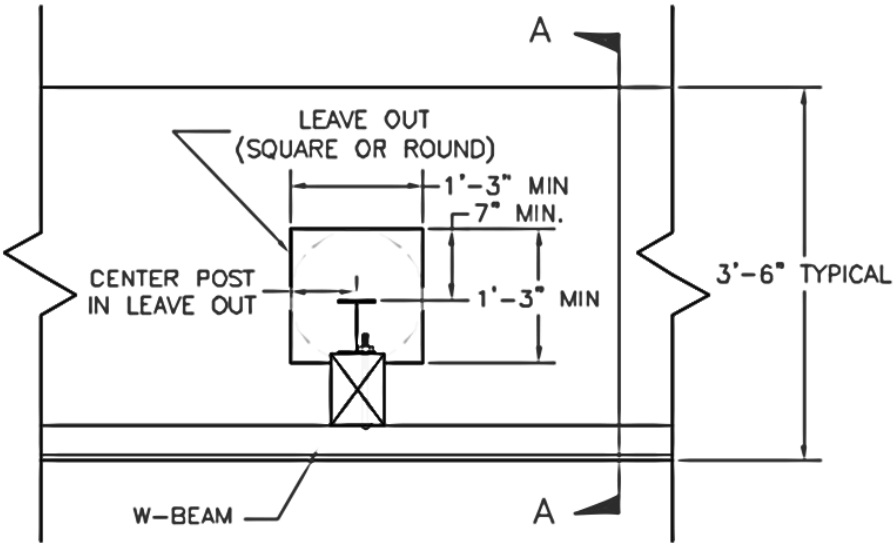


Figure 34. Post Leave-Out Guidance for Posts 9 and Above

The UBSPs in the system require additional considerations due to their loading in both the lateral and longitudinal axes. This would include posts 3 through 8 in the bullnose. Soil rotation is necessary for these posts to function properly in both the lateral and longitudinal directions. In order to allow proper movement in the lateral and longitudinal directions, we recommend that the leave outs for the UBSPs (posts 3 through 8) use a leave-out with 7-in. clear on each side of the post as well as the back. Thus, the recommended leave-out for the UBSP is similar to the schematic shown in Figure 34 except that the leave-out should be 20 in. wide by 15 in. deep.

The anchor posts at posts 1 and 2 would require similar consideration to accommodate the potential displacement of the anchor posts in soil. It is recommended that the leave-out for posts 1 and 2 have 7 in., the same as posts 3 through 8.

4 INSTALLATION

4.1 Materials

Details on the system pay limits, basic system configuration, and the various parts and assemblies are detailed in Chapter 2.

4.2 Recommended Tools

The tools required for installation of the MASH Bullnose system are the same as those used to install standard highway guardrails, including sockets/wrenches, a hammer, vice grips or pipe wrench, and other equipment such as augers, tampers, and post pounders commonly used in driving guardrail posts. Drift pins for installation of rail splices may be useful in the system assembly as well. Appropriate post driving caps shall be used when driving the various posts and foundation tubes to prevent damaging the components. Contractors shall provide driving caps compatible with their equipment.

4.3 Installation Procedure

The major steps in the installation of the bullnose system are as follows:

1. Site preparation/grading
2. Establish the layout of the post and rail components
3. Lay out materials
4. Splice rail sections, install nose cables, and assemble UBSPs
5. Install BCT posts
6. Install UBSPs
7. Install standard guardrail posts
8. Install blockouts and mount guardrail to posts
9. Install cable anchorage
10. Tighten connections and complete final inspection

Installation may be completed in a different order if each step is completed correctly.

4.3.1 Site Preparation/Grading

See Chapter 3 Site Preparation/Grading.

4.3.2 Determine System Layout

Multiple options exist for determination of the layout of the bullnose system. MnDOT designers can provide survey coordinates for the system posts directly to the installer. For a second layout option, the designer will provide the location of the bullnose system relative to the roadway and hazard shielded and the layout of the system can be determined using the relative position of the system posts via coordinate geometry. A diagram of the post layout and numbering scheme for the this type of relative position layout is shown in Figure 35 with the reference frame starting at the center of post 13A. Figure 36 shows the angle of the post flange relative to the roadway for posts 1 through 4. The coordinates for post locations are shown in Table 7. A third layout option

for the bullnose system uses an alternate system layout diagram showing post distance from the system centerline is shown in Figure 37. Site grading with the nose location staked out is shown in Figure 38.

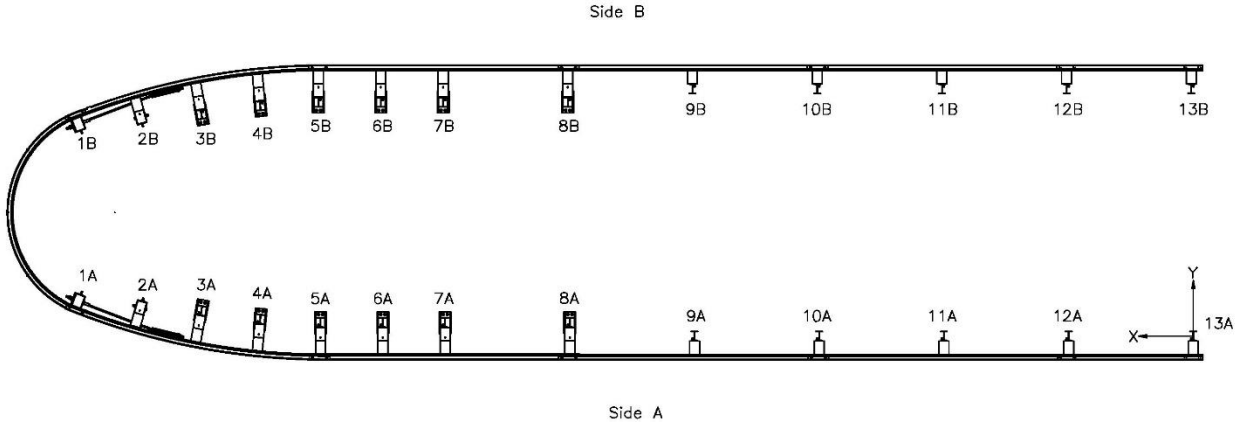


Figure 35. Guardrail Post Layout Schematic

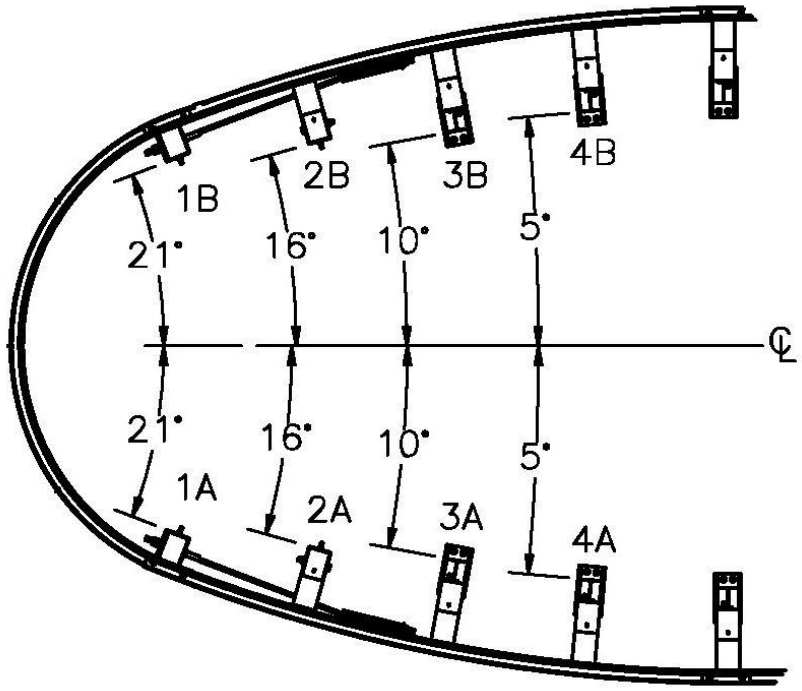


Figure 36. Face of Post Flange Angle Relative to Roadway

Table 7. Coordinates for Post Layout

Post No.	X	Y	Face of Post Flange Angle Relative to Roadway (deg.)
13A	0	0	0
12A	6’ – 3”	0	0
11A	12’ – 6”	0	0
10A	18’ – 9”	0	0
9A	25’ – 0”	0	0
8A	31’ – 3”	0’ – 8”	0
7A	37’ – 6”	0’ – 8”	0
6A	40’ – 7½”	0’ – 8”	0
5A	43’ – 9”	0’ – 8”	0
4A	46’ – 9¼”	0’ – 10”	5
3A	49’ – 8⅝”	1’ – 3¼”	10
2A	52’ – 9¼”	1’ – 5⅛”	16
1A	55’ – 10½”	1’ – 9¼”	21
1B	55’ – 10½”	10’ – 7⅜”	21
2B	52’ – 9¼”	10’ – 11⅝”	16
3B	49’ – 8⅝”	11’ – 1⅜”	10
4B	46’ – 9¼”	11’ – 6⅝”	5
5B	43’ – 9”	11’ – 8⅝”	0
6B	40’ – 7½”	11’ – 8⅝”	0
7B	37’ – 6”	11’ – 8⅝”	0
8B	31’ – 3”	11’ – 8⅝”	0
9B	25’ – 0”	12’ – 4⅝”	0
10B	18’ – 9”	12’ – 4⅝”	0
11B	12’ – 6”	12’ – 4⅝”	0
12B	6’ – 3”	12’ – 4⅝”	0
13B	0	12’ – 4⅝”	0

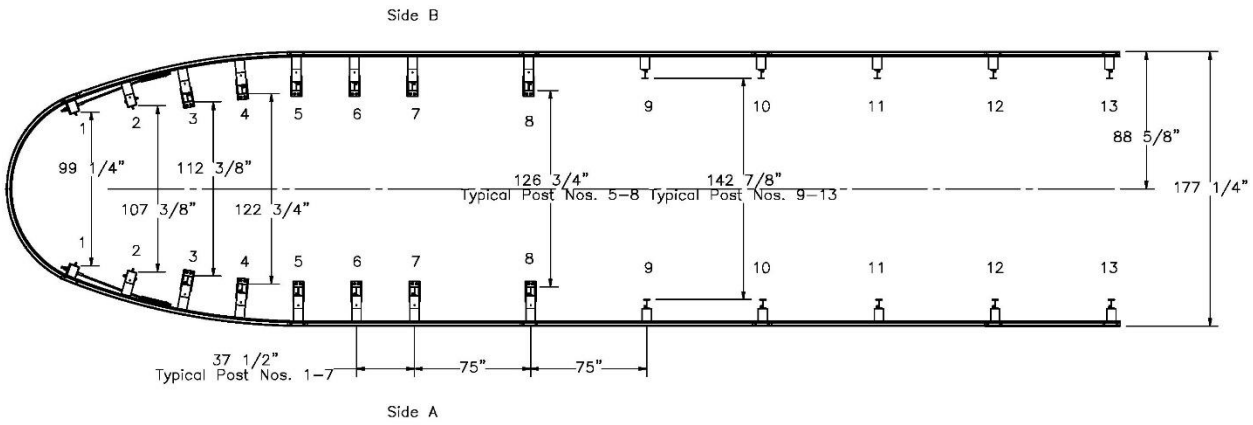


Figure 37. Alternative Post Layout Method

Figure 38. Site Grading with Nose Location Staked Out

4.3.3 Lay Out Materials

Lay the system materials described in Chapter 3 in their approximate final location, as shown in Figures 39 through 41.

Figure 39. Guardrail in Approximate Final Location

Figure 40. Posts and Blockouts in Approximate Final Location

Figure 41. Posts in Approximate Final Location

4.3.4 Connect Nose Guardrail, Assemble UBSPs, and Install Nose Cables

Connect Guardrail

Connect rail sections 1, 2, and 3 at the splices while on the ground before attaching to posts. Do not fully tighten bolts until all components are assembled and the rail is mounted on the posts. Note that rail section 2 should have the cable anchor bracket attachment holes located on the upper thrie beam valley between posts 2 and 3 in order to facilitate proper installation of the cable anchorage later in the assembly process.

Splice Lapping

Lap splices should always be oriented based on the traffic flow on each side of the system, such that the upstream rail segment overlaps the downstream rail segment, as shown in Figure 42. For a median installation, the thrie-beam bullnose lap splicing should proceed in a continuous manner all the way around the system in the direction of oncoming traffic. For a gore installation, the lap splicing would be reversed on one side to match the traffic direction.

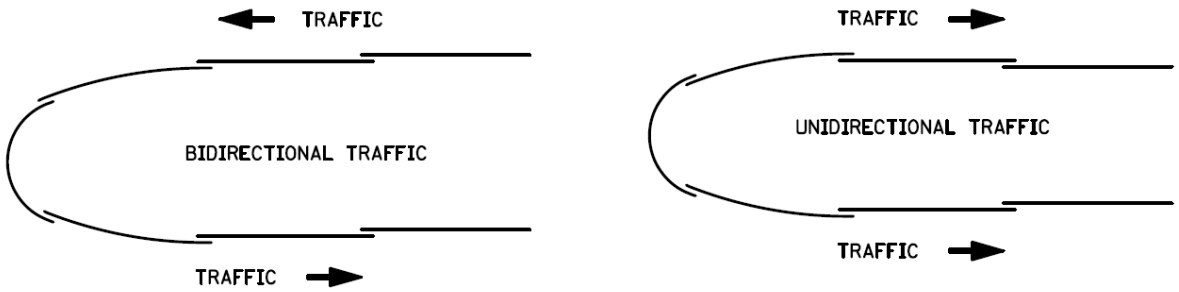


Figure 42. Lap Splicing Diagram

Assemble UBSPs

UBSPs should be assembled with one upper UBSP assembly (tube and plate, part a5) and one lower UBSP assembly (post and plate, part a4) per post. Bolt upper and lower UBSP assemblies together with four $^{7}/_{16}$-in. dia., 2¼-in. long hex bolts and nuts (part c5), as shown in Figures 8 and 9. Assembled UBSPs are shown in Figure 43. The bolts connecting the upper and lower base plates should be installed with the nuts on the upper base plate so they are accessible for maintenance.

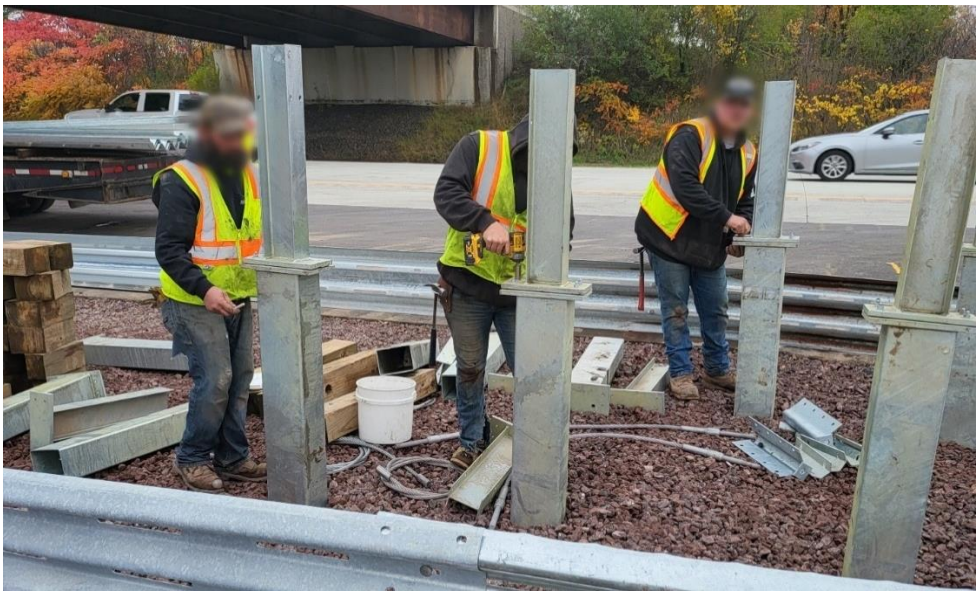


Figure 43. UBSP Assembly

Install Nose Cables

Install the three nose cables on the back side of rail section 1 by securing the end of the cables behind the 12⅝"x5$^{13}/_{16}$"x$^{3}/_{16}$" nose cable anchor plates (part g4) located at the slice between rail sections 1 and 2, as shown in Figure 44. Secure the anchor plates with the guardrail splice bolts. There is sufficient cable length for the button ferrule ends on the cable to extend slightly past the anchor plates. Insert U-bolts, nuts, and washers (parts g6 and f5) at the middle and quarter points of rail section 1 to secure the nose cables to backside the rail corrugations in rail section 1, ensuring that the radius of the U-bolt is on the traffic-side face of the guardrail, as shown in Figure 44 through Figure 46.

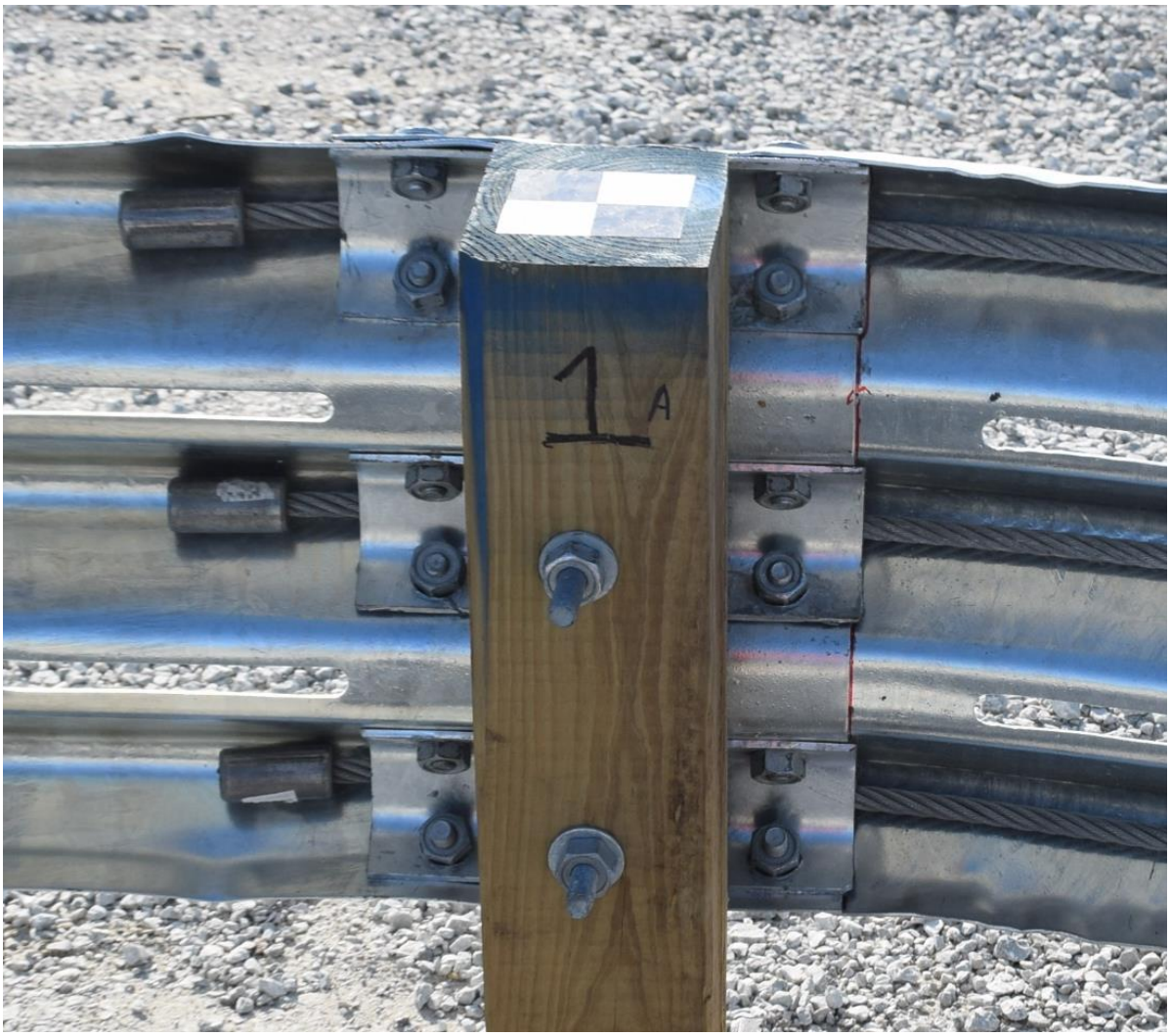


Figure 44. Nose Cable and Cable Anchor Plate Configuration

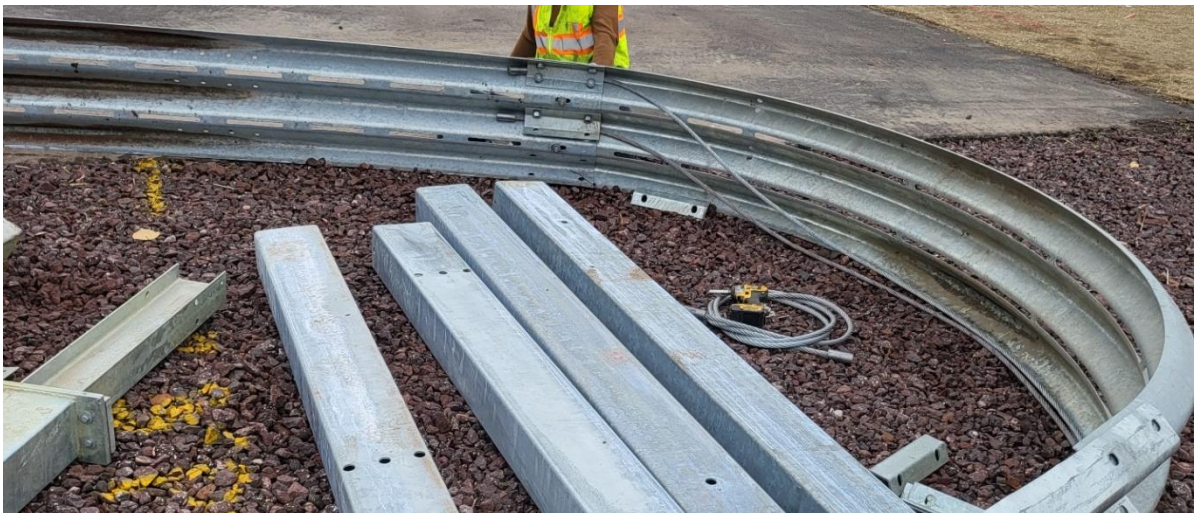


Figure 45. Partial Nose Cable Installation

Figure 46. Nose Cable U-bolt Orientation

4.3.5 Install Breakaway Cable (BCT) Posts - Posts 1 and 2

Posts 1 and 2 are 32⅝-in. long BCT timber posts inserted into foundation tubes. A 6-in. wide by 8-in. deep by 8-ft long foundation tube is used for post 1 and a 6-in. wide by 8-in. deep by 6-ft long foundation tube is used for post 2. The foundation tubes must be installed before inserting the timber post.

The tubes must be installed such that the narrow side faces the rail. Using an appropriate driving cap, drive the foundation tubes until the top of the foundation tube extends 2 in. above the ground. Figure 47 shows the driving process. Ensure that the driven tubes do not fill with soil so the timber posts can be inserted to the correct embedment depth. A ⅞-in.-9 UNC, 8-in. long hex head bolt must be installed into the lower hole in the foundation tube and secured with nut and ⅞-in. washer (parts c6 and f2) prior to driving. This bolt prevents the BCT post from dropping to the bottom of the tube when installed.

Note: All bullnose posts may also be installed by auguring and backfilling if the contractor prefers. The initial hole must be large enough to allow adequate room for proper compaction of the soil during backfill. Additional details for this installation method are provided in Appendix D.

Figure 47. Driving BCT Foundation Tubes

After the foundation tubes are installed, insert timber BCT posts into the foundation tubes (parts a1 and a2) and secure with bolts and nuts. Insert a ⅝-in.-11 UNC, 10-in. long hex head bolt through upper hole in foundation tube and bottom of each BCT post and secure with a nut and ⅝-in. dia. washer (parts c2 and e2).

Figure 48. Installation of BCT Post in Foundation Tube

4.3.6 Install UBSPs – Posts 3 through 8

Posts 3 through 8 are universal breakaway steel posts (UBSPs) consisting of assembled upper and lower UBSP sections. Drive the assembled posts into the soil using an appropriate driving cap until the underside of the lower base plate is flush with the ground. Figure 49 shows the driving process and Figure 50 shows an installed UBSP.

Figure 49. Driving UBSPs

Figure 50. Installed UBSP

After driving the UBSP, the bolts connecting the top and bottom halves of the post should be inspected to ensure that they were not damaged, loosened, or otherwise disengaged during the process of driving the post. Damaged or disengaged bolts should be replaced and loosened bolts should be tightened.

4.3.7 Install Standard Steel Guardrail Posts – Posts 9 through 13

Posts 9 through 12 are W6x9 or W6x8.5 x 6-ft 6-in. long steel guardrail posts spaced at 6-ft 3-in. on center. Post 13 is a W6x9 or W6x8.5 x 6-ft long steel guardrail post. The steel posts should be driven into the soil using an appropriate driving cap. The top of the post should be at 32⅝ in. above grade to facilitate a finished guardrail top mounting height of 31⅝ in.

4.3.8 Attach Blockouts & Install Guardrail

Begin mounting the guardrail and blockout installation at the nose of the system.

Post 1: Begin guardrail installation at post 1 by lifting preassembled rail sections 1 through 3 into position. Note that rail sections 1 and 2 may need to be temporarily supported vertically prior to the attachment of the rail to post 1. Post 1 does not use a blockout, so the guardrail should be attached directly to the post using two ⅝-in.-11 UNC, 10-in. long guardrail bolts and nuts and two ⅝-in. dia. plain round washers (parts c7 and e2).

Post 2: Next, install the blockout and guardrail at post 2, which uses a tapered 6x8x14¼-in. timber blockout (part a4). This process is shown in Figure 51. The blockout should be installed

behind the guardrail and flush against the post. Pass one ⅝-in.-11 UNC, 18-in. long guardrail bolt through the front of the guardrail, through the blockout and post, and secure with one nut and one ⅝-in. dia. plain round washer at the back of the post. Insert one nail (part c8) through the top of the post and into the blockout at a downward angle to prevent blockout rotation.

Figure 51. Attaching Blockouts and Installing Guardrail

UBSPs: Install guardrail at UBSPs, posts 3 through 8, which use a combination of rectangular 6x8x14¼-in. blockouts (part a6) and tapered blockouts (part a7). The rectangular blockout should be installed behind the guardrail and flush against the post, with the tapered blockout attached to the adjacent blockout and to the back side of the thrie beam rail. Pass one ⅝-in.-11 UNC, 18-in. long guardrail bolt through the front of the guardrail, through the tapered blockout, standard blockout, and post flange, and secure with one nut and one ⅝-in. dia. plain round washer behind the post flange. Two nails (part c8) must be inserted at the top of the post and blockouts to prevent blockout rotation: (1) insert one nail through the steel post flange into the rectangular blockout at a downward angle and (2) insert one nail through the top of the rectangular blockout and into the tapered blockout at a downward angle.

Steel Guardrail Posts with Thrie-Beam Guardrail and W-to-Thrie Beam Transition Section: Install guardrail and blockouts on standard steel guardrail posts, which are post nos. 9 through 13. The 6x8x14¼-in. standard blockout (part a6) should be installed behind the guardrail and flush against the post. Pass one ⅝-in.-11 UNC, 18-in. long guardrail bolt through the front of the guardrail, through the blockout and post flange, and secure with one nut and one ⅝-in. dia. plain round washer behind the post flange. Insert one nail (part c8) through the post flange and into the blockout at a downward angle to prevent blockout rotation. Install thrie beam rail section 4 between posts 8 through 12 and the W-to-thrie transition section between posts 12 and 13.

4.3.9 Install Cable Anchor Anchorage

Attach the cable anchor to the back side of the upper thrie beam valley on rail section 2 downstream from post 2 and secure using the cable anchor bracket assembly (part h2), eight ⅝"-11 UNC, 1½" long hex head bolts (part c4), and eight ⅝-in. dia. plain round washer (part e2). The cable should pass below the tapered blockout at post 2. Insert the 2⅜" O.D. x 6" long BCT post sleeve into the hole at the base of post 1. Place the 8"x8"x⅝" anchor bearing plate on the upstream side of post 1. Note that the anchor bearing plate should be oriented with the hole in the plate near the lower end of the plate vertically (5 in. of plate above the hole and 3 in. of plate below the hole) such that the plate can be installed with the hole in the plate aligned with the hole in the BCT post with the plate entirely above grade. Pass the end of the cable through the BCT post sleeve in the base of post 1 and the anchor bearing plate and secure with two 1-in. dia. hex nuts and one washer. The cable anchor should be tightened until the anchor cable is taut with no slack in the cable. Install two nails above the anchor plate and bent down over a portion of the plate to prevent plate rotation in the field, as shown in Figure 52.

Figure 52. Cable Anchorage Installation

4.3.10 Tighten Connections

When finished assembling all the components of the bullnose system, tighten all connections in the system. This includes all splice bolts, U-bolts, post bolts, and cable anchorages. Ensure that the nose cables are tensioned.

4.3.11 Snow Markers

MnDOT installs snow markers to indicate the position of the bullnose system in deep snow and prevent damage from snowplows impacting the barrier. MnDOT typically requires a marker that is installed by bolting perforated steel square tubing (PSST) to the back-downstream corner of post no. 1 or 2 in the installation and installing a vertical plastic delineation tube or a small PSST reflective sign delineator. An example of the snow marker installation is shown in Figure 53.

It should be noted that attachments such as snow markers have not been evaluated when used in conjunction with the bullnose system. Thus, their crashworthiness and behavior during an impact event and the associated hazards to vehicles and their occupants are unknown.

Figure 53. Snow Marker Installation

4.3.12 Final Inspection

Following the completed installation of the bullnose, the MnDOT inspection checklist in Chapter 5 should be completed to verify the successful system installation. Any items noted in the checklist should be addressed immediately by the contractor/installer.

5 INSPECTION CHECKLIST

Inspection Performed By: _____ Date: _____

Location: _____

Rail	
	Rail is continuous.
	No vertical tears.
	No horizontal tears.
	No sections of flattened rail.
	No excessive deflection.
	No non-manufactured holes.
	Nominal height of rail is 31 5/8 in.
	No threaded ends of mechanical fasteners or washers on face of rail.
	Rail is secured – no separation at posts.
	Three cables are present in the nose section and anchored with anchor plates and U-bolts.
Splices	
	No missing splice bolts or bolts torn through the rail.
	All bolts secure and tightened.
	Splice lapping consistent with direction of traffic.
	Splices in correct location.
Posts	
	No missing posts.
	No broken/damaged posts.
	Post spacing is in accordance with standard.
	Posts are plumb.
	BCT wood posts are in accordance with Standard Plate 8365
	BCT foundation tubes are in accordance with Standard Plate 8366.

	Universal Breakaway Steel Posts are in accordance with Standard Plate 8362.
	Steel guardrail posts are in accordance with Standard Plate 8361.
	Timber blockouts are installed properly on all posts, including tapered blockouts adjacent to the rail at post nos. 2 through 8.
	No steel posts severely twisted.
	No tears in steel posts.
	Nuts/bolts secure.
	Non-breakaway components are no more than 4 in. above ground (includes foundation tubes for wood posts).
	Leave-out areas for posts in pavement match the standards shown on Standard Plan 5-297.611.
	No significant erosion around posts.
	Grading behind and in front of posts per standard.
Blockouts	
	No missing blockouts (at locations per standard).
	No significant section loss.
	No twisted/rotated blockouts.
Anchor Cable	
	Cable is properly installed between post nos. 1 and 3.
	Cable is taut.
	Cable anchor bracket is firmly attached to rail.
	Bearing plates are oriented with long side up and secured with bent over nails.
General	
	All metallic components are free of significant rust or deterioration.
	All wooden materials free of deterioration, rot, excess damage.
	No slope-related lean of barrier.
	Nothing in front of barrier that could cause vehicle vaulting.
	Obstacles are located beyond working width.
	Layout and grading in accordance with Standard Plan 5-297.611.

6 ADDITONAL CONSIDERATIONS AND ALTERNATIVE CONFIGURATIONS

Real-world bullnose installations may potentially involve site considerations and alternative installation not covered in the installation guidance provided previously. The following sections provide recommendations for use in the implementation of the bullnose system in the alternative configurations. Additionally, there are three foreseeable field applications for the bullnose barrier system: (1) the protection of the gap between twin bridges; (2) gore area protection; and (3) protection of narrow median hazards, such as bridge piers and overhead sign support structures. For each of the three bullnose applications, there are installation and design factors that should be addressed before the system can properly be used in these situations. These additional considerations will be addressed for each application.

For all non-standard bullnose installations not discussed in this chapter, see the MnDOT Standard Plans, shown in Appendix A.

6.1 Breakaway Posts

A final note with respect to the UBSPs relates to the bolts used to hold the upper and lower sections of the post together. These bolts can potentially be difficult to install/repair due to the lower base plate being flush with the ground. A potential solution to this issue proposes using welded nuts on the lower base plate that would eliminate the need for excavation. While this solution would make installation easier, removal of fractured bolts would tend to be difficult. Thus, it would be up to end users to determine whether to use the welded nut option.

6.2 Transitioning to MGS

It is recommended that an asymmetrical W-to-thrie transition segment between posts 12 and 13 be used to connect the bullnose to MGS. The asymmetrical W-to-thrie transition section should not be added until the end of rail section 5 or post 12. When transitioning from the bullnose to the MGS, there is a need to transition the splices to the mid-span between the posts as well. It is recommended that this transition be accomplished by placing the first post downstream from the asymmetrical W-to-thrie transition section at ½-post spacing and then using standard spacing from that point on. This layout would correspond to installing a post at ½-post spacing after post 14 in the thrie-beam bullnose system and using standard post spacing afterward. A schematic of the recommended transition is shown in Figure 54.As the top rail height of the thrie-beam bullnose is currently 31⅝ in., the height of the barrier system would need to be transitioned to match the 31-in. height of the MGS following the adjustment of the post spacing and splice location. Thus, the height transition should occur beginning at post 16 and can be done over a length of 25 ft.

The thrie-beam bullnose system should not be attached to the G9 thrie-beam guardrail system rather than the MGS as standard G9 thrie-beam guardrail has not met the MASH 2016 TL-3 safety requirements.

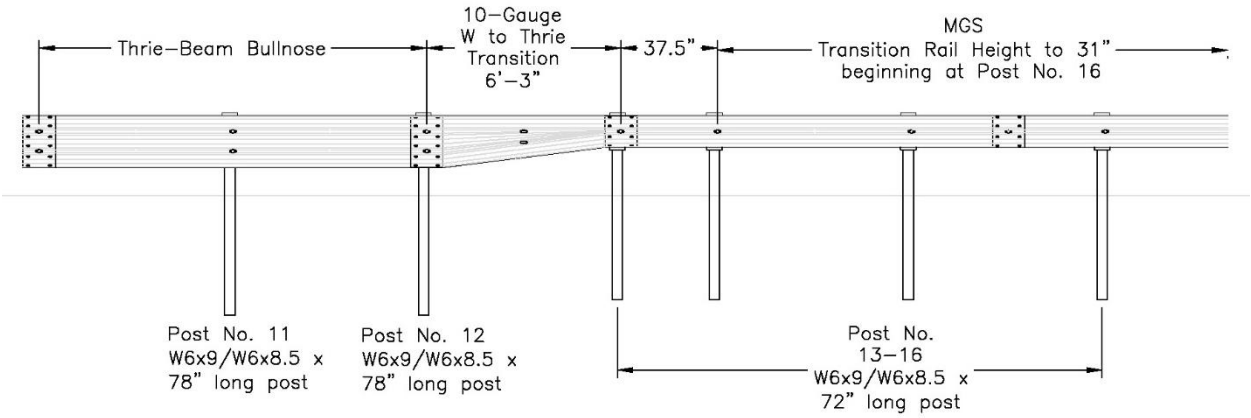


Figure 54. Thrie-Beam Bullnose Transition to MGS

6.3 Transitioning to Thrie-Beam AGTs

Another application for the thrie-beam bullnose system involves its attachment directly to a thrie-beam approach guardrail transition (AGT) when used to shield twin-bridge median hazards. Attachment of the bullnose to an AGT should consider both the length of the bullnose system required upstream of the AGT as well as the configuration of the connection between the thrie-beam bullnose system and the AGT. It is recommended that any transitions used in conjunction with the bullnose median barrier be placed no closer than the end of rail section 5 or post 12. This guidance should allow for the necessary deformation of the thrie-beam guardrail in advance of any transition.

In addition to the location of the AGT connection, the thrie-beam bullnose system should be attached to a MASH-compliant, thrie-beam AGT that is crashworthy at both the upstream stiffness transition and the connection to the bridge rail, concrete buttress, or concrete parapet.

A schematic of the proposed transition from the thrie-beam bullnose system to a thrie-beam AGT alongside a standard thrie beam AGT is shown in Figure 55. In order to attach the AGT to the bullnose system, the 10-gauge W-thrie transition piece and adjacent 75-in., 12-gauge thrie-beam section were removed and replaced with a single 150-in. long, 12-gauge thrie-beam section. In addition, the first post at ½-post spacing on the upstream end of the stiffness transition was removed. The remainder of the AGT was retained, including the ½-post spacing and the use of 12-in. deep blockouts. The proposed transition design currently shows the use of 6-ft long posts in the AGT in order to minimize changes to the basic AGT configuration. However, there would be no safety performance concerns with switching to 6.5-ft long posts in that region of the MGS upstream stiffness transition if end users desired to limit the number of post types.

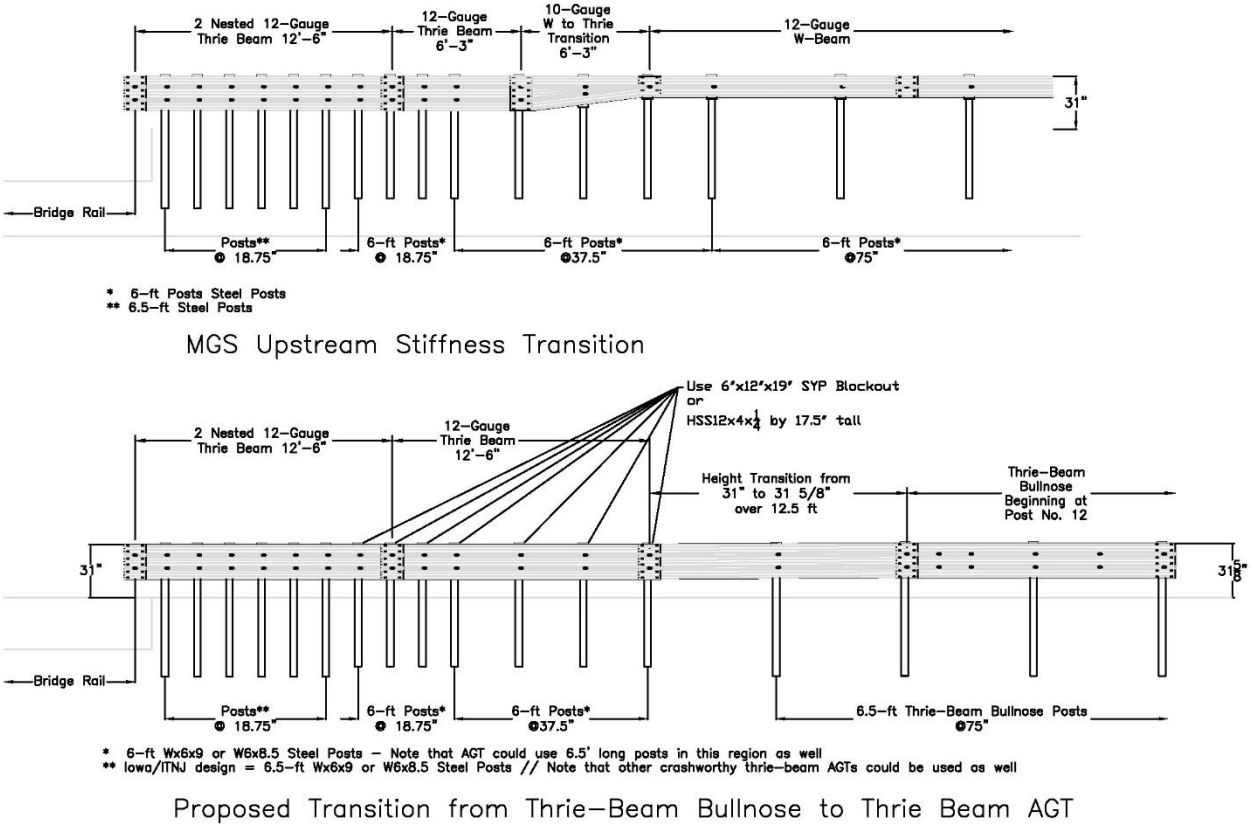


Figure 55. Thrie-Beam Bullnose Transition to Thrie-Beam AGTs

6.4 Wide Designs

Two wider bullnose configurations were created by laterally pushing out the sides of the system and then modifying the size of the nose section, as shown in Figure 56 through Figure 61. The geometry and slot patterns of rail sections 2 and 3 remained unchanged. For the two new configurations, an 18.75-ft long and 25-ft long section of thrie-beam guardrail was bent to form the $93^{5}/_{16}$-in. and 124⅜-in. radii, respectively. A 12.5-ft long section of guardrail was used for the nose section of the system that was crash tested. While the size of the nose section was increased, it was simply scaled upward to account for the longer section length and did not change in shape. The new widths for the widened bullnose configurations are $235^{5}/_{16}$ in. and $293^{7}/_{16}$ in. These widened systems may be used for shielding twin bridges or wide hazards on divided highways. The wider bullnose systems offer economy over the narrower, crash-tested configuration as the potential exists for reduced lengths of flared guardrail between the bullnose barrier and the bridge rail and transition systems. It should be noted that the proposed wide designs are based on the best, currently available, engineering judgment. Further analysis and full-scale crash testing would be required to verify the performance of the wide designs.

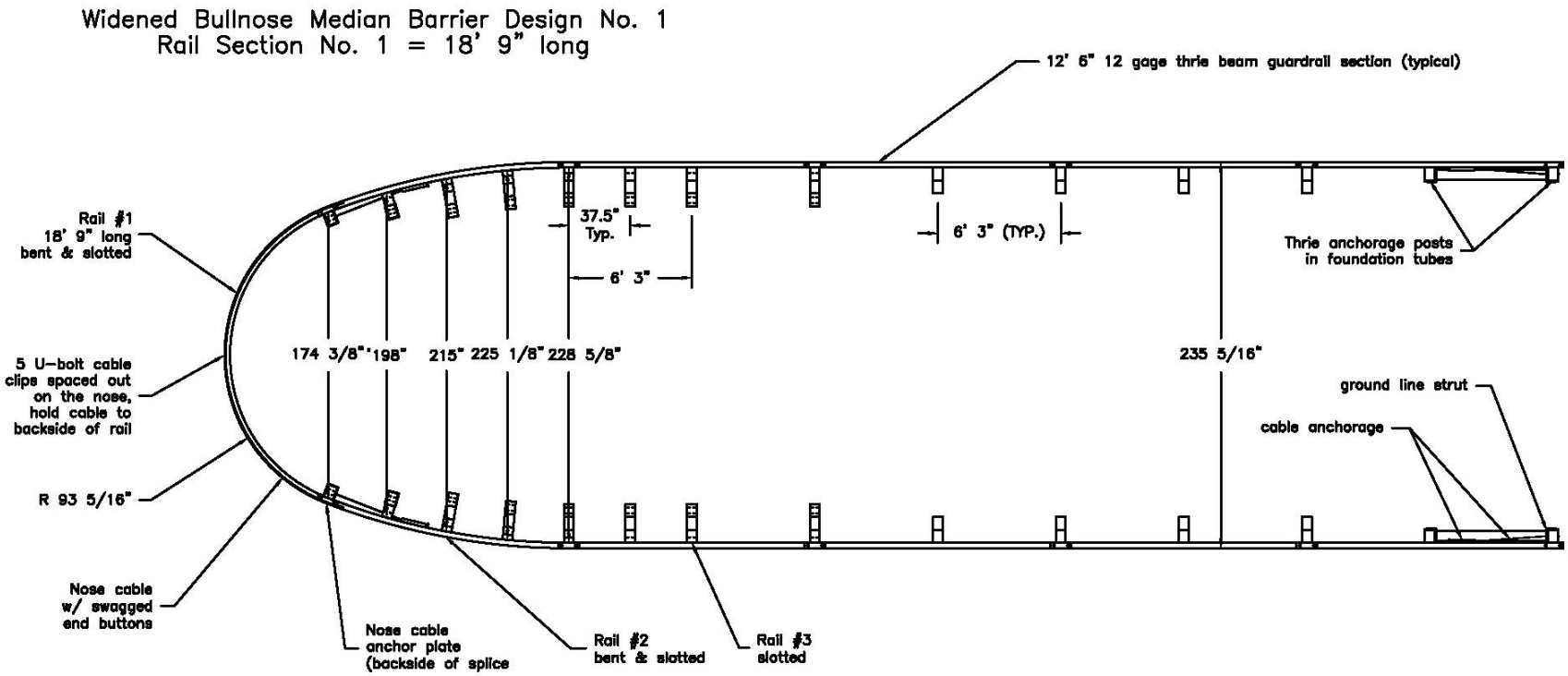


Figure 56. Wide Thrie-Beam Bullnose, Option 1

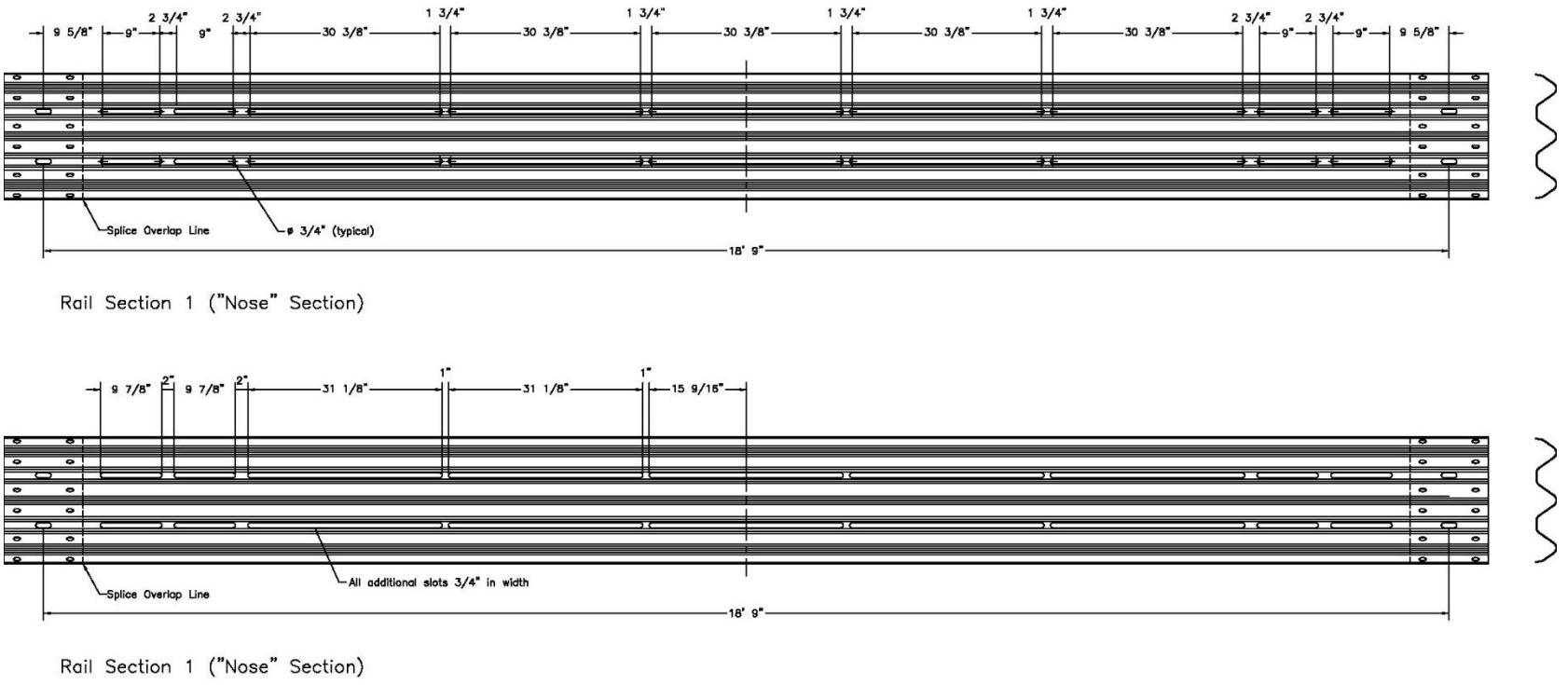


Figure 57. Wide Thrie-Beam Bullnose, Option 1

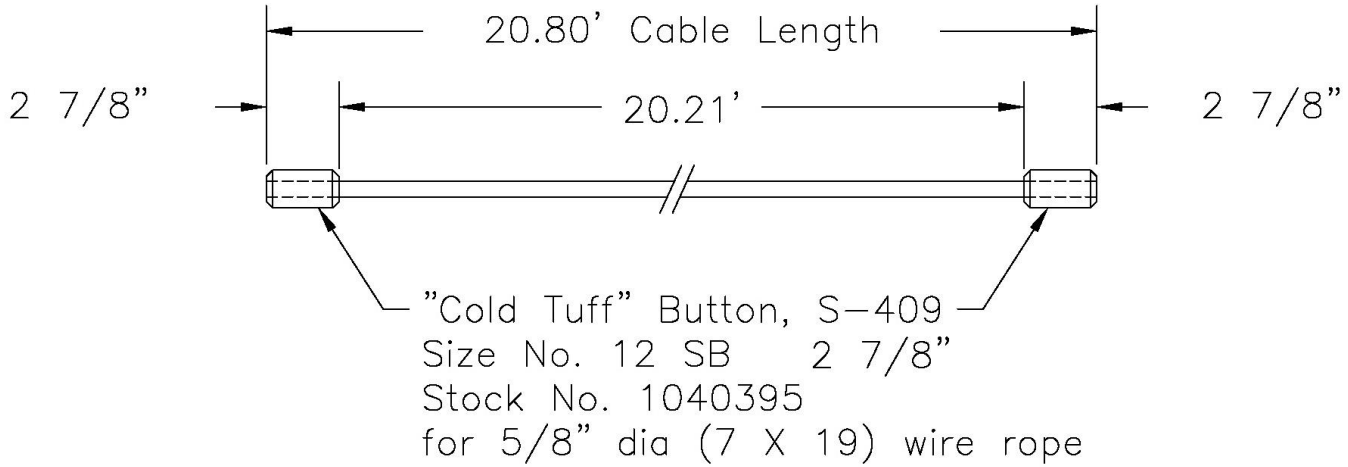


Figure 58. Wide Thrie-Beam Bullnose, Option 1

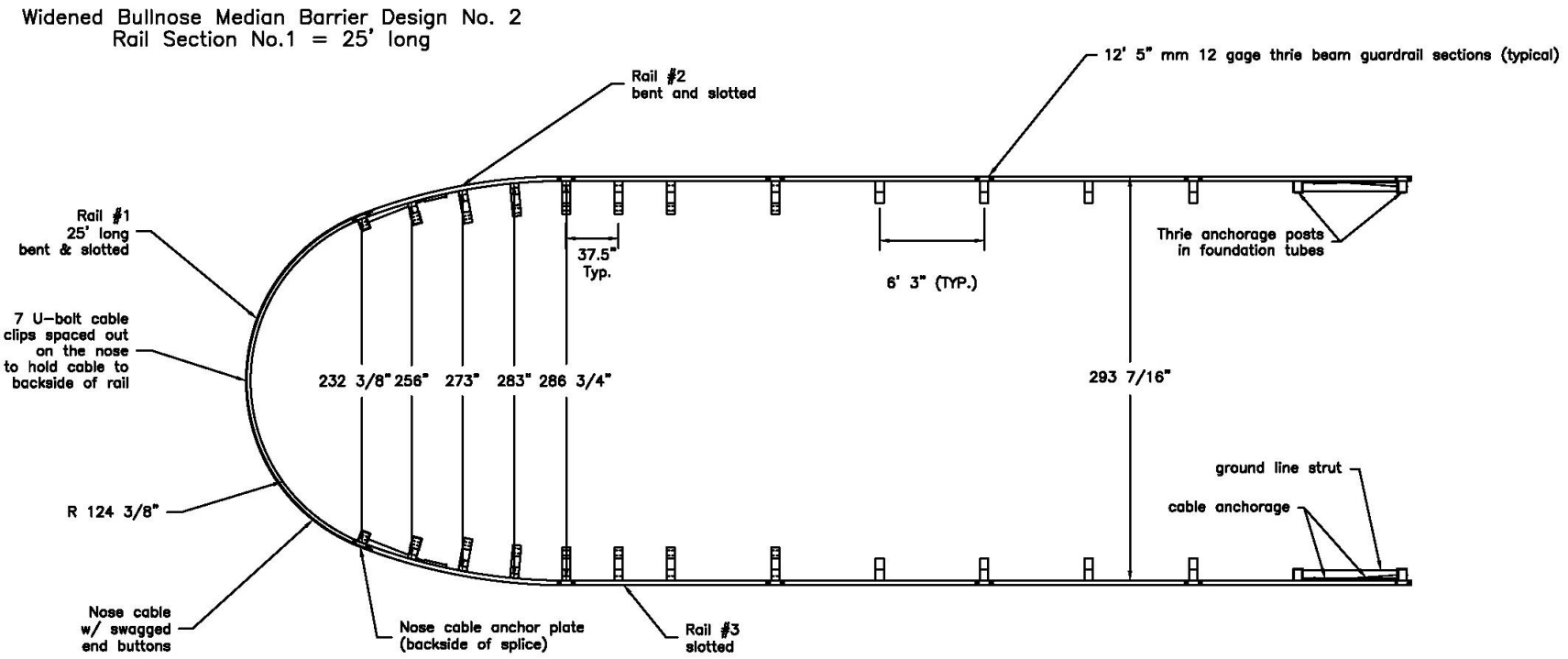


Figure 59. Wide Thrie-Beam Bullnose, Option 2

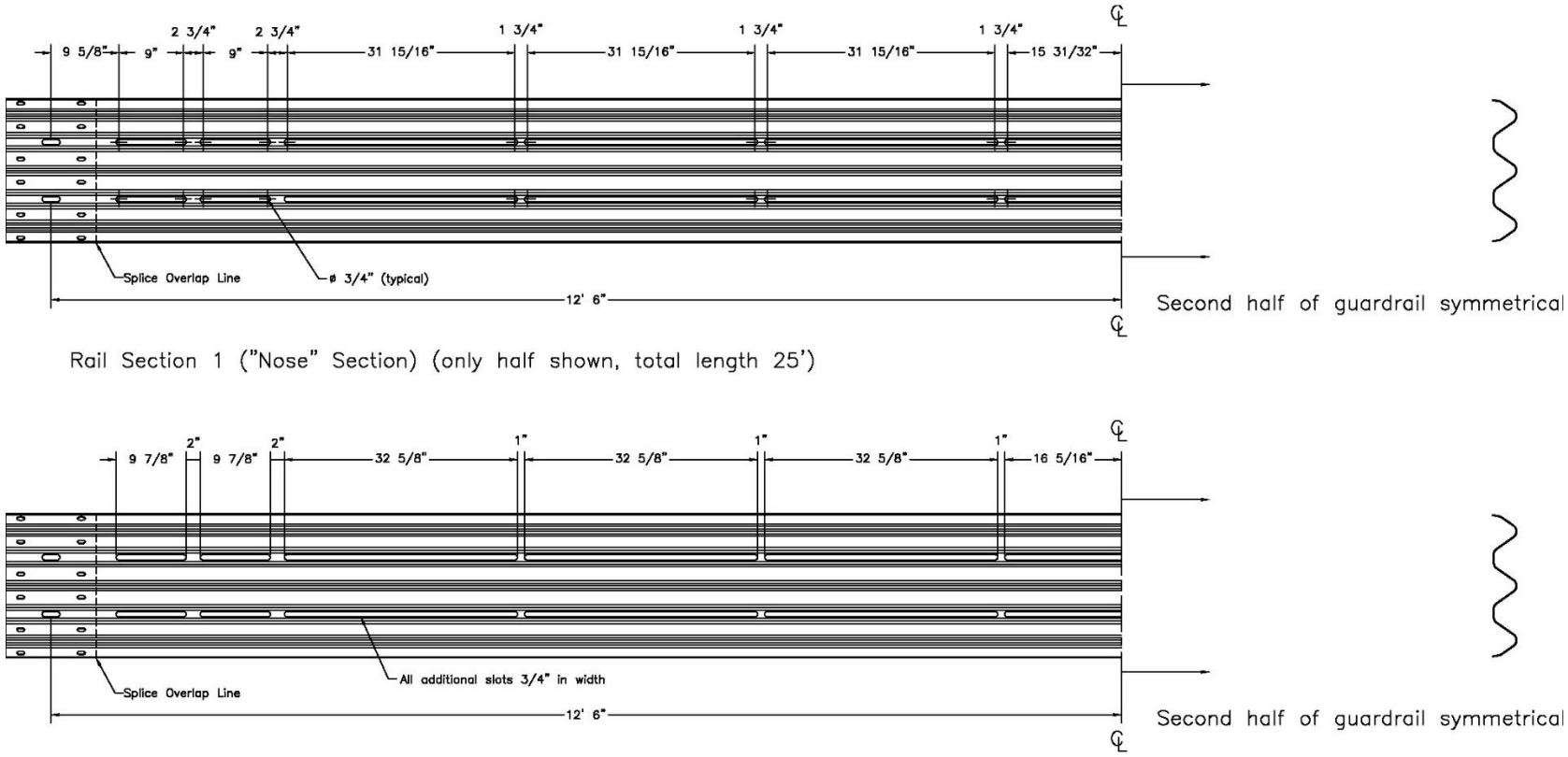


Figure 60. Wide Thrie-Beam Bullnose, Option 2

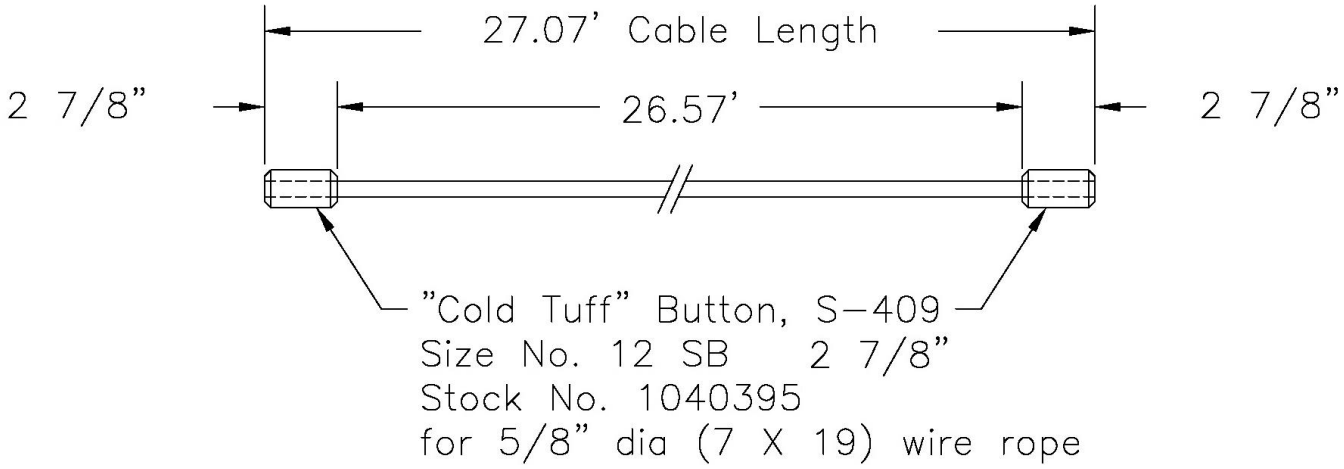


Figure 61. Wide Thrie-Beam Bullnose, Option 2

6.5 Flaring

The flare rates used for the bullnose should be obtained based on guidelines set forth in the AASHTO Roadside Design Guide or other applicable research. Current MnDOT guidance allows for a 15:1 flare rate for the sides of the bullnose. It is recommended that the flare begin no sooner than the start of rail section 3 or post 5. It is believed that flaring the bullnose system prior to this first straight section could adversely affect the performance of the barrier. While the shape of rail section 2 should not be changed, it should be allowable to straighten the end of the section to meet the specified flare rate. Such a configuration would facilitate a smooth transition from the curved guardrail to the flare. A schematic of the flared bullnose taken from the MnDOT standards is shown in Figure 62.

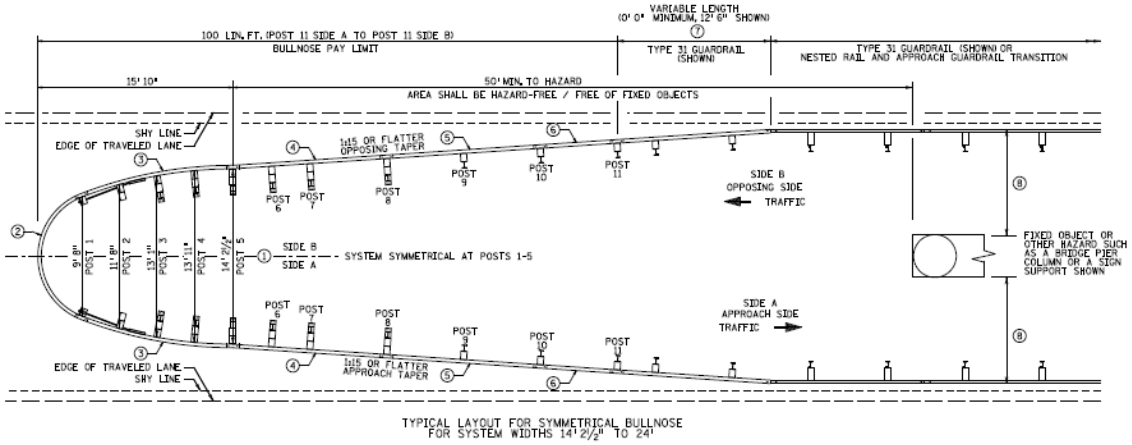


Figure 62. Flared Bullnose System

A second flaring option is specified in the MnDOT for medians with widths greater than 24 ft, as shown in . This option flares the side of the bullnose opposite oncoming traffic at 10.9 degrees, while the side adjacent to oncoming traffic is flared at 15:1 as noted above.

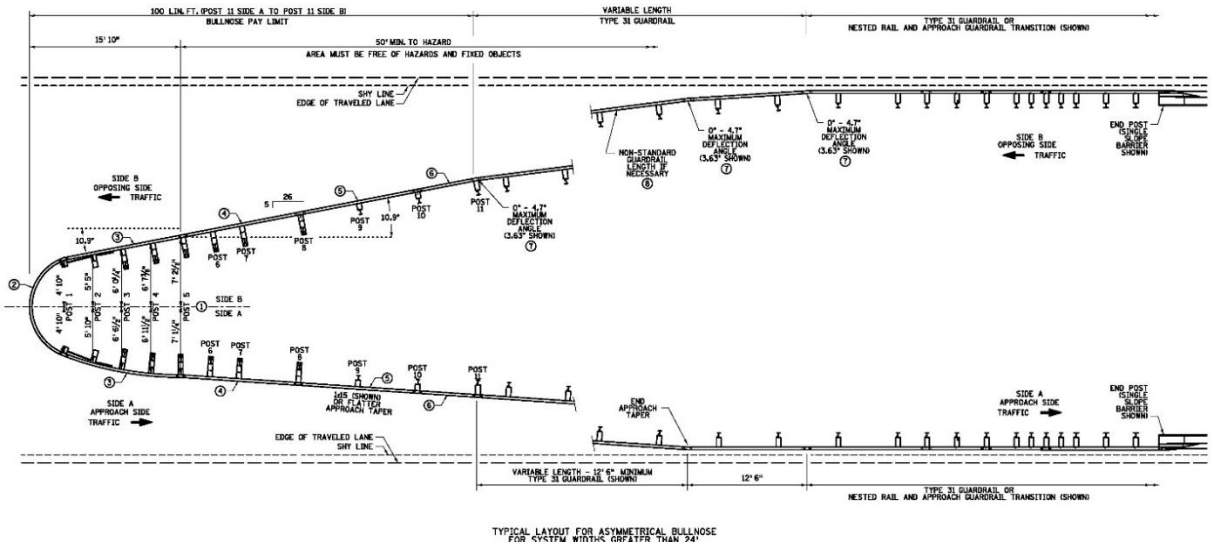


Figure 63. Flared Bullnose System for Median Widths Greater than 24 ft

7 MAINTENANCE AND REPAIR

7.1 Maintenance

The bullnose system is based on components similar to many existing guardrail systems. As such, the maintenance guidance for the bullnose should follow similar state guidance and procedures as those used for W-beam and thrie-beam guardrail systems. MnDOT maintenance guidance for beam guardrail can be found in the MnDOT Standard Plans Manual, Standard Plates Manual, and Maintenance Manual.

7.2 Repair

System inspection for damage should utilize the inspection checklist provided in Chapter 5. Reinstallation of any components or portions of the bullnose following a crash event inspection or maintenance inspection should follow the procedures previously outlined in this manual.

Note that any repair guidance provided in this manual refers to only the MASH TL-3 version of the bullnose system detailed herein. Older versions of the bullnose system may exist on the roadway but may differ from the MASH version of the system in terms of rail sections, nose cables, timber breakaway posts, and other critical components.

The MASH TL-3 version of the bullnose can be identified for repair purposes using the MnDOT hardware identification details provided in Figure 64.

7.2.1 Equipment Needed for Repair

Equipment required for repair of the bullnose should be consistent with equipment used for general guardrail repair. Hydraulic post removal equipment may be necessary for removal and replacement of damaged posts and foundation tubes in the system.

Repair crews will also need bullnose-specific hardware for replacing damaged portions of the system including UBSP posts and bolts, bullnose timber blockouts, bullnose specific curved and/or slotted rail sections, and any other hardware not consistent with typical beam guardrail.

7.2.2 Additional Repair Guidance

There are two comments that should be noted regarding the reuse of components in the bullnose system if they are undamaged following a crash event inspection or maintenance inspection.

The lower half of the UBSP including the tube and lower base plate can be reused if it displays no plastic or permanent deformation of the tube or base plate. Examples of plastic deformation would include deformation of the base plate and/or hinging or buckling of the lower tube. In addition, if the lower half of the UBSP has not deflected more than ½ in. in the soil, it would be acceptable to re-compact the soil around the post base and mount a new top section (i.e., post and upper base plate) to the lower base plate to reset the post. Soil deflections greater than ½ in. would require pulling the post base, checking for damage, and resetting the post. Deflection of the post in soil can be measured by using a tape or ruler to measure the gap between the soil and

the side of the lower tube on the post after impact. Alternatively, if the top of the post is out of plumb more than 1 ⅛ in., then would indicate more than ½ in of post displacement in the soil and would require pulling the post base, checking for damage, and resetting the post.

Similarly, the foundation tubes at posts 1 and 2 may be reused if they do not exhibit any plastic or permanent deformation and have not deflected in the soil more than ½ in. Soil deflections greater than ½ in. would require pulling the foundation, checking for damage, and resetting the tube. If the foundation tube was permanently deformed, the foundation tube should be replaced as well. The BCT posts at posts 1 and 2 should be replaced following any impact that damaged the post itself or causes displacement of the foundation tube in the soil of over ½ in. The cable anchorage should be re-installed and re-tensioned following resetting or reinstallation of posts 1 and 2.

Non-Proprietary

BULLNOSE (THRIE BEAM, BREAKAWAY STEEL POST)

MASH

Standard Plan 5-297.611

Identification details:

1. Rails are curved **thrie beam** with 31⅝" to top of rail.
2. Thrie beam rail is **slotted longitudinally** from front to post 8 on each side.
3. BCT cable and components on both sides at post 1 running past post 2.
4. Thrie beam to W-beam rail transition after post 10 on each side. Symmetrical transition for 28" guardrail or asymmetrical transition for Type 31 guardrail.

Note: The W-beam guardrail portion of the system may connect to another thrie beam bullnose or an approach guardrail transition to bridge rail or other rigid barrier.

5. 10 Posts on each side:
   a. Posts 1 and 2 are **BCT wood posts** in steel foundation tubes (Standard Plans 8365 and 8366).
   b. Posts 3 through 8 are **universal breakaway steel posts.**
   c. Posts 9 and 10 are **78" steel guardrail posts.**
6. Three nose cables attached in the three ribs of thrie beam nose between posts 1.

Figure 64. MnDOT MASH Bullnose System Identification Guidelines

8 REFERENCES

1. *Manual for Assessing Safety Hardware* (MASH), *Second Edition*, American Association of State Highway and Transportation Officials (AASHTO), Washington, D.C., 2016.

2. Bielenberg, R.W., Faller, R.K., Stolle, C.S., "MASH TL-3 Development and Evaluation of the Thrie-Beam Bullnose Attenuator," Paper submitted to 18th IRF World Meeting & Exhibition, 2021.

3. Bielenberg, R.W., Faller, R.K., Ammon, T.J., Holloway, J.C., and Lechtenberg, K.A., *Phase I Testing of a Thrie Beam Bullnose with Breakaway Steel Posts (Test Nos. MSPBN-1, -2, and -3)*, Final Report, Report No. 03-389-20, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, August 27, 2020.

4. Bielenberg, R.W., Faller, R.K., Ammon, T.J., Holloway, J.C., and Lechtenberg, K.A., *MASH Testing of Bullnose with Break Away Steel Posts (Test Nos. MSPBN-4 through MSPBN-8)*, Final Report, Report No. 03-418-20, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, September 1, 2020.

Appendix A. MnDOT Standard Plans

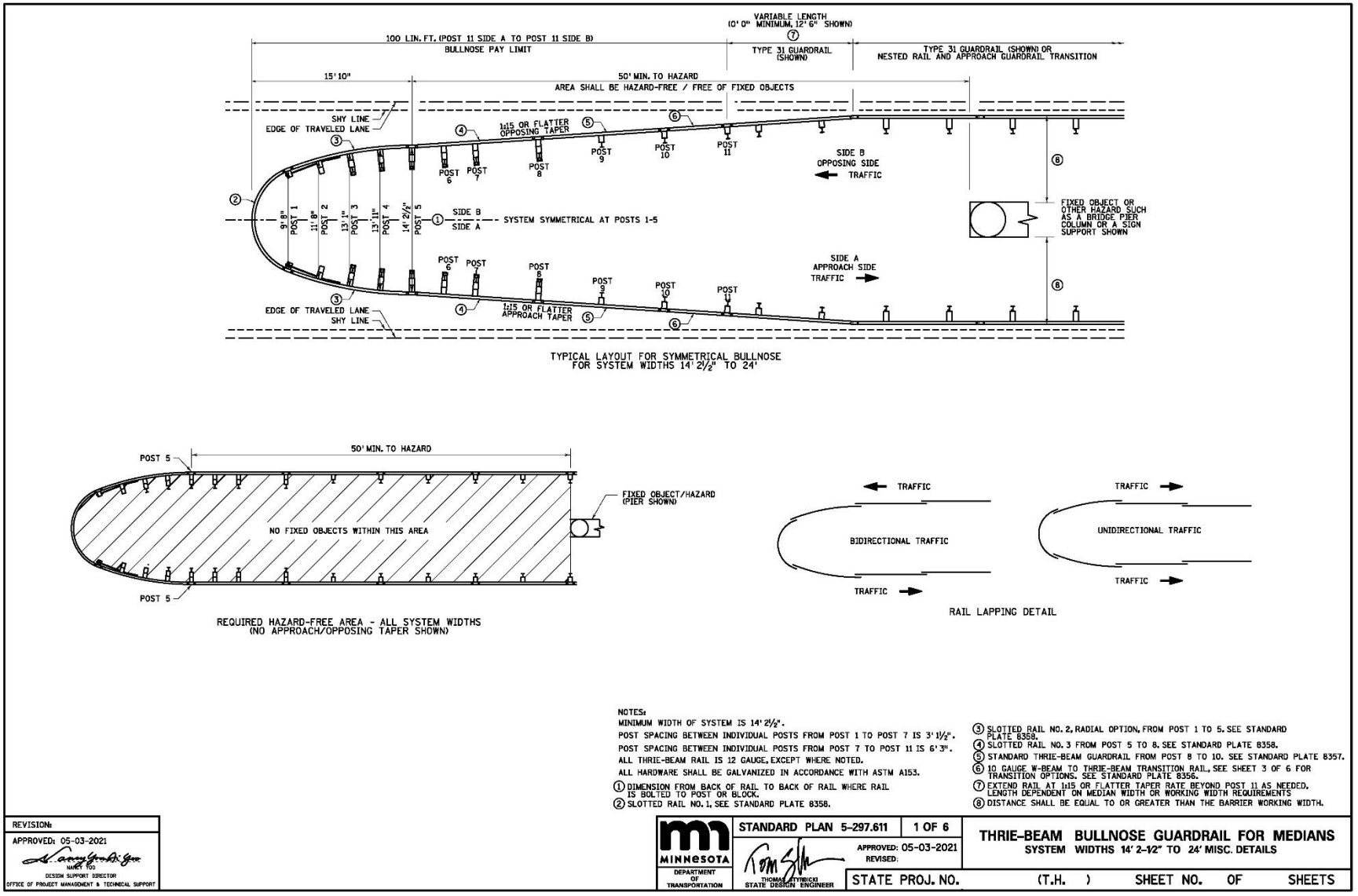
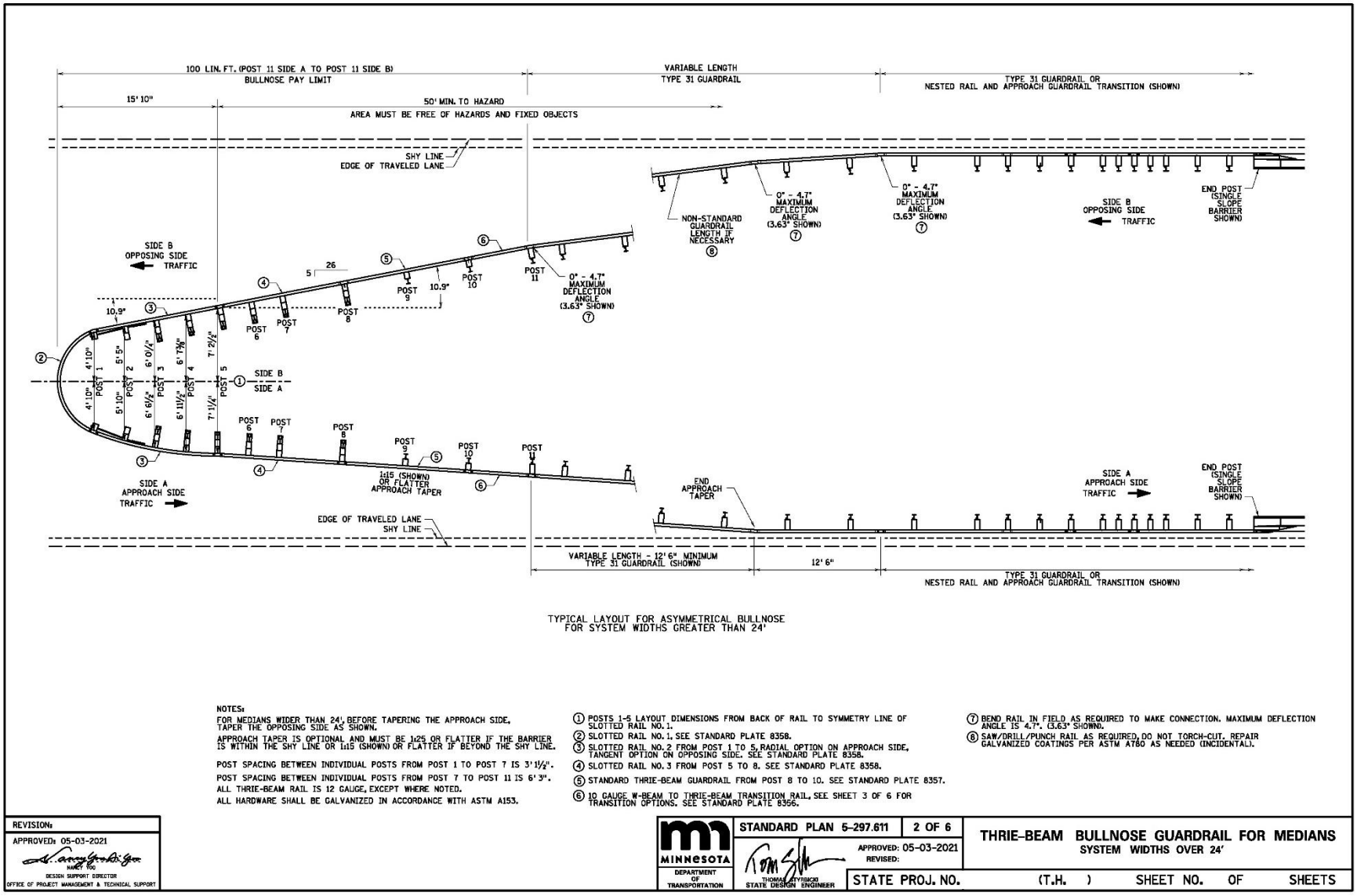


Figure A-1. MnDOT Standard Plans, Page 1



TYPICAL LAYOUT FOR ASYMMETRICAL BULLNOSE
FOR SYSTEM WIDTHS GREATER THAN 24'

NOTES:

FOR MEDIANS WIDER THAN 24', BEFORE TAPERING THE APPROACH SIDE, TAPER THE OPPOSING SIDE AS SHOWN.

APPROACH TAPER IS OPTIONAL AND MUST BE 1:25 OR FLATTER IF THE BARRIER IS WITHIN THE SHY LINE OR 1:15 (SHOWN) OR FLATTER IF BEYOND THE SHY LINE.

POST SPACING BETWEEN INDIVIDUAL POSTS FROM POST 1 TO POST 7 IS 3' 1½".

POST SPACING BETWEEN INDIVIDUAL POSTS FROM POST 7 TO POST 11 IS 6' 3".

ALL THRIE-BEAM RAIL IS 12 GAUGE, EXCEPT WHERE NOTED.

ALL HARDWARE SHALL BE GALVANIZED IN ACCORDANCE WITH ASTM A153.

① POSTS 1-5 LAYOUT DIMENSIONS FROM BACK OF RAIL TO SYMMETRY LINE OF SLOTTED RAIL NO. 1.

② SLOTTED RAIL NO. 1. SEE STANDARD PLATE 8358.

③ SLOTTED RAIL NO. 2 FROM POST 1 TO 5, RADIAL OPTION ON APPROACH SIDE, TANGENT OPTION ON OPPOSING SIDE. SEE STANDARD PLATE 8358.

④ SLOTTED RAIL NO. 3 FROM POST 5 TO 8. SEE STANDARD PLATE 8358.

⑤ STANDARD THRIE-BEAM GUARDRAIL FROM POST 8 TO 10. SEE STANDARD PLATE 8357.

⑥ 10 GAUGE W-BEAM TO THRIE-BEAM TRANSITION RAIL, SEE SHEET 3 OF 6 FOR TRANSITION OPTIONS. SEE STANDARD PLATE 8356.

⑦ BEND RAIL IN FIELD AS REQUIRED TO MAKE CONNECTION. MAXIMUM DEFLECTION ANGLE IS 4.7°. (3.63° SHOWN).

⑧ SAW/DRILL/PUNCH RAIL AS REQUIRED, DO NOT TORCH-CUT. REPAIR GALVANIZED COATINGS PER ASTM A780 AS NEEDED (INCIDENTAL).

REVISION:

APPROVED: 05-03-2021

DESIGN SUPPORT DIRECTOR
OFFICE OF PROJECT MANAGEMENT & TECHNICAL SUPPORT

MINNESOTA
DEPARTMENT OF TRANSPORTATION

STANDARD PLAN 5-297.611 | 2 OF 6

APPROVED: 05-03-2021
REVISED:

THOMAS SZYMBORSKI
STATE DESIGN ENGINEER

THRIE-BEAM BULLNOSE GUARDRAIL FOR MEDIANS
SYSTEM WIDTHS OVER 24'

STATE PROJ. NO. (T.H.) SHEET NO. OF SHEETS

Figure A-2. MnDOT Standard Plans, Page 2

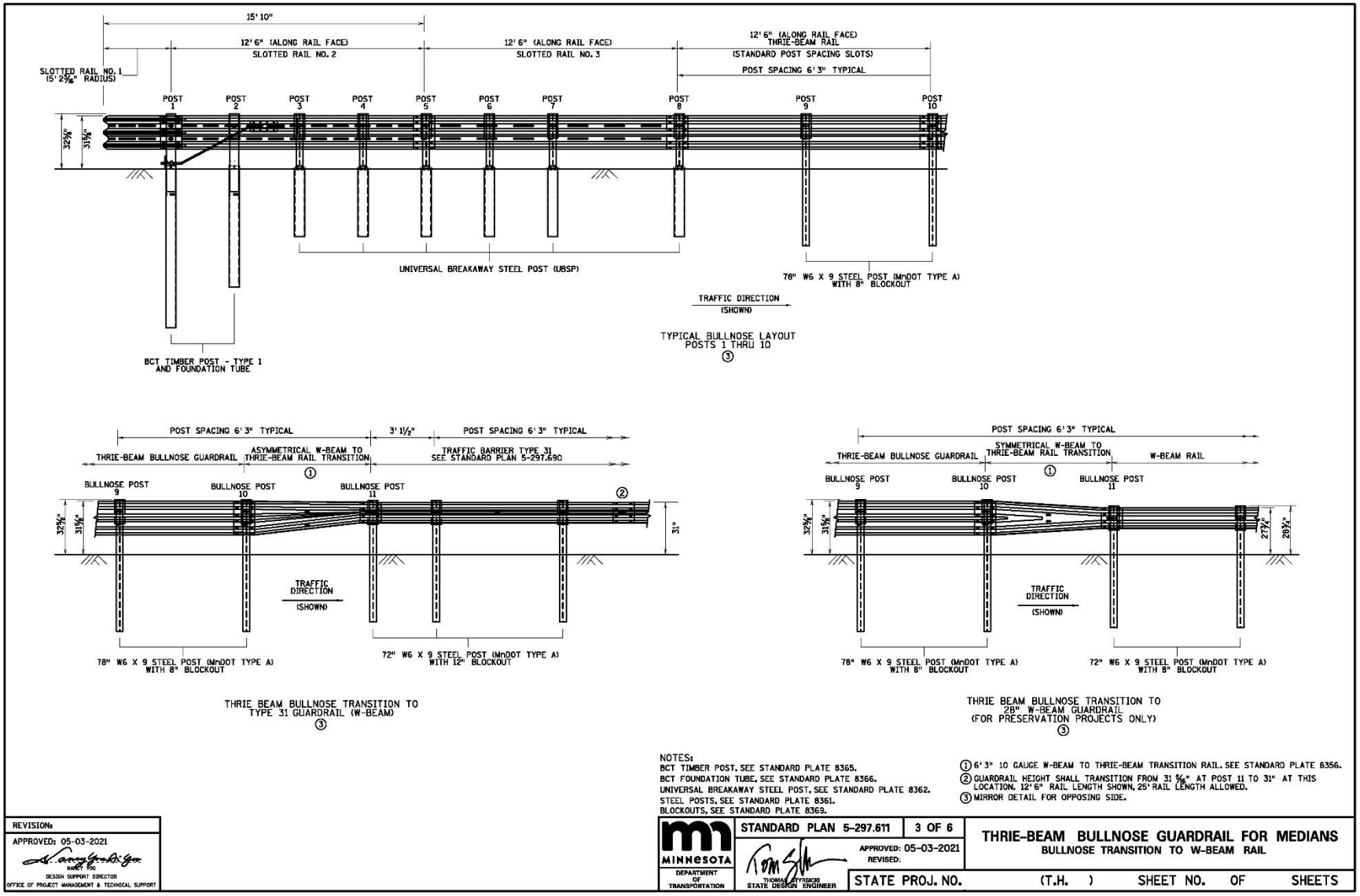


Figure A-3. MnDOT Standard Plans, Page 3

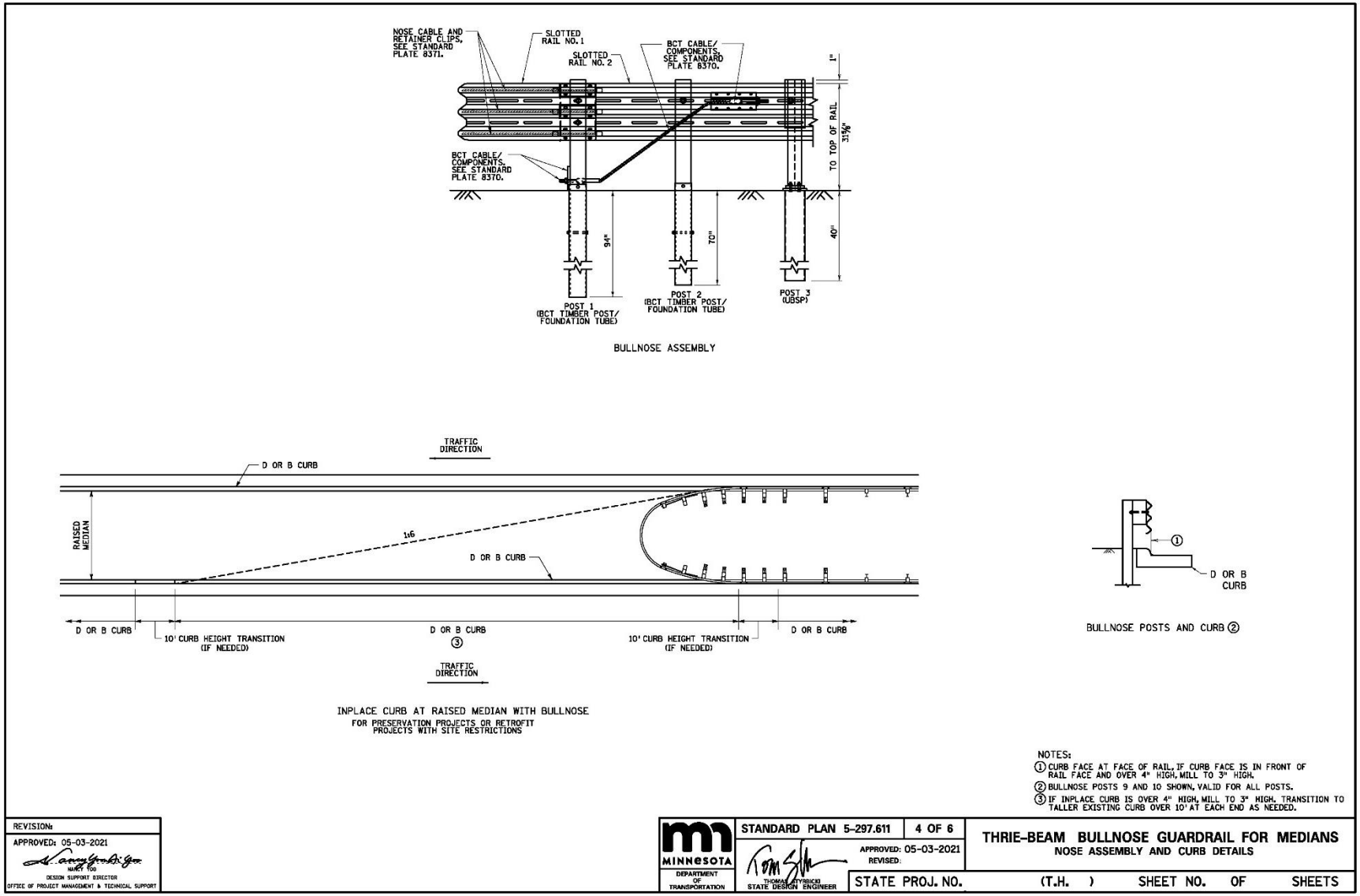


Figure A-4. MnDOT Standard Plans, Page 4

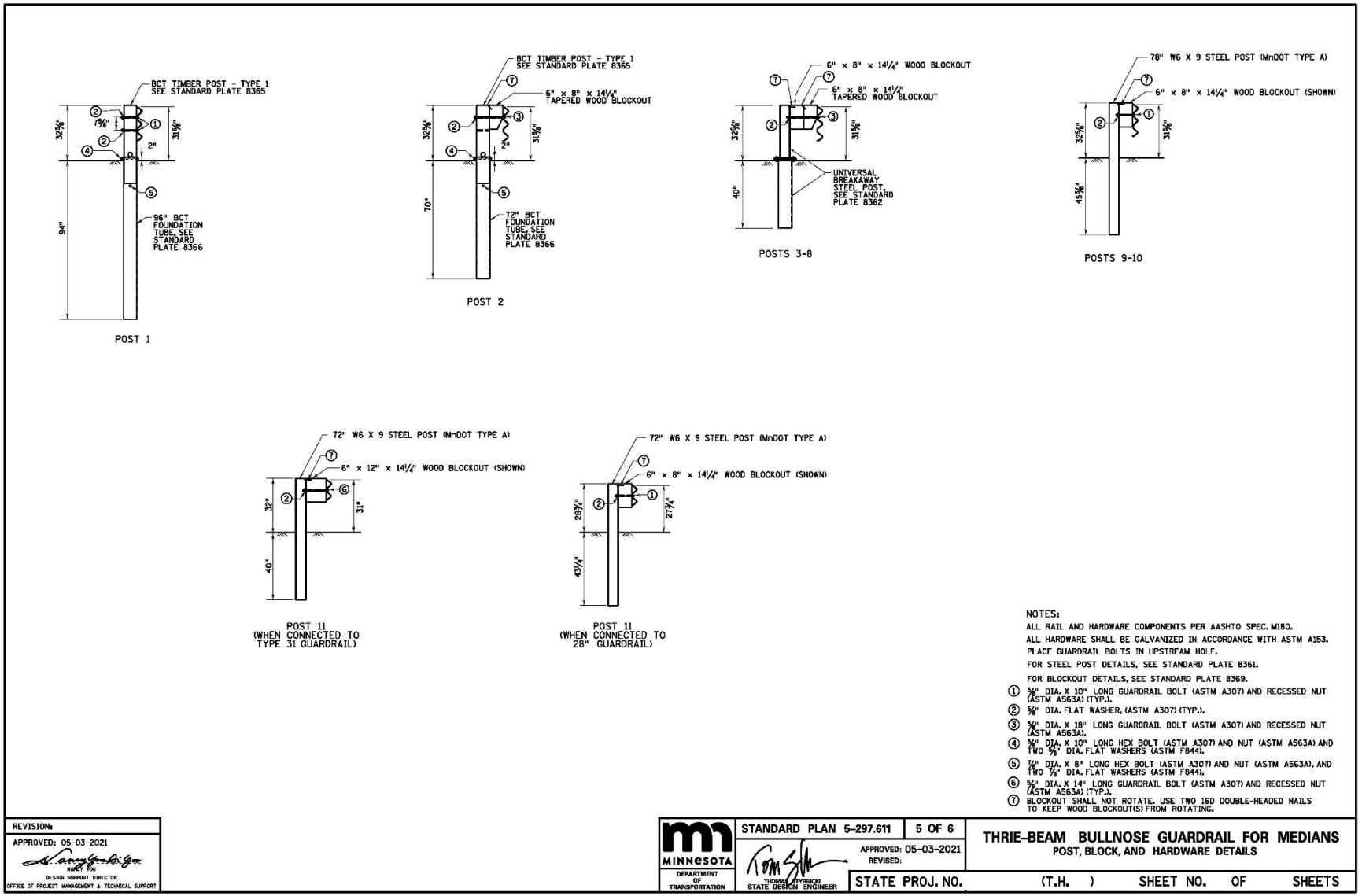


Figure A-5. MnDOT Standard Plans, Page 5

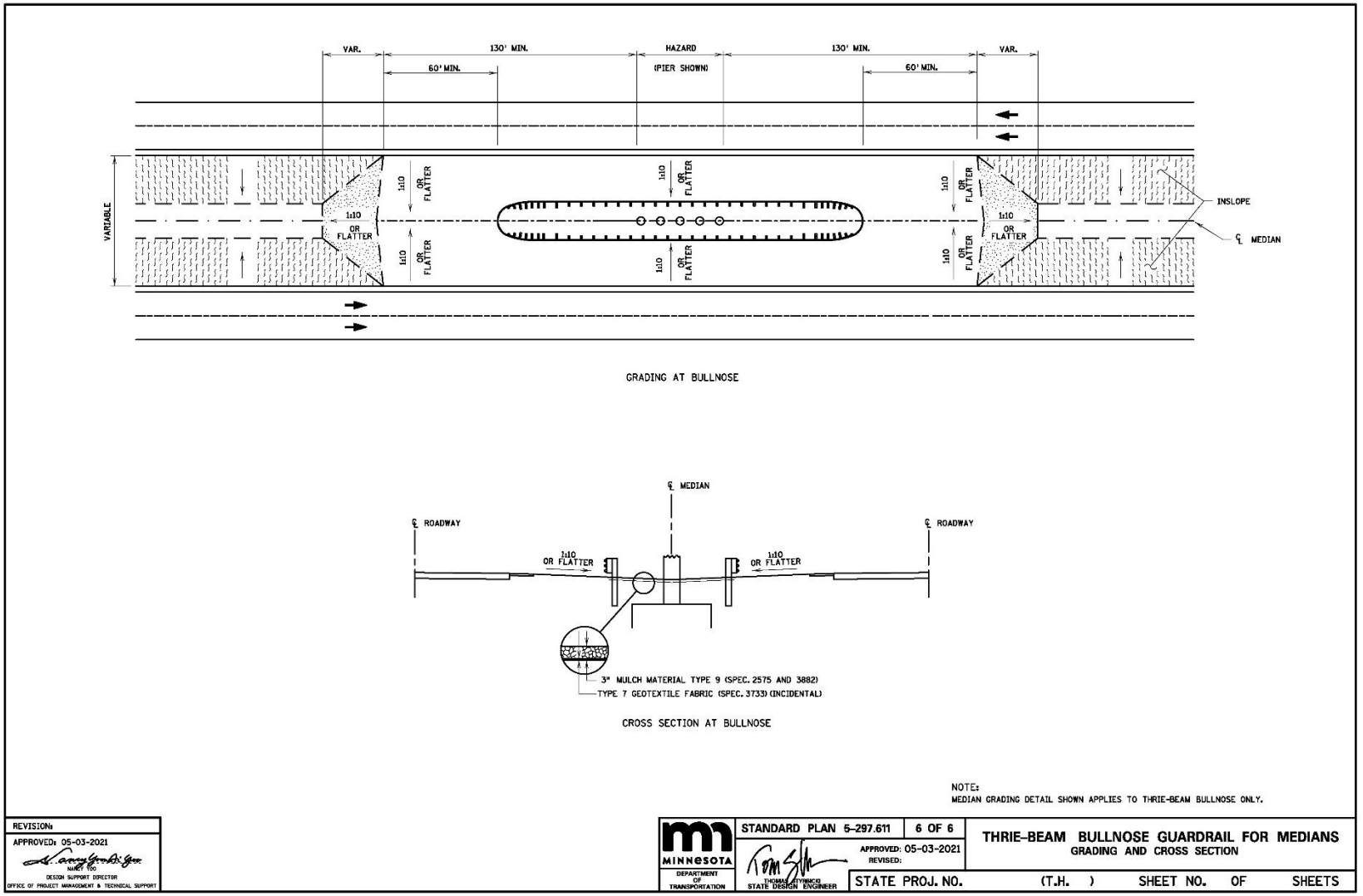


Figure A-6. MnDOT Standard Plans, Page 6

Appendix B. MwRSF Final Bullnose Drawings

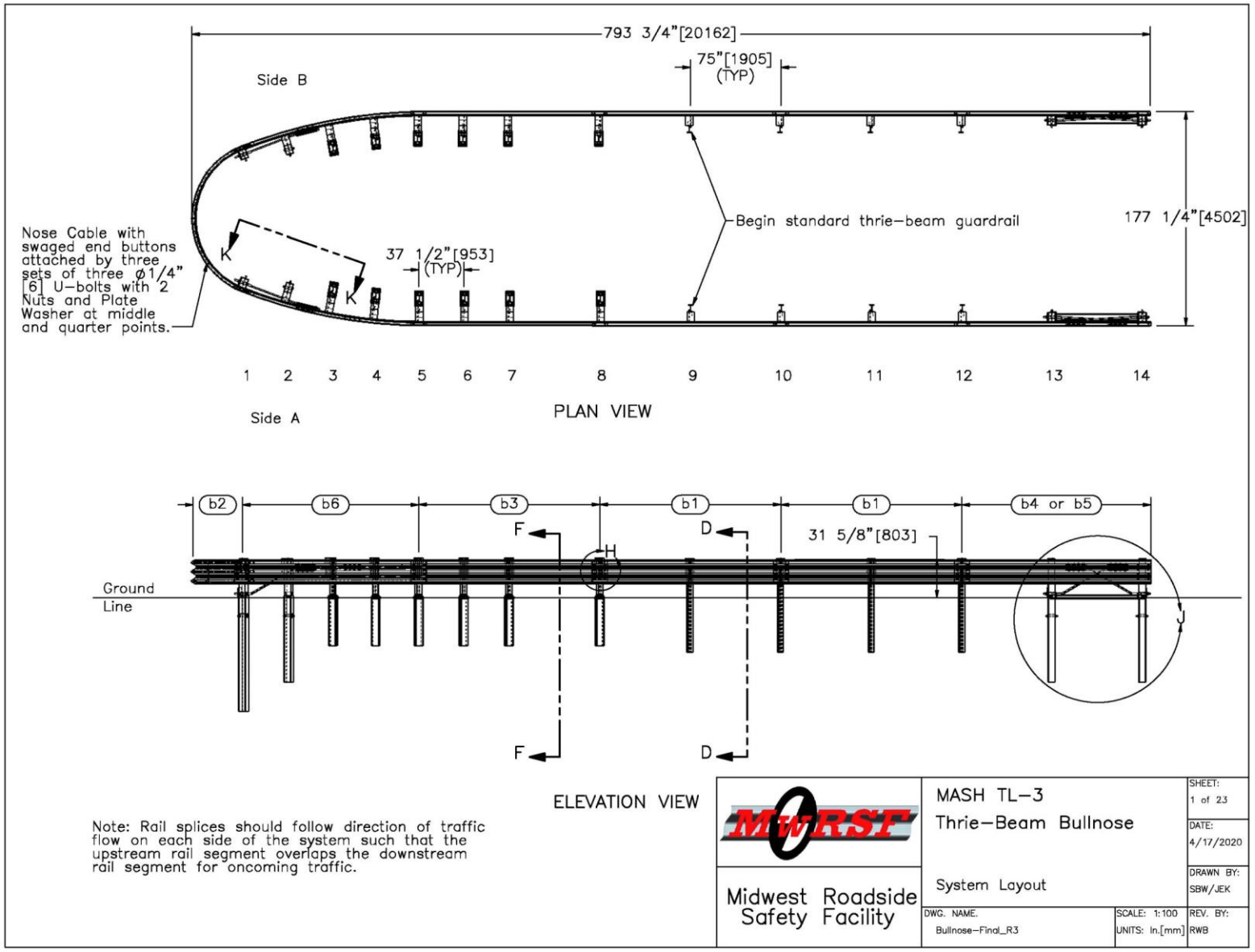


Figure B-1. System Layout, MASH TL-3 Thrie-Beam Bullnose

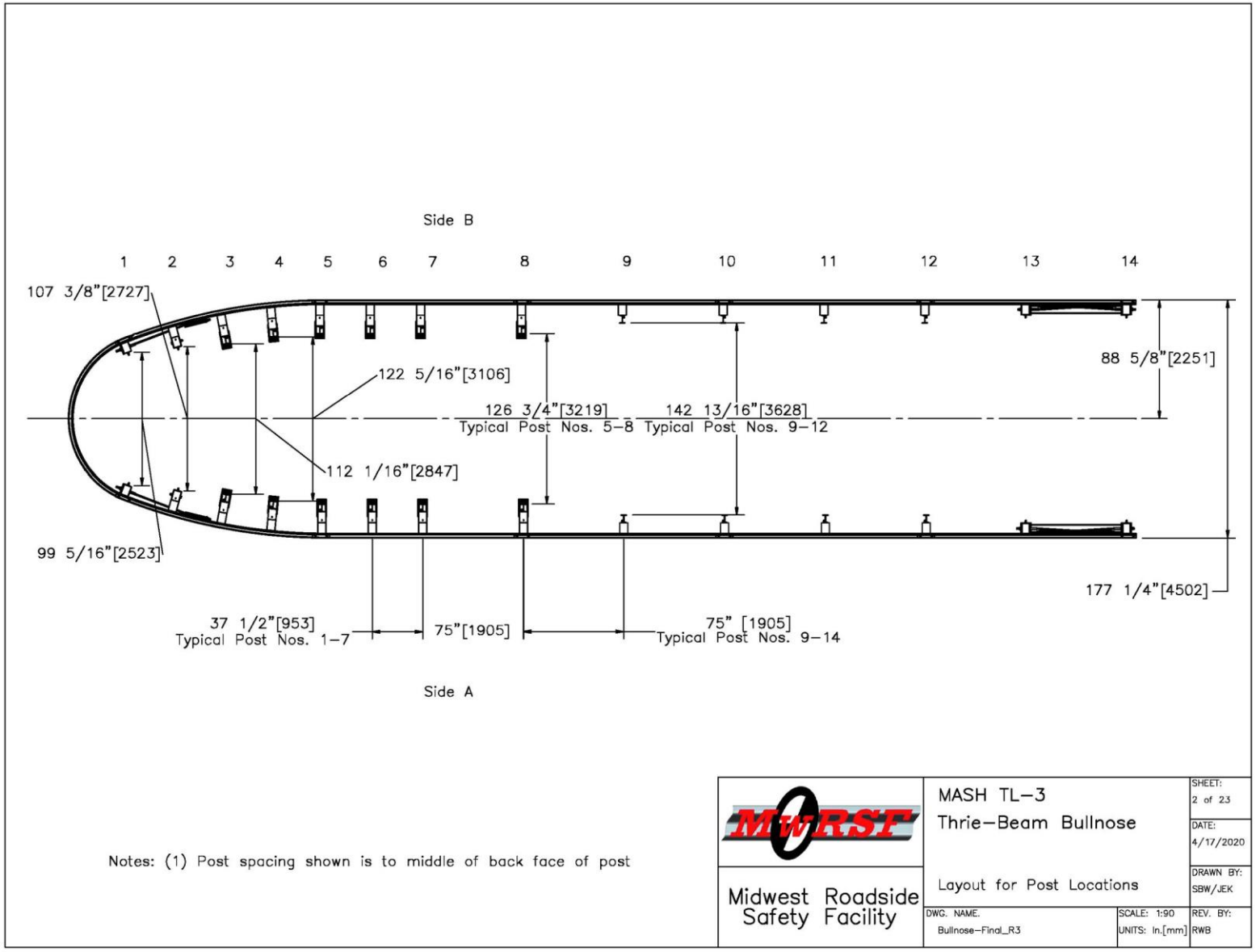


Figure B-2. Layout for Post Locations, MASH TL-3 Thrie-Beam Bullnose

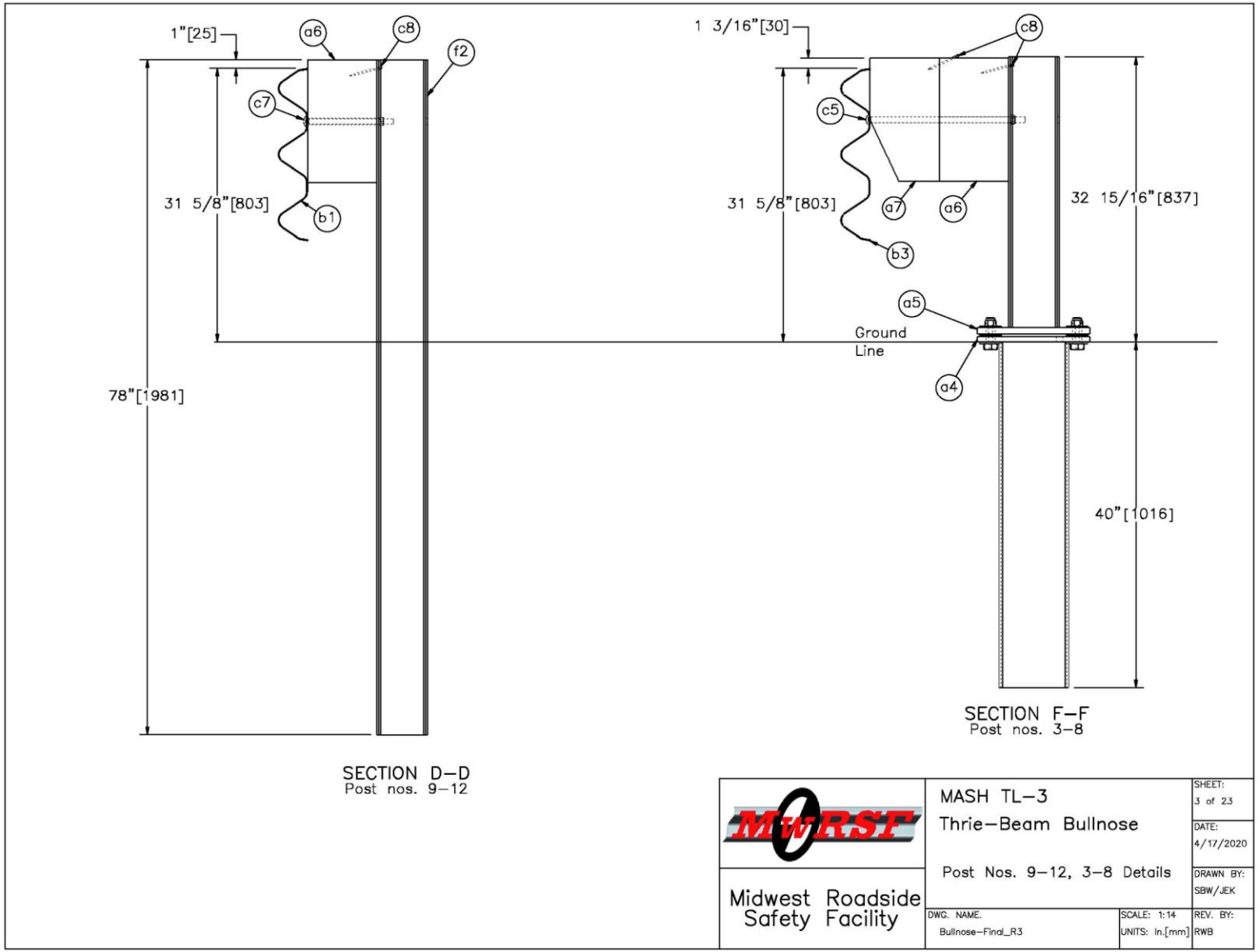


Figure B-3. Post Nos. 9-12 and 3-8 Details, MASH TL-3 Thrie-Beam Bullnose

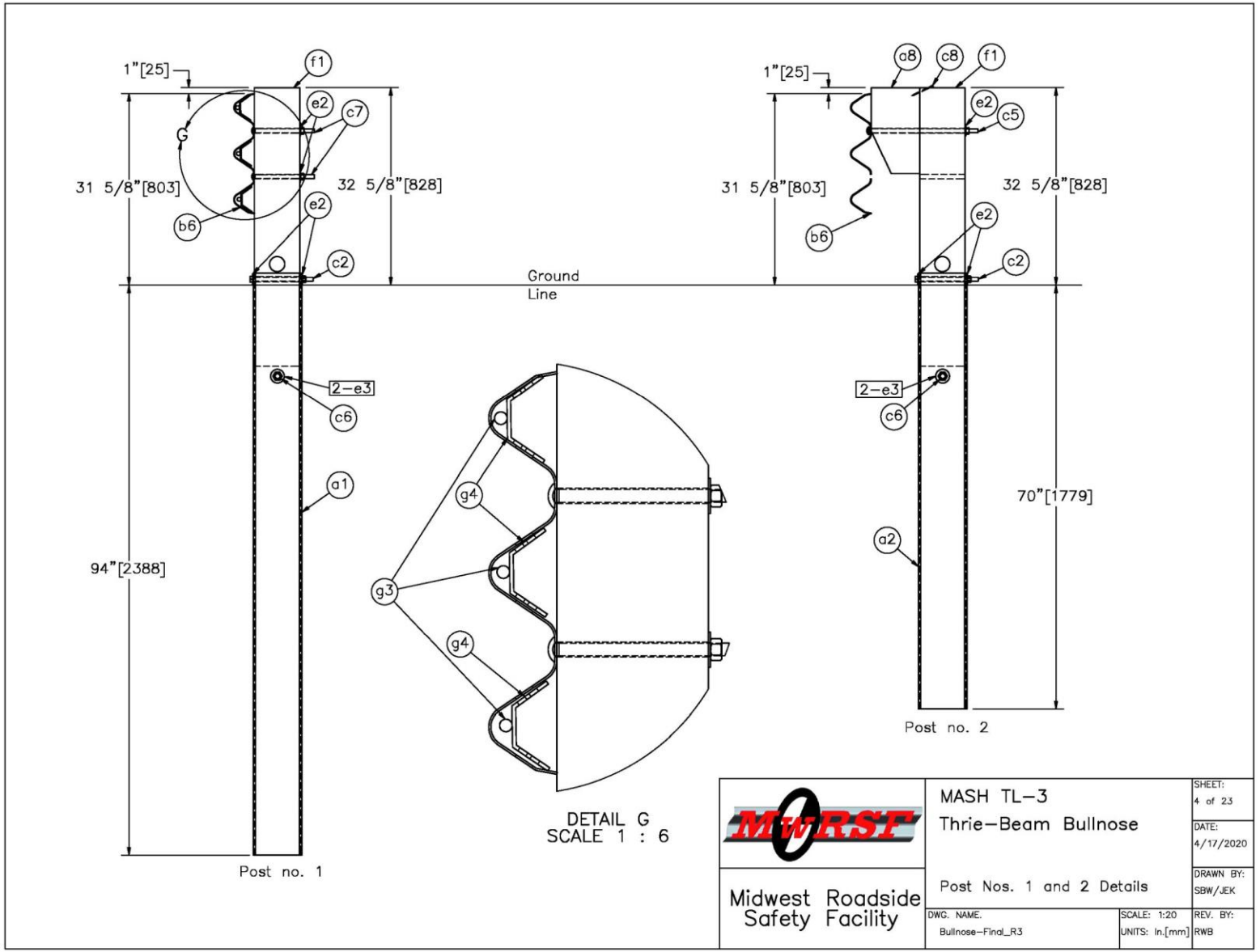


Figure B-4. Post Nos. 1 and 2 Details, MASH TL-3 Thrie-Beam Bullnose

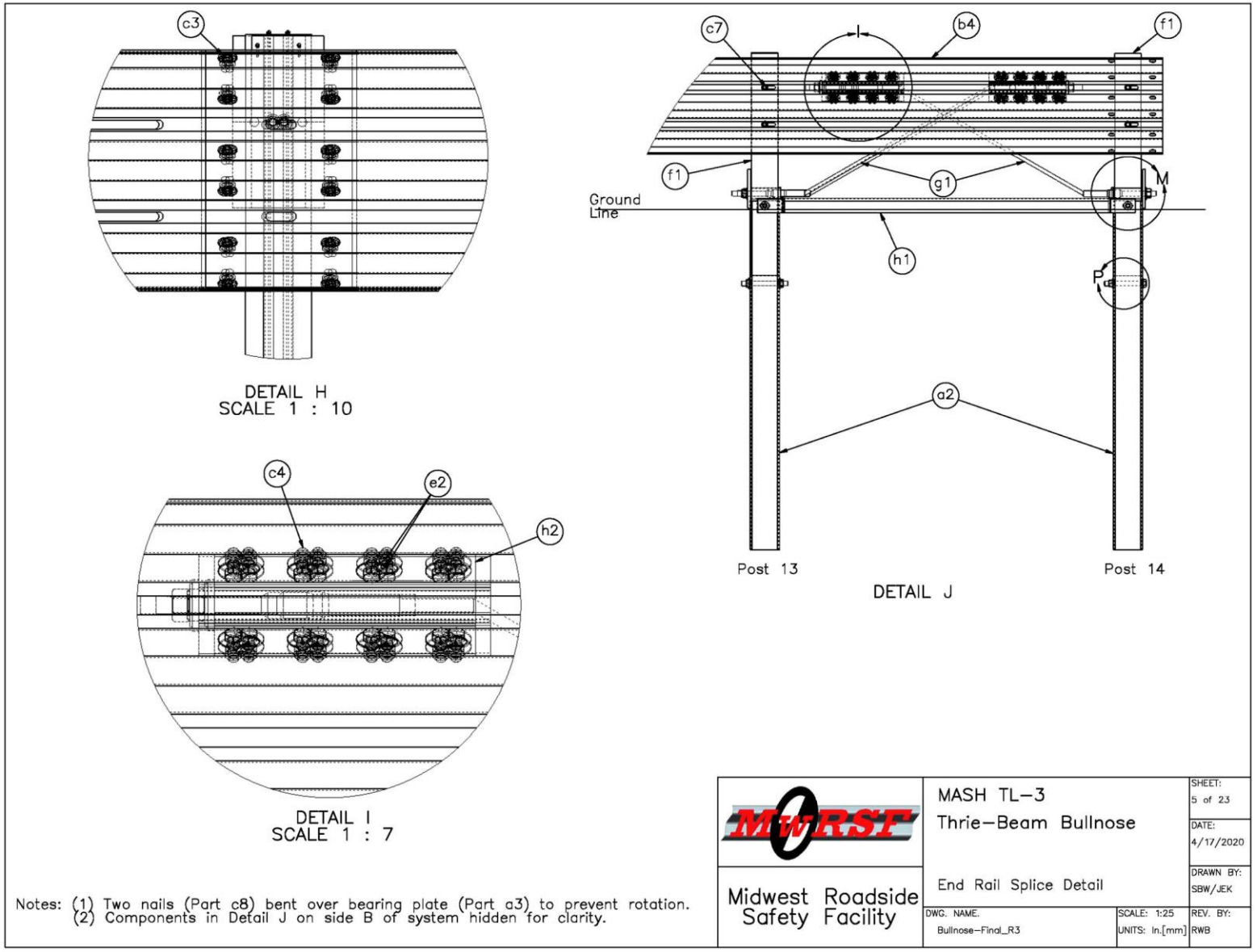


Figure B-5. End Rail Splice Detail, MASH TL-3 Thrie-Beam Bullnose

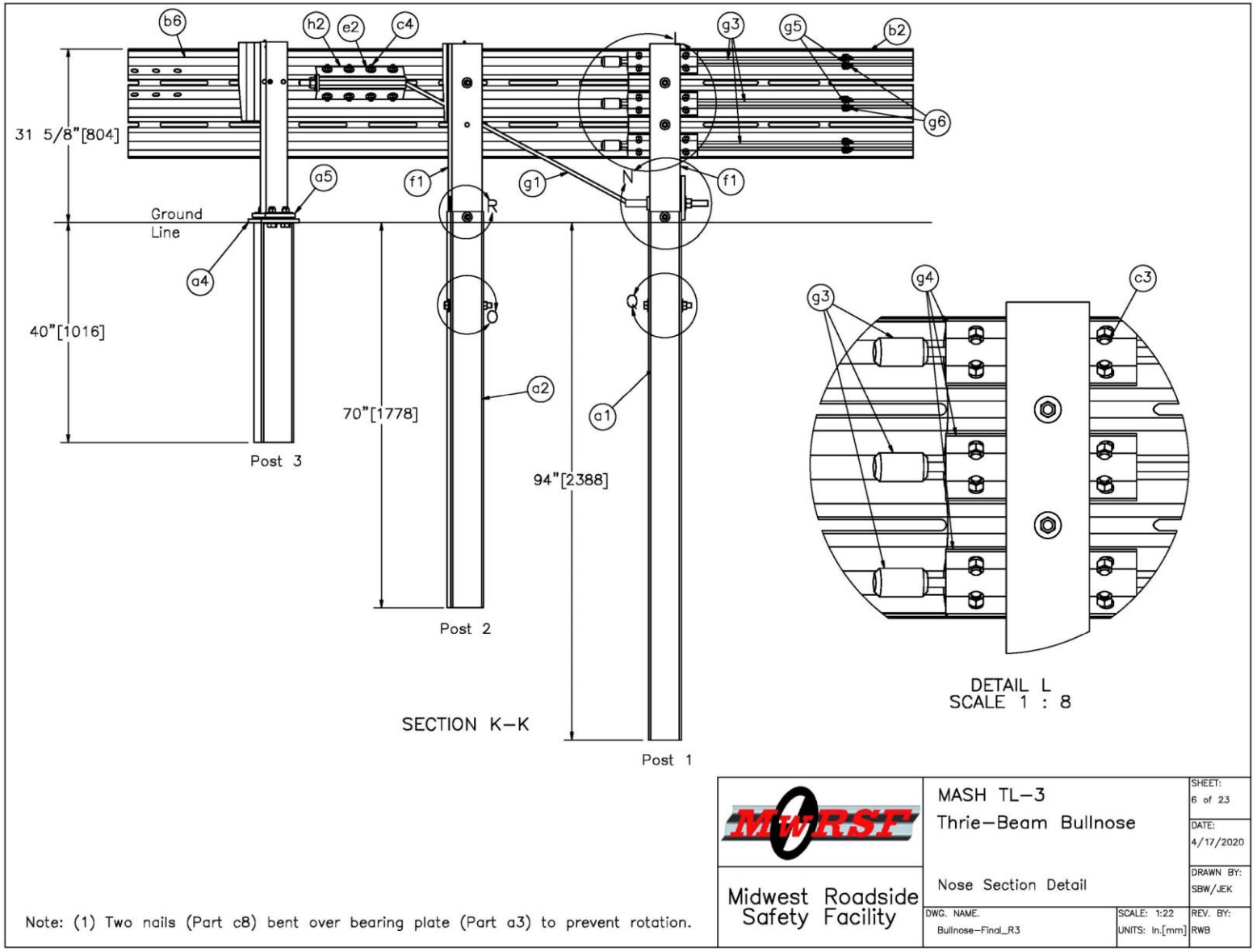


Figure B-6. Nose Section Detail, MASH TL-3 Thrie-Beam Bullnose

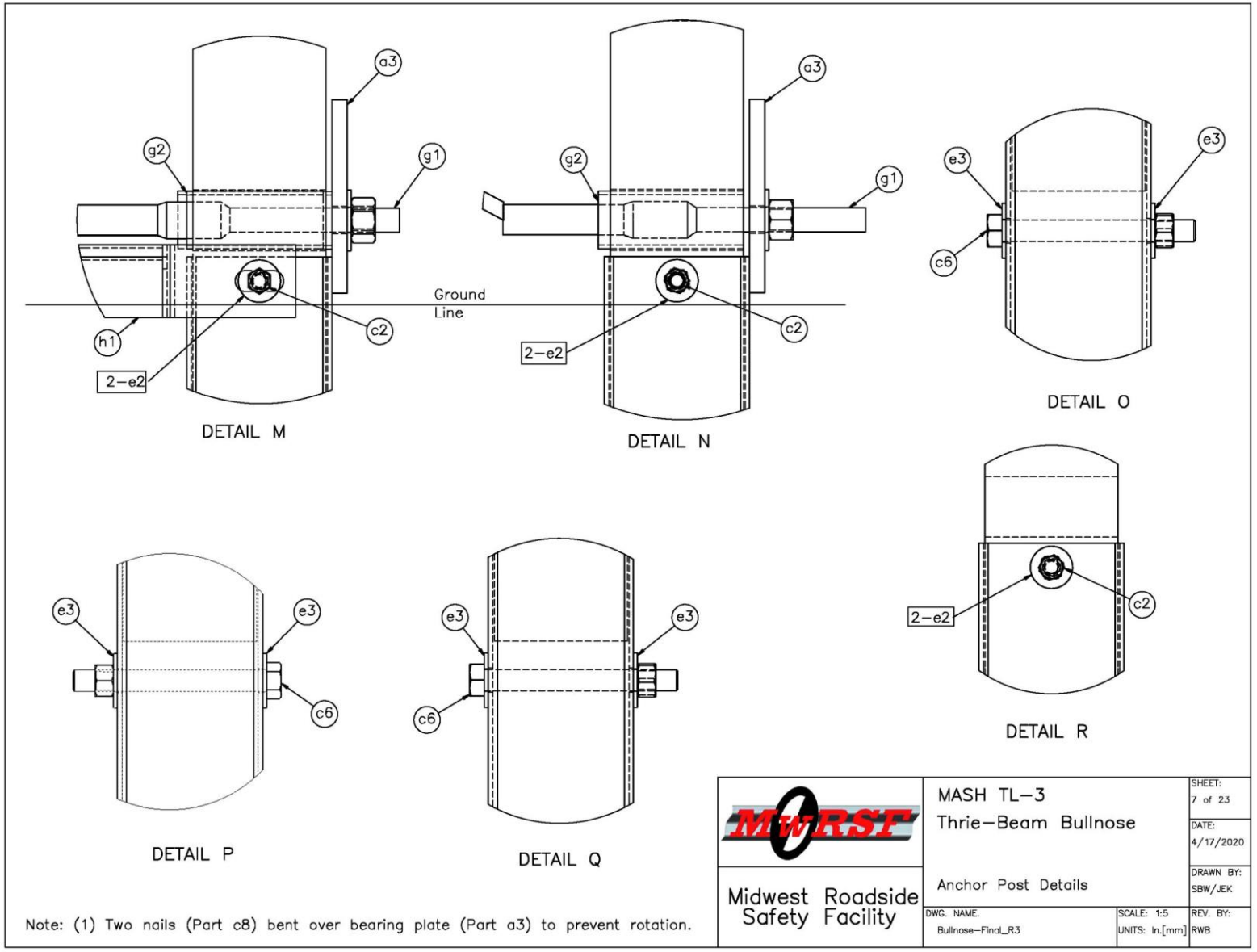


Figure B-7. Anchor Post Details, MASH TL-3 Thrie-Beam Bullnose

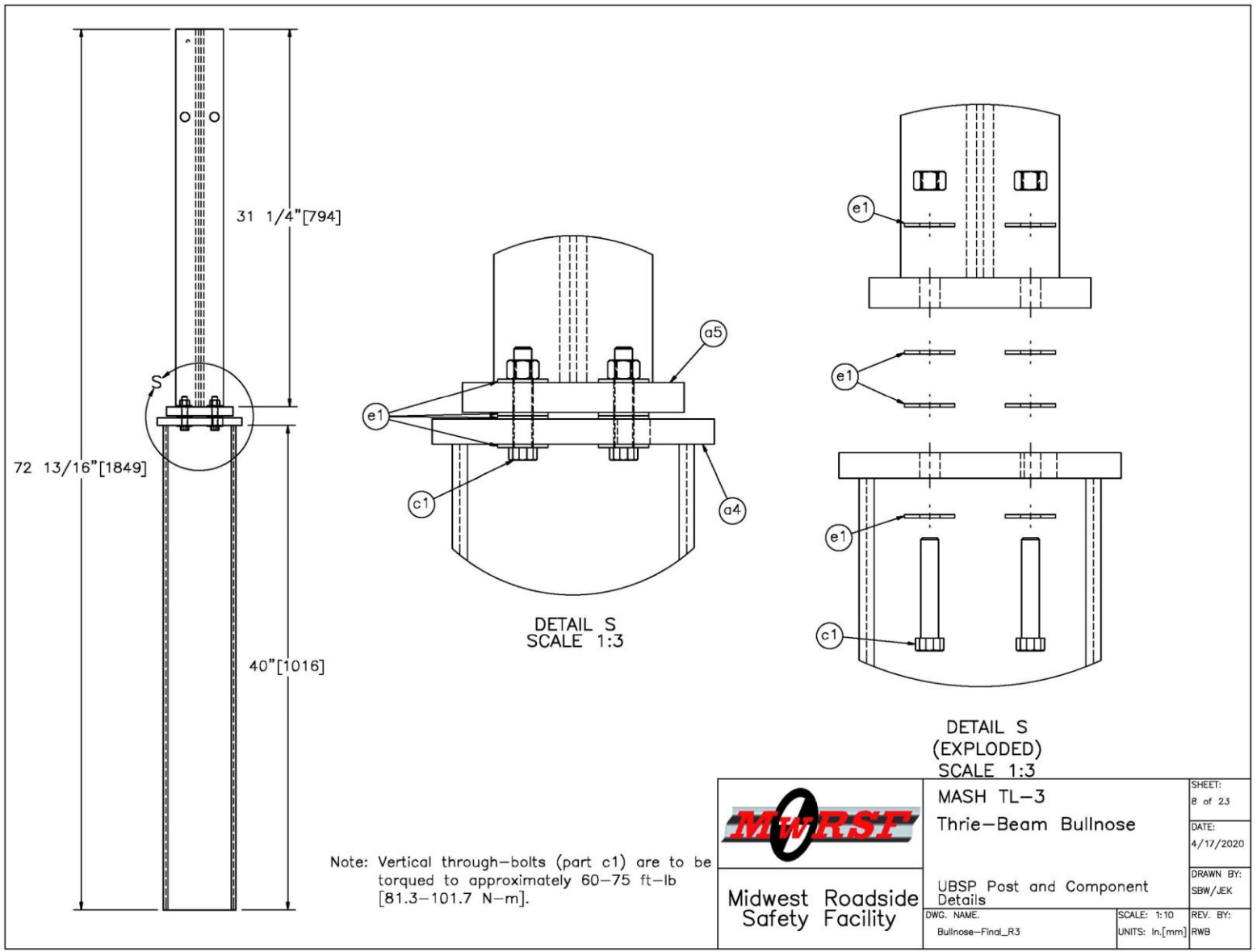


Figure B-8. UBSP Post and Component Details, MASH TL-3 Thrie-Beam Bullnose

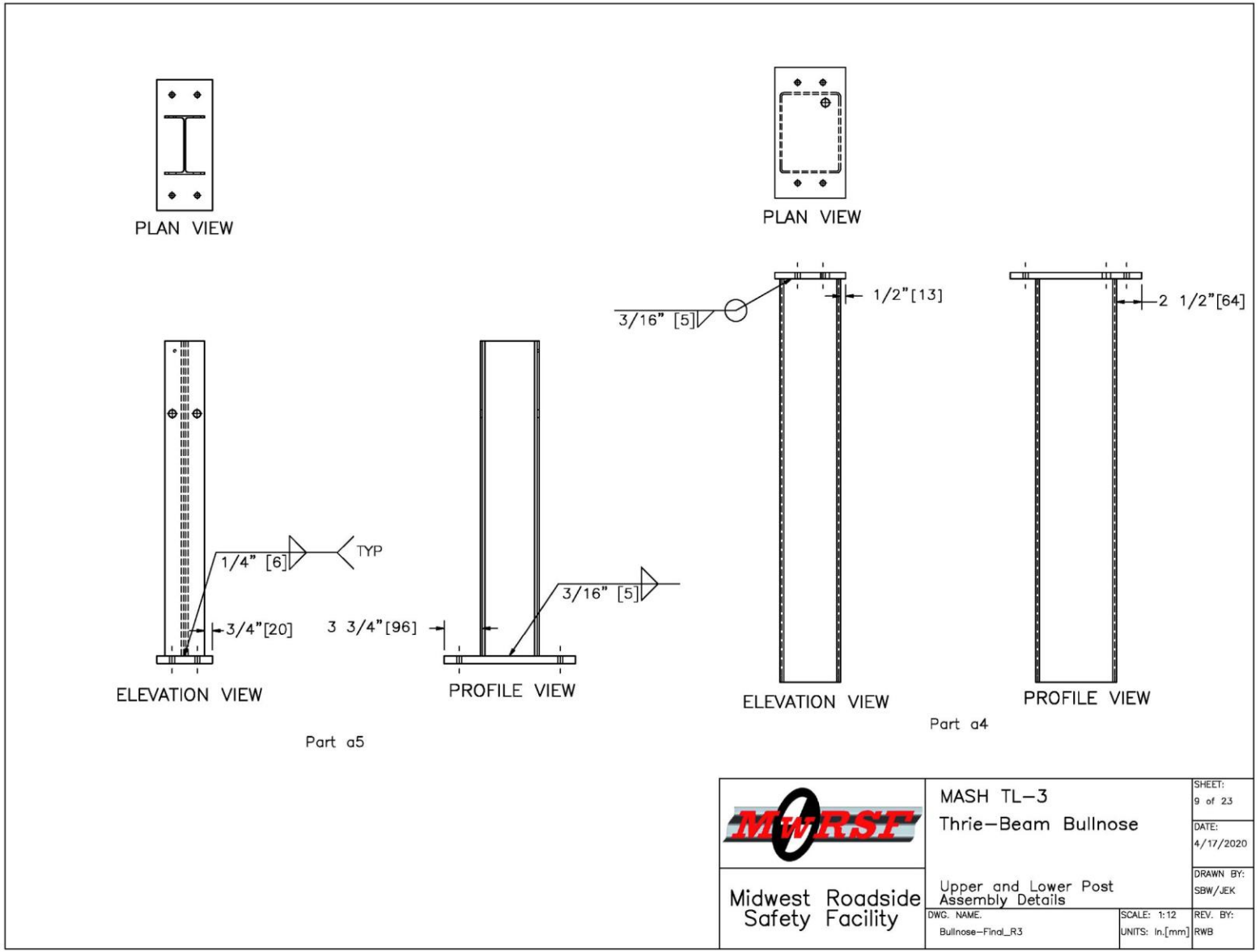


Figure B-9. Upper and Lower Post Assembly Details, MASH TL-3 Thrie-Beam Bullnose

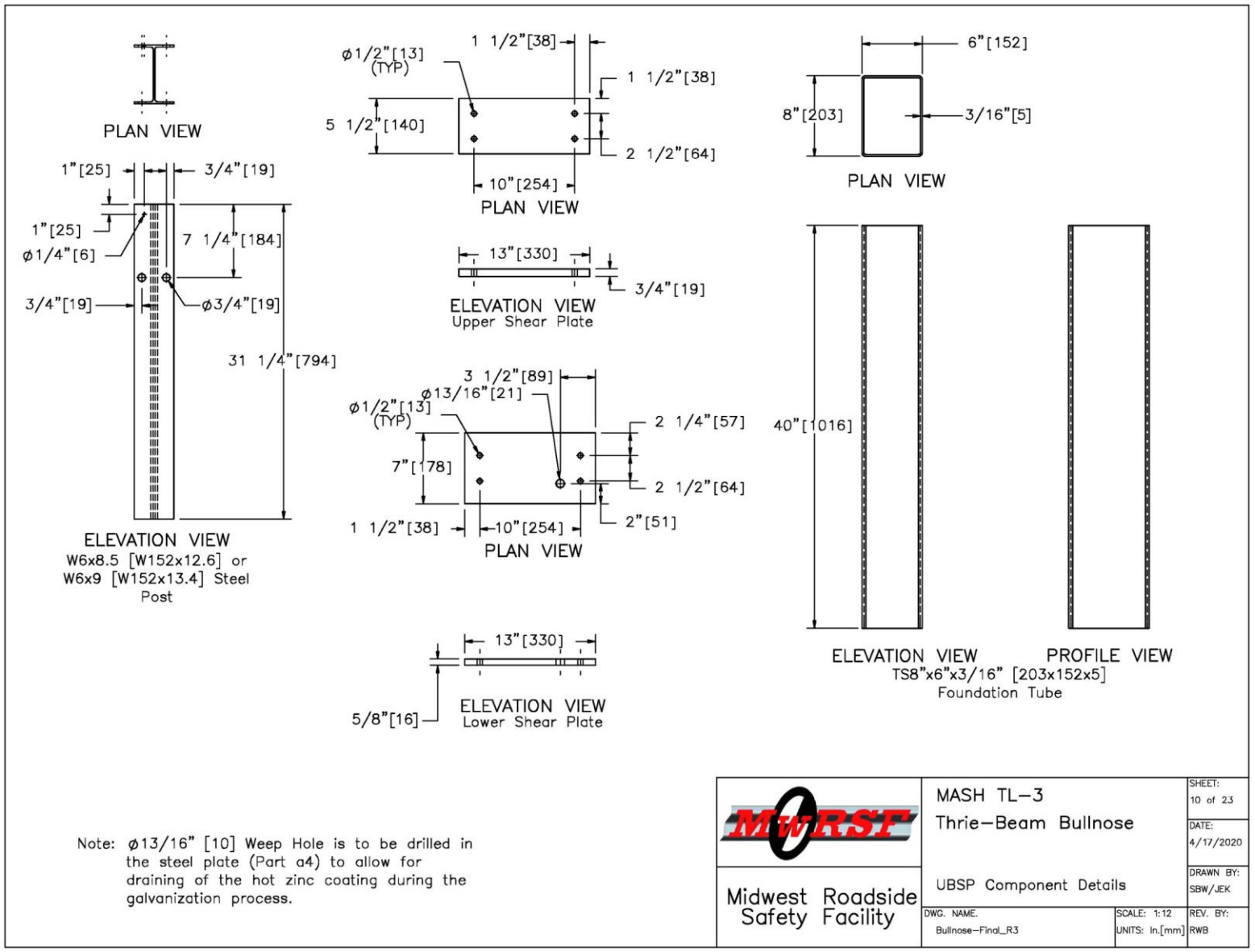


Figure B-10. UBSP Component Details, MASH TL-3 Thrie-Beam Bullnose

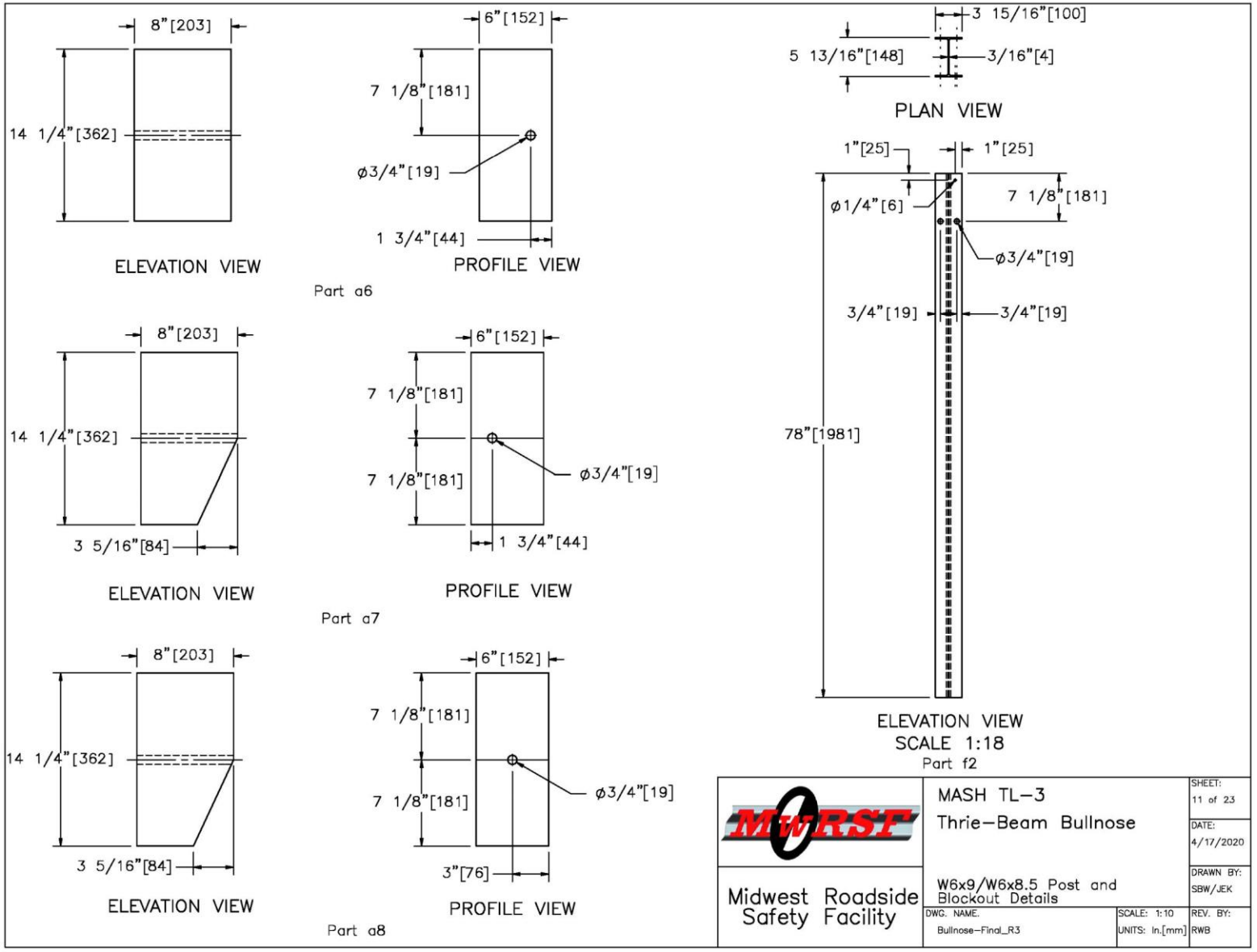


Figure B-11. W6x9/W6x8.5 Post and Blockout Details, MASH TL-3 Thrie-Beam Bullnose

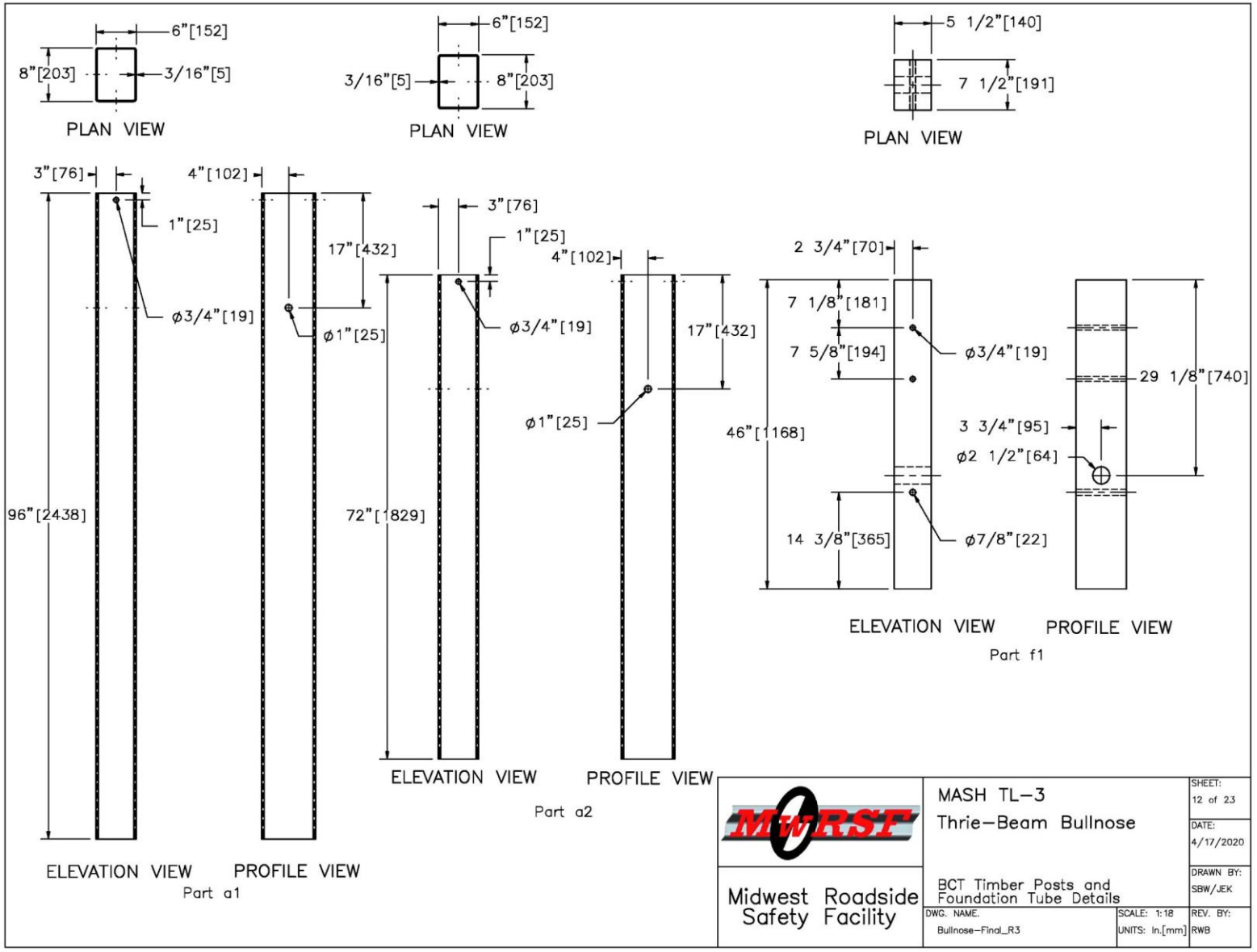


Figure B-12. BCT Timber Posts and Foundation Tube Details, MASH TL-3 Thrie-Beam Bullnose

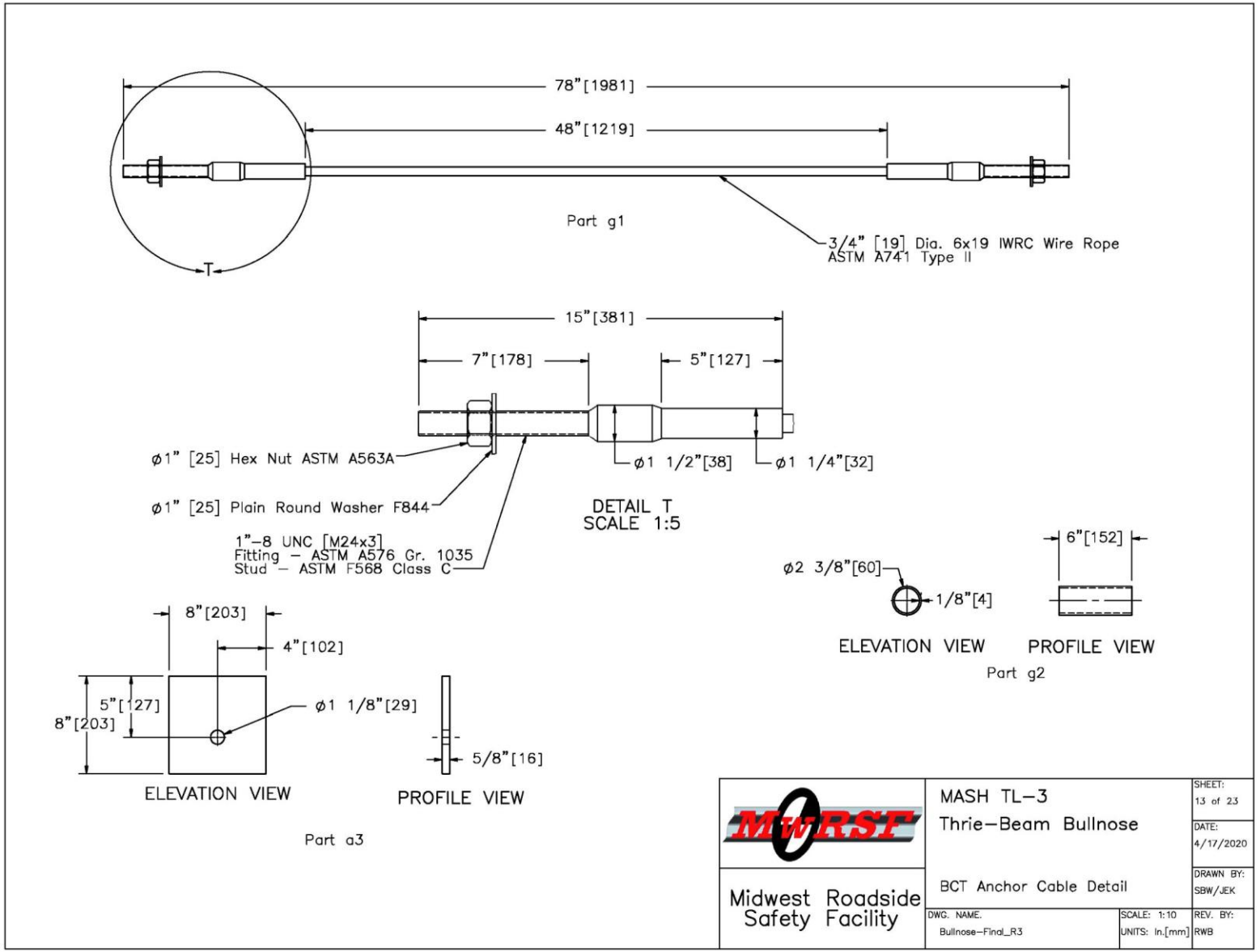


Figure B-13. BCT Anchor Cable Detail, MASH TL-3 Thrie-Beam Bullnose

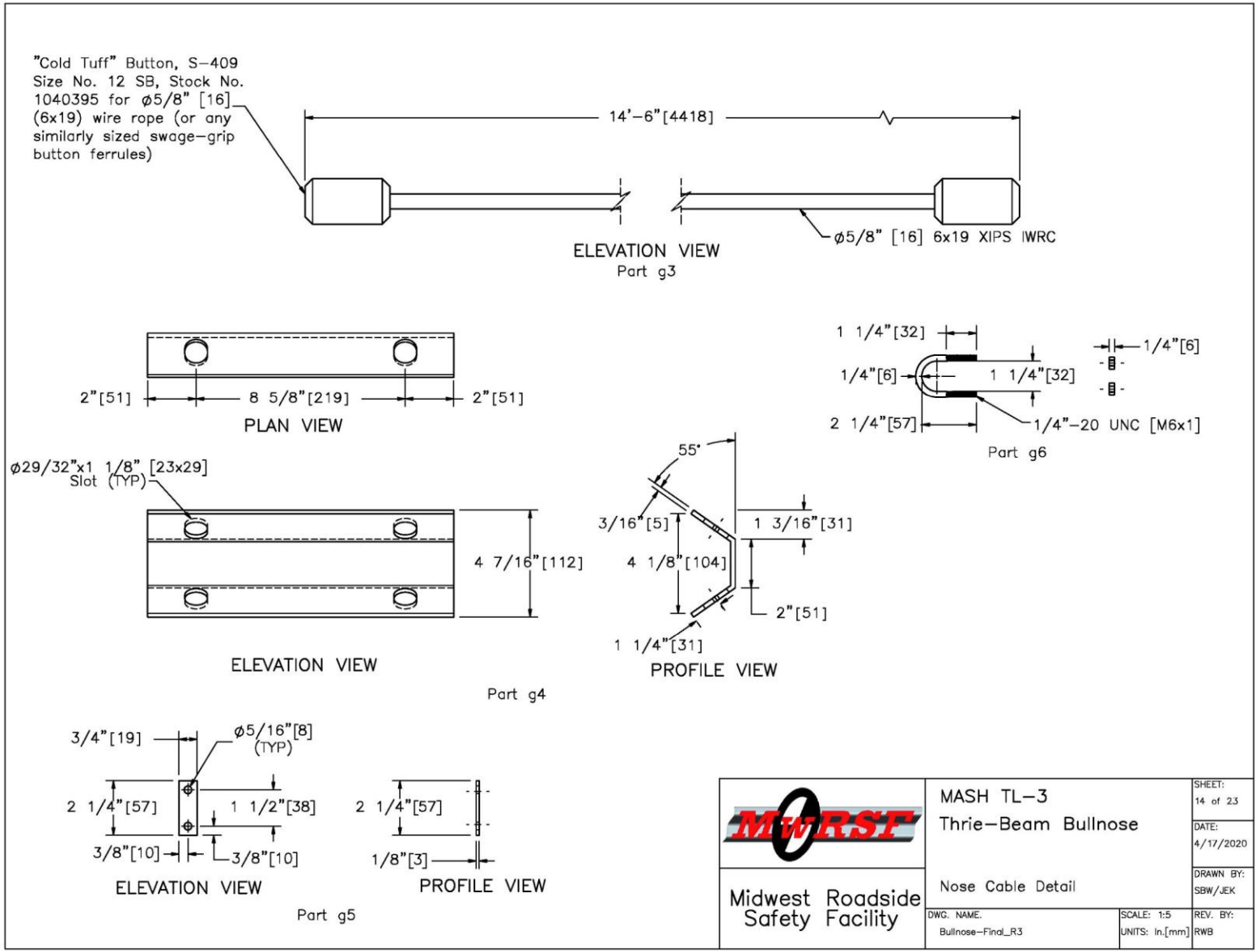


Figure B-14. Nose Cable Detail, MASH TL-3 Thrie-Beam Bullnose

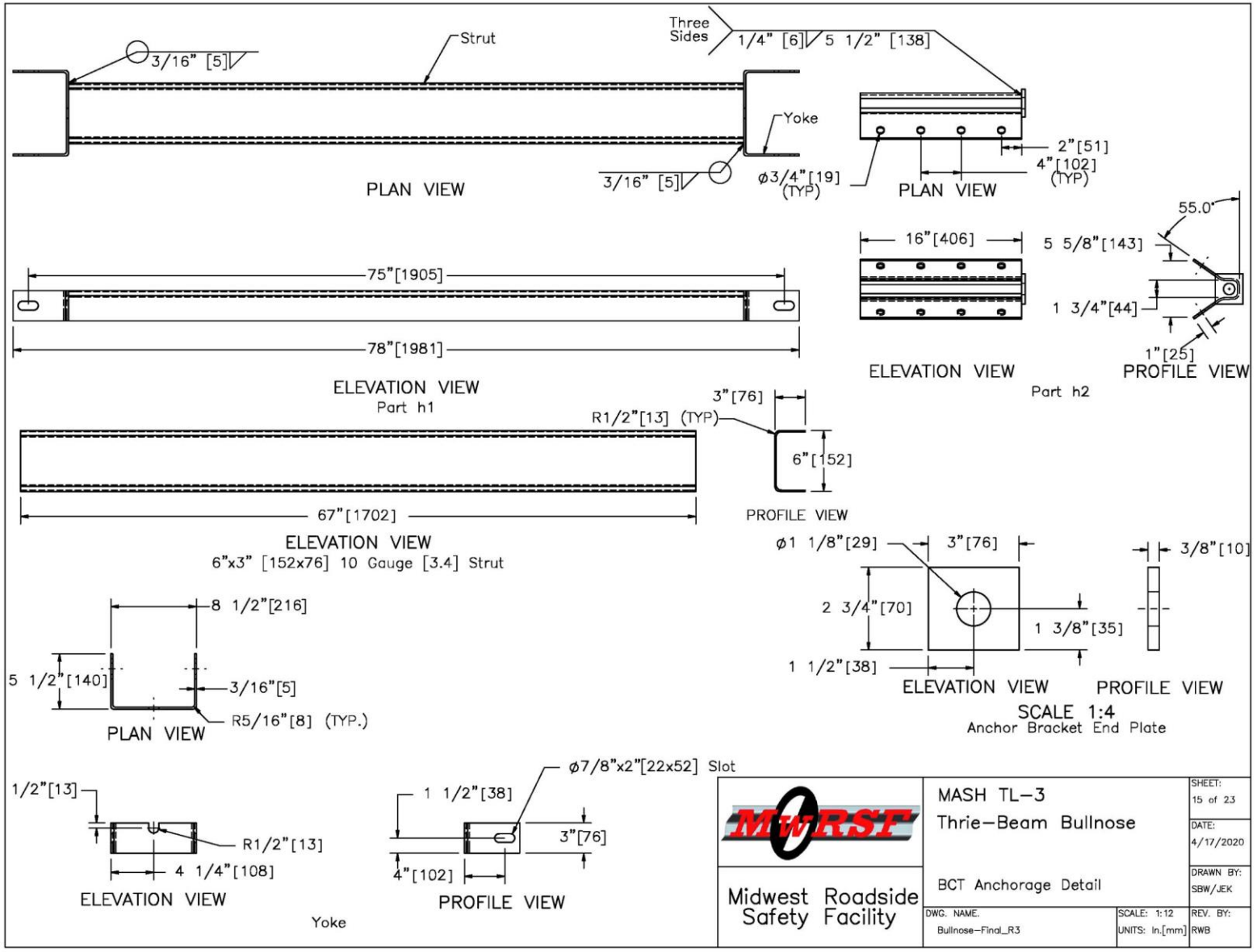


Figure B-15. BCT Anchorage Detail, MASH TL-3 Thrie-Beam Bullnose

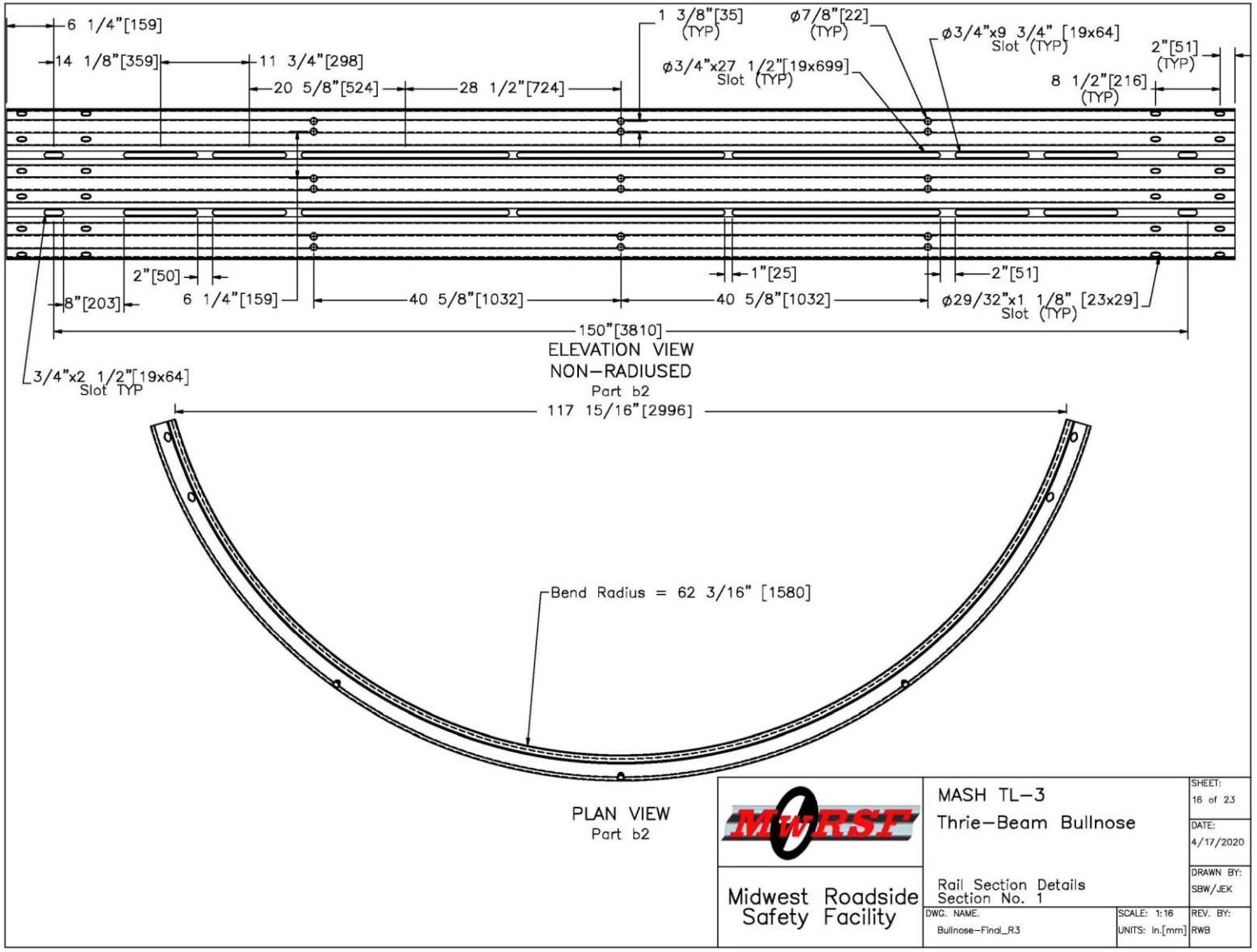


Figure B-16. Rail Section Details, Section No. 1, MASH TL-3 Thrie-Beam Bullnose

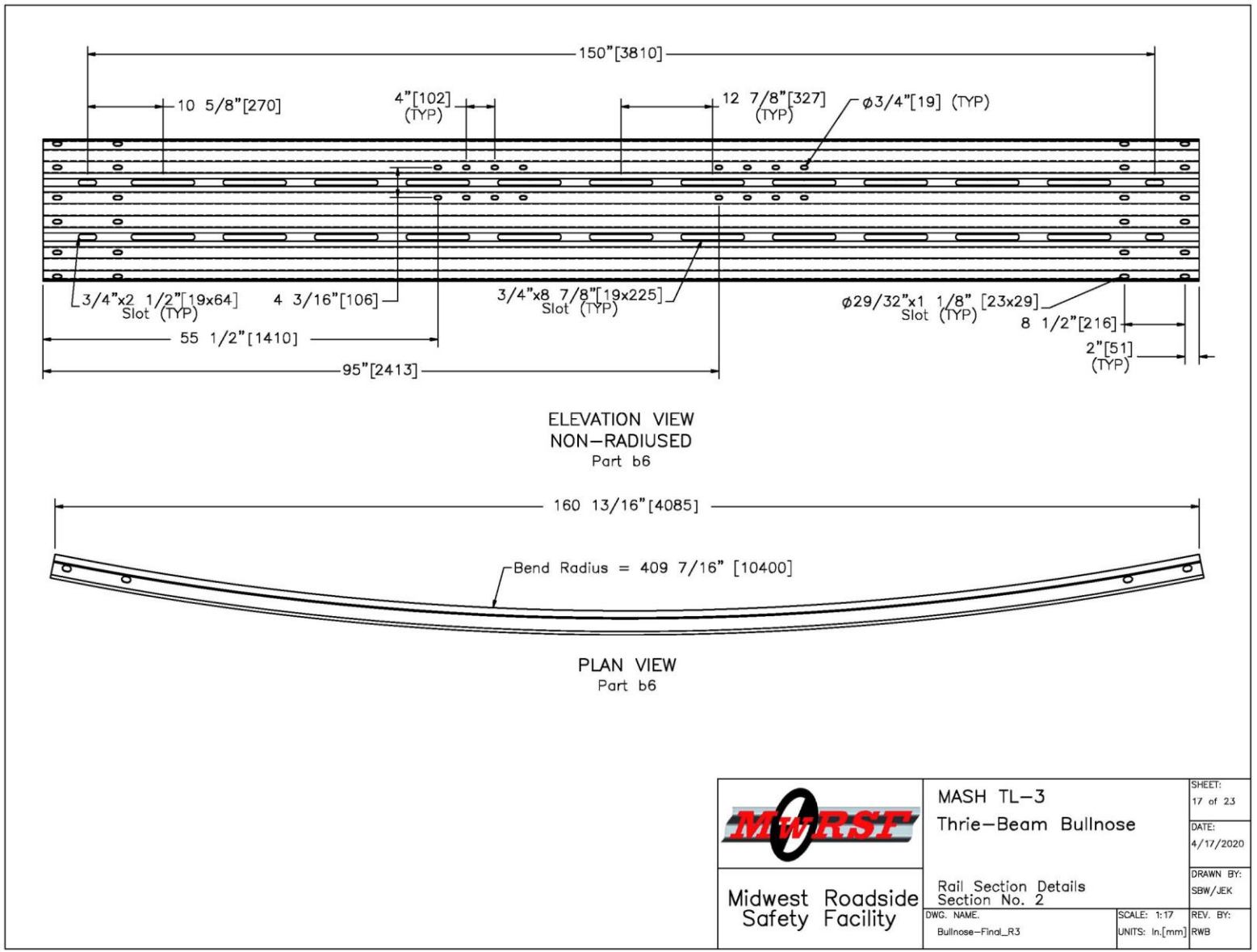


Figure B-17. Rail Section Details, Section No. 2, MASH TL-3 Thrie-Beam Bullnose

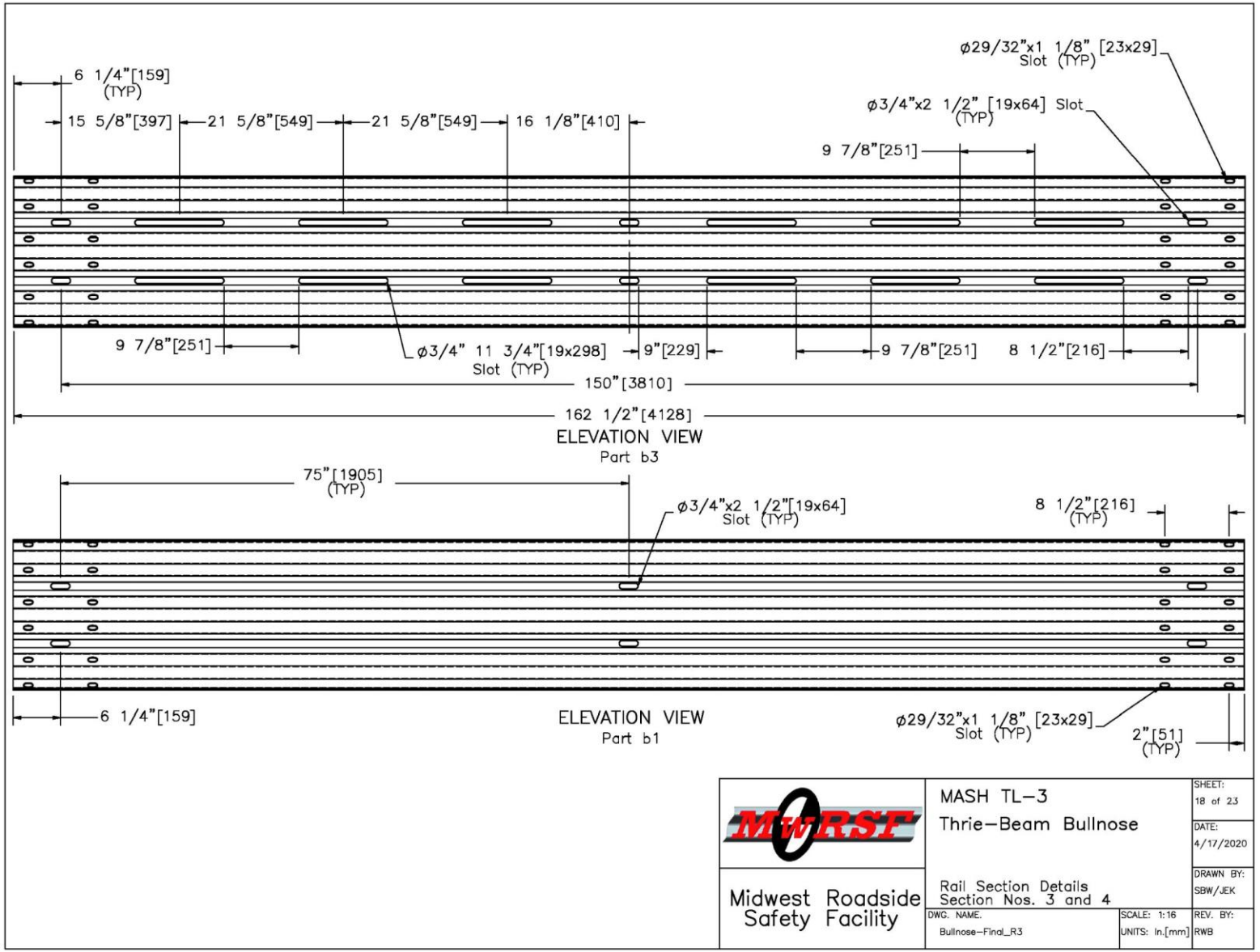


Figure B-18. Rail Section Details, Section Nos. 3 and 4, MASH TL-3 Thrie-Beam Bullnose

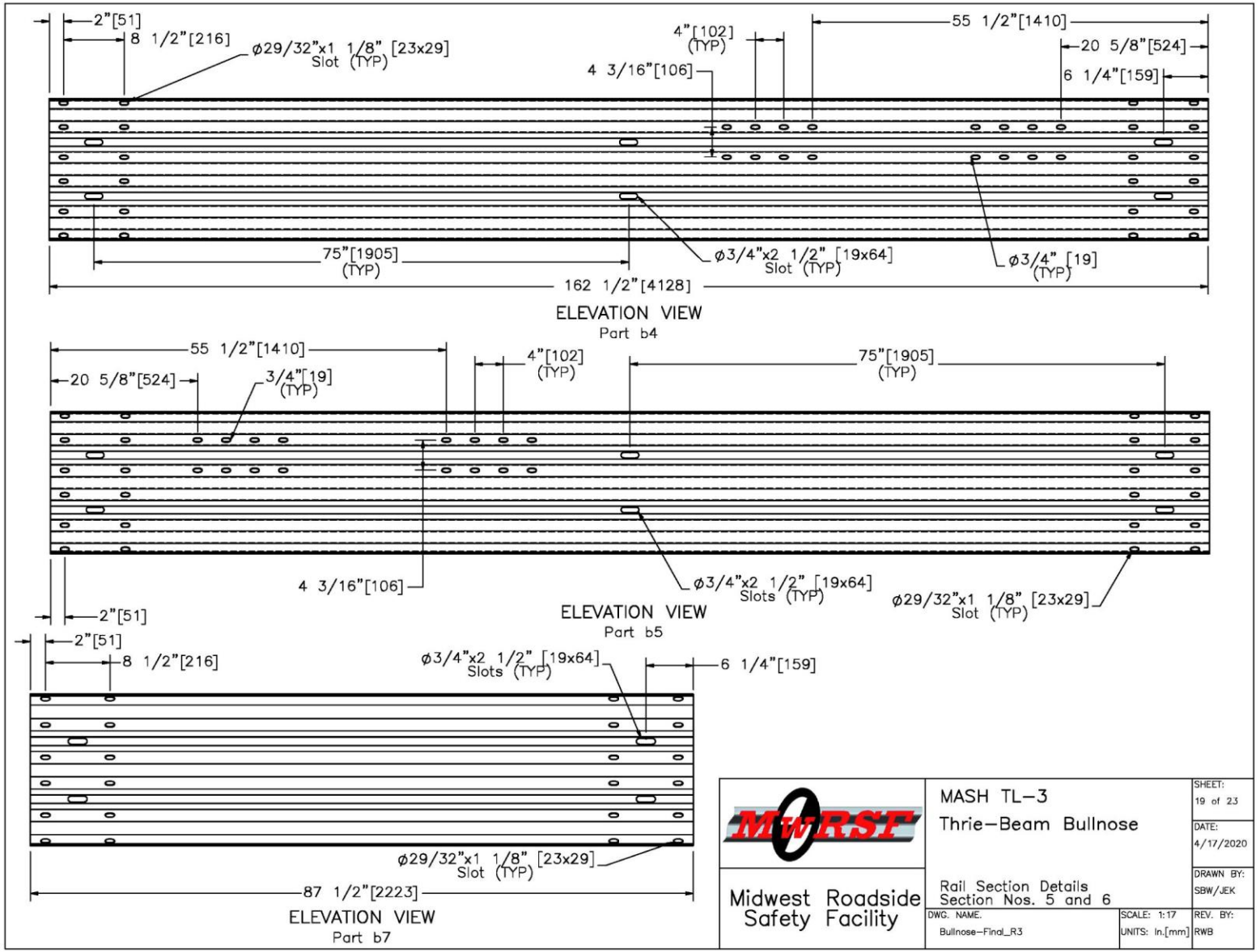


Figure B-19. Rail Section Details, Section Nos. 5 and 6, MASH TL-3 Thrie-Beam Bullnose

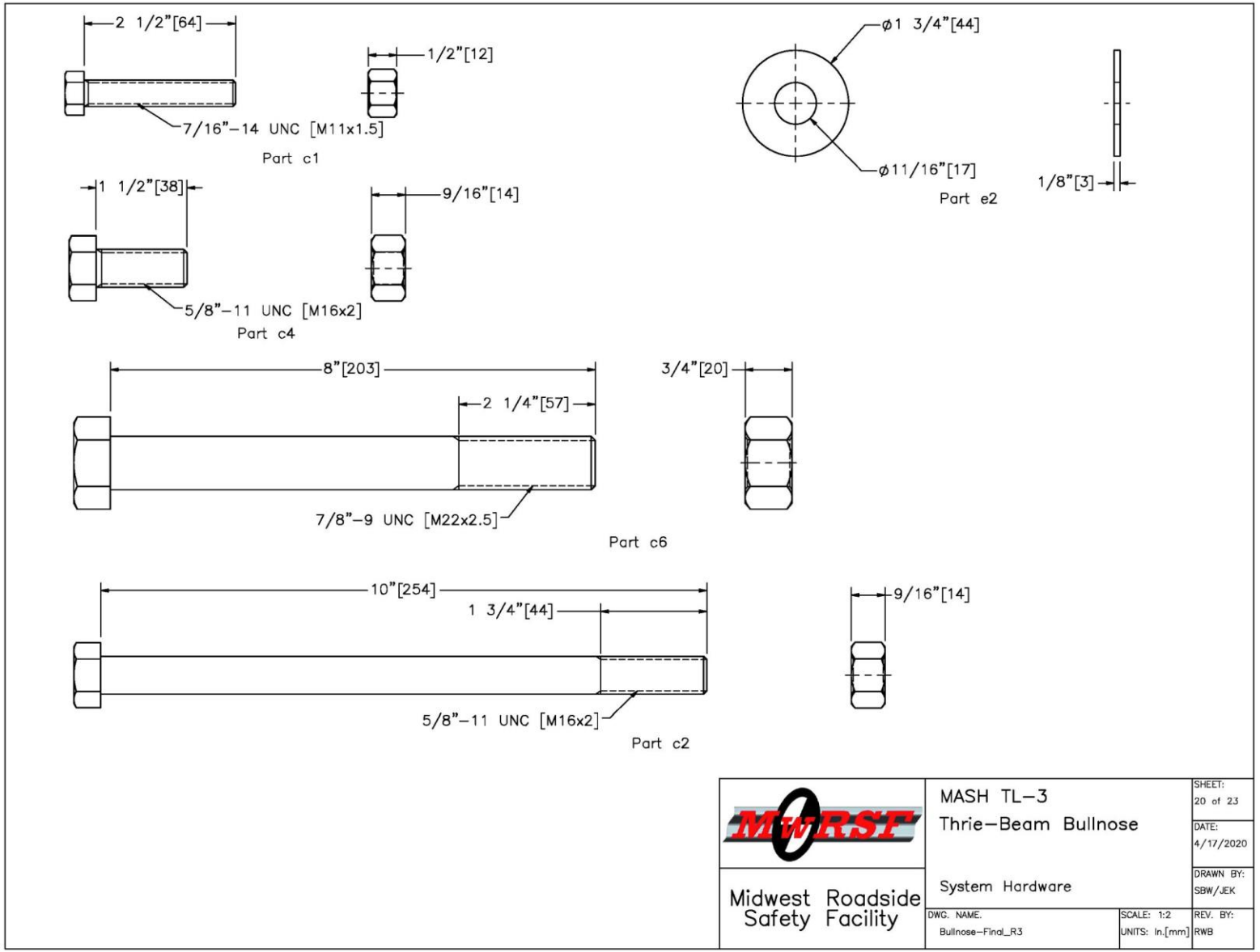


Figure B-20. System Hardware, MASH TL-3 Thrie-Beam Bullnose

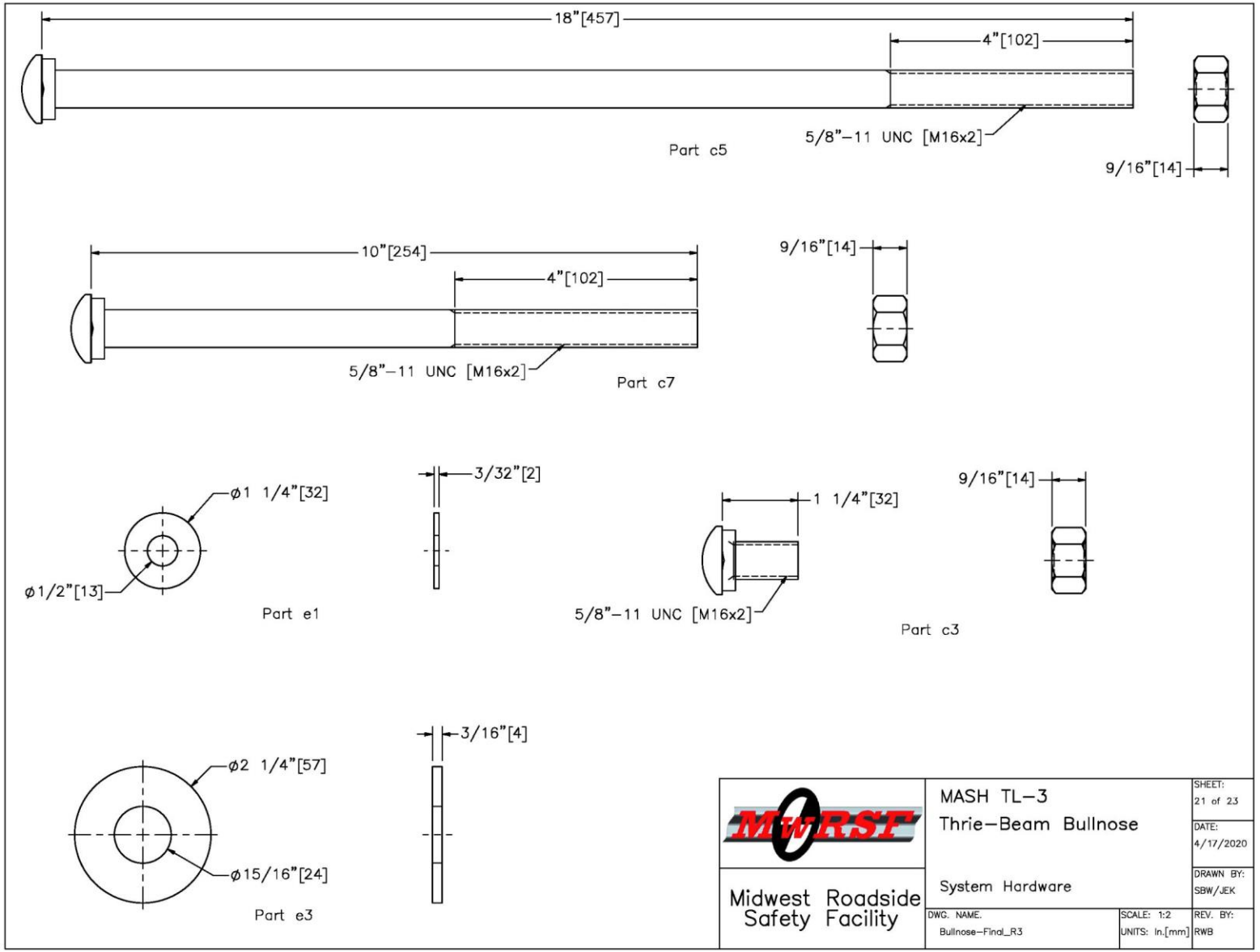


Figure B-21. System Hardware, Cont., MASH TL-3 Thrie-Beam Bullnose

Item No.	QTY.	Description	Material Specification	Treatment Specification	Hardware Guide
a1	2	TS8"x6"x3/16" [203x152x5], 96" [2,438] Long Foundation Tube	ASTM A500 Gr. B	ASTM A123	PTE07
a2	6	TS8"x6"x3/16" [203x152x5], 72" [1,829] Long Foundation Tube	ASTM A500 Gr. B	ASTM A123	PTE06
a3	6	8"x8"x5/8" [203x203x16] Anchor Bearing Plate	ASTM A36	ASTM A123	FPB01
a4	12	Lower Slip Post Assembly	Plate–ASTM A36 Foundation Tube–ASTM A500 Gr. B	ASTM A123	PTE08
a5	12	Upper Slip Post Assembly	Plate–ASTM A36 Post–ASTM A992	ASTM A123	PWE11
a6	20	6"x8"x14 1/4" [152x203x362] Timber Blockout	SYP Grade No. 1 or better	–	PDB09
a7	12	6"x8"x14 1/4" [152x203x362] Tapered Timber Blockout	SYP Grade No. 1 or better	–	PDB20
a8	2	6"x8"x14 1/4" [152x203x362] Tapered Timber Blockout – Post 2	SYP Grade No. 1 or better	–	PDB12
b1	4	12'–6" [3,810] 12 gauge [2.7] Thrie Beam Section	AASHTO M180	ASTM A123 or A653	RTM02a
b2	1	12'–6" [3,810] 12 gauge [2.7] Bent Thrie Beam Section	AASHTO M180	ASTM A123 or A653	RTM07a
b3	2	12'–6" [3,810] 12 gauge [2.7] Thrie Beam Section	AASHTO M180	ASTM A123 or A653	RTM07e
b4	1	12'–6" [3,810] 12 gauge [2.7] Thrie Beam End Section – Side A	AASHTO M180	ASTM A123 or A653	–
b5	1	12'–6" [3,810] 12 gauge [2.7] Thrie Beam End Section – Side B	AASHTO M180	ASTM A123 or A653	–
b6	2	12'–6" [3,810] 12 gauge [2.7] Bent Thrie Beam Section	AASHTO M180	ASTM A123 or A653	RTM07d
c1	48	7/16"–14 UNC [M11x1.5], 2 1/2" [64] Long Hex Tap Bolt (Fully Threaded) and Nut	Bolt – ASTM A449 or SAE J429 Gr. 5 Nut – ASTM A563DH or SAE J995 Gr. 5	ASTM A153 or B695 Class 55 or F2329	FBX12b
c2	8	5/8"–11 UNC [M16x2], 10" [254] Long Hex Head Bolt	Bolt – ASTM A307 Gr. A Nut – ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBX16a
c3	120	5/8"–11 UNC [M16x2], 1 1/4" [32] Long Guardrail Bolt and Nut	Bolt – ASTM A307 Gr. A Nut – ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBB01
c4	48	5/8"–11 UNC [M16x2], 1 1/2" [38] Long Hex Head Bolt and Nut	Bolt – ASTM A307 Gr. A Nut – ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBX16a
c5	14	5/8"–11 UNC [M16x2], 18" [457] Long Guardrail Bolt and Nut	Bolt – ASTM A307 Gr. A Nut – ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBB04
c6	8	7/8"–9 UNC [M22x2.5], 8" [203] Long Hex Head Bolt and Nut	Bolt – ASTM A307 Gr. A Nut – ASTM A563A	ASTM A153 or B695 Class 55 or F2329	–
c7	20	5/8"–11 UNC [M16x2], 10" [254] Long Guardrail Bolt and Nut	Bolt – ASTM A307 Gr. A Nut – ASTM A563A	ASTM A153 or B695 Class 55 or F2329	FBB03
c8	46	16D Double Head Nail	–	–	–

Midwest Roadside Safety Facility

MASH TL–3
Thrie–Beam Bullnose

Bill of Materials

SHEET: 22 of 23
DATE: 4/17/2020
DRAWN BY: SBW/JEK
REV. BY: RWB
DWG. NAME. Bullnose–Final_R3
SCALE: None
UNITS: In.[mm]

Figure B-22. Bill of Materials, MASH TL-3 Thrie-Beam Bullnose

Item No.	QTY.	Description	Material Specification	Treatment Specification	Hardware Guide
e1	192	7/16" [11] Dia. Plain Round Washer	ASTM F844	ASTM A153 or B695 Class 55 or F2329	FWC12a
e2	118	5/8" [16] Dia. Plain Round Washer	ASTM F844	ASTM A153 or B695 Class 55 or F2329	FWC16a
e3	16	7/8" [22] Dia. Plain Round Washer	ASTM F844	ASTM A153 or B695 Class 55 or F2329	–
f1	8	BCT Timber Post – MGS Height	SYP Grade No. 1 or better (No knots +/– 18" [457] from ground on tension face)	–	PDF04
f2	8	W6x8.5 [W152x12.6] or W6x9 [W152x13.4], 78" [1,981] Long Steel Post	ASTM A992	ASTM A123	–
g1	6	BCT Anchor Cable Assembly	–		FCA01
g2	6	2 3/8" [60] O.D. x 6" [152] Long BCT Post Sleeve	ASTM A53 Gr. B Schedule 40	ASTM A123	FMM02
g3	3	5/8" Dia. [15.9] x 14.4' [4,389] Long Cable and Swage Button	"Cold Tuff" Button, S–409 Size No. 12 SB, Stock No. 1040395 for 5/8" [16] Dia. (6x19) wire rope (or any similarly sized swage–grip button ferrules)	Wire Rope – Class A Coating	RCM02
g4	6	12 5/8"x5 13/16"x3/16" [321x148x5] Nose Cable Anchor Plate	ASTM A36	ASTM A123	FPA04
g5	9	2 1/4"x3/4" [57x19] 11 gauge [3] U–Bolt Plate Washer	ASTM A1011 CS Type B	ASTM A123	–
g6	9	1/4" [6] Dia. U–Bolt and Nut	U–Bolt – ASTM A307 Gr. A Nut – ASTM A563A	ASTM A153 or B695 Class 55 or F2329	–
h1	2	Ground Strut Assembly	ASTM A36	ASTM A123	PFP01
h2	6	Anchor Bracket Assmbely	ASTM A36	ASTM A123	FPA01

MwRSF

Midwest Roadside Safety Facility

MASH TL–3
Thrie–Beam Bullnose

Bill of Materials

SHEET: 23 of 23
DATE: 4/17/2020
DRAWN BY: SBW/JEK
REV. BY: RWB
DWG. NAME. Bullnose–Final_R3
SCALE: None
UNITS: In.[mm]

Figure B-23. Bill of Materials, Cont., MASH TL-3 Thrie-Beam Bullnose

Appendix C. Grading Diagrams

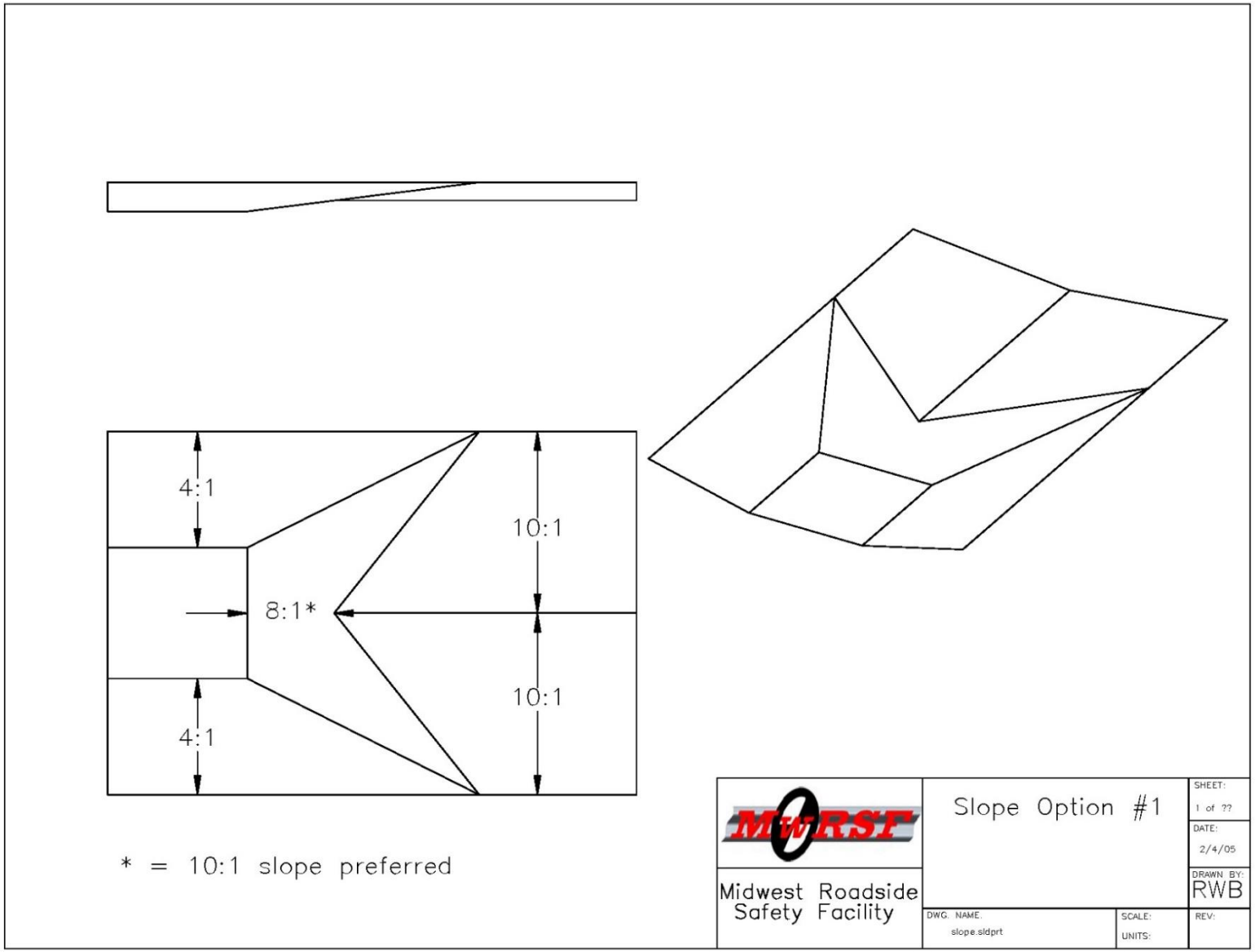


Figure C-1. Thrie-Beam Bullnose Ditch Grading Schematic, Option 1

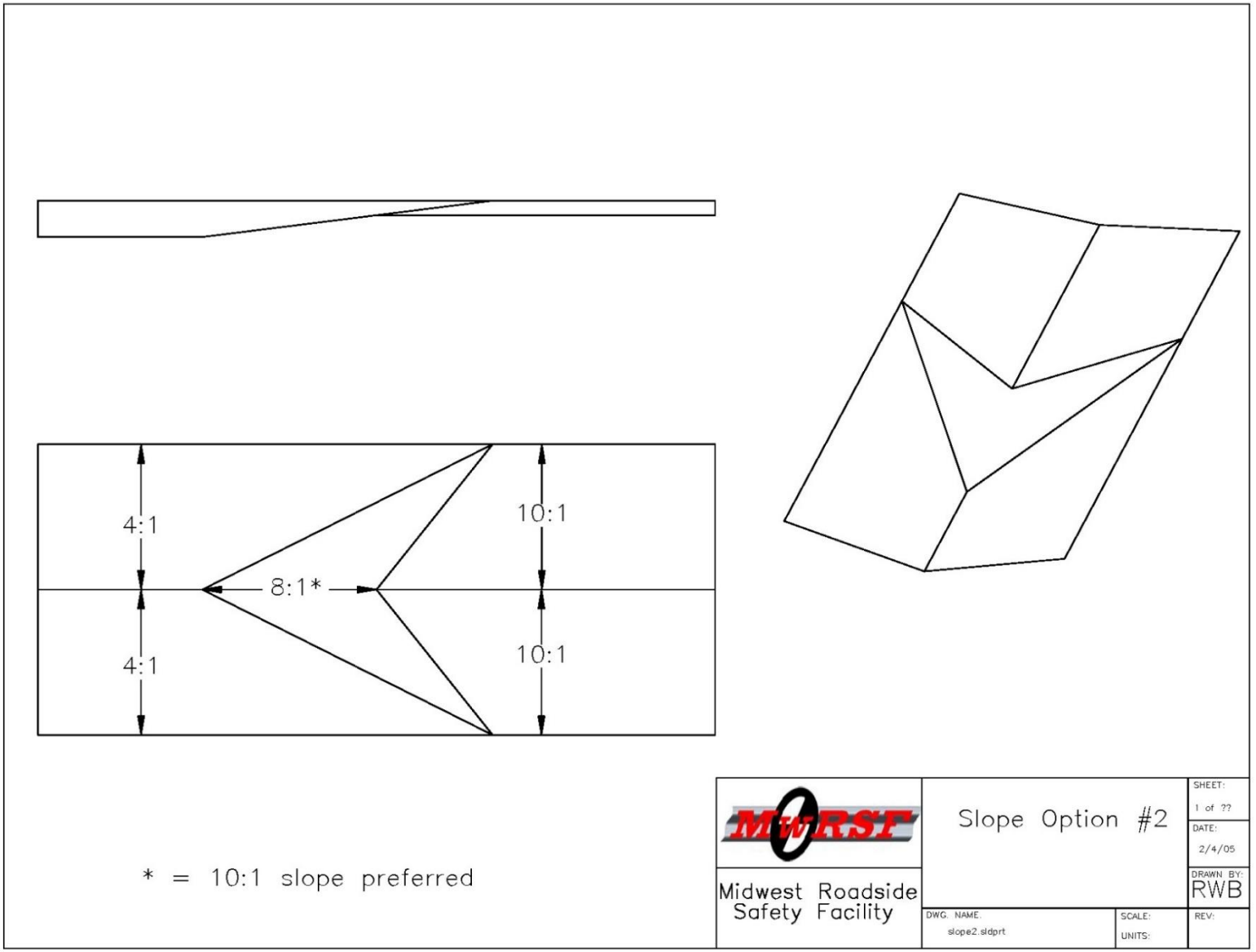


Figure C-2. Thrie-Beam Bullnose Ditch Grading Schematic, Option 2

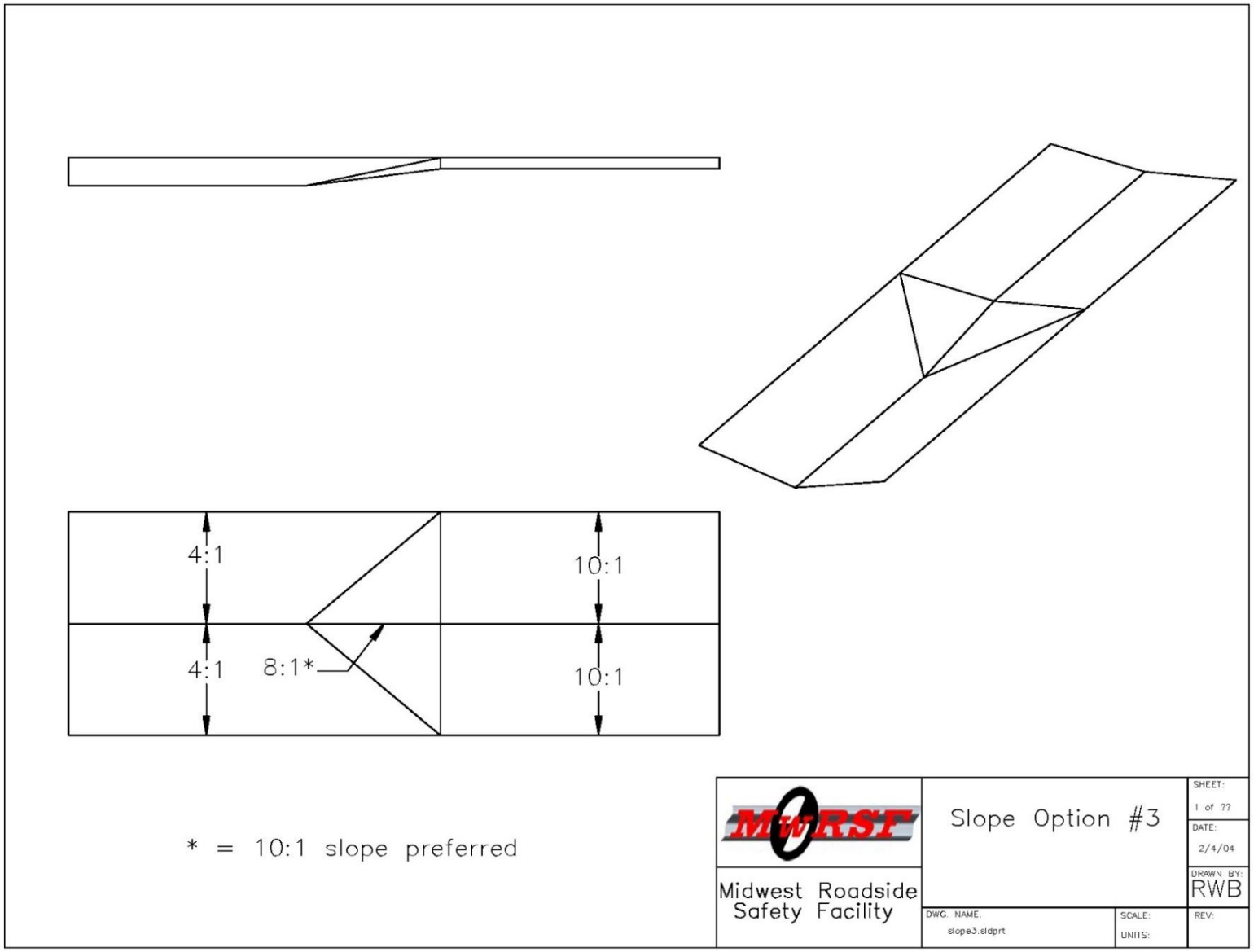


Figure C-3. Thrie-Beam Bullnose Ditch Grading Schematic, Option 3

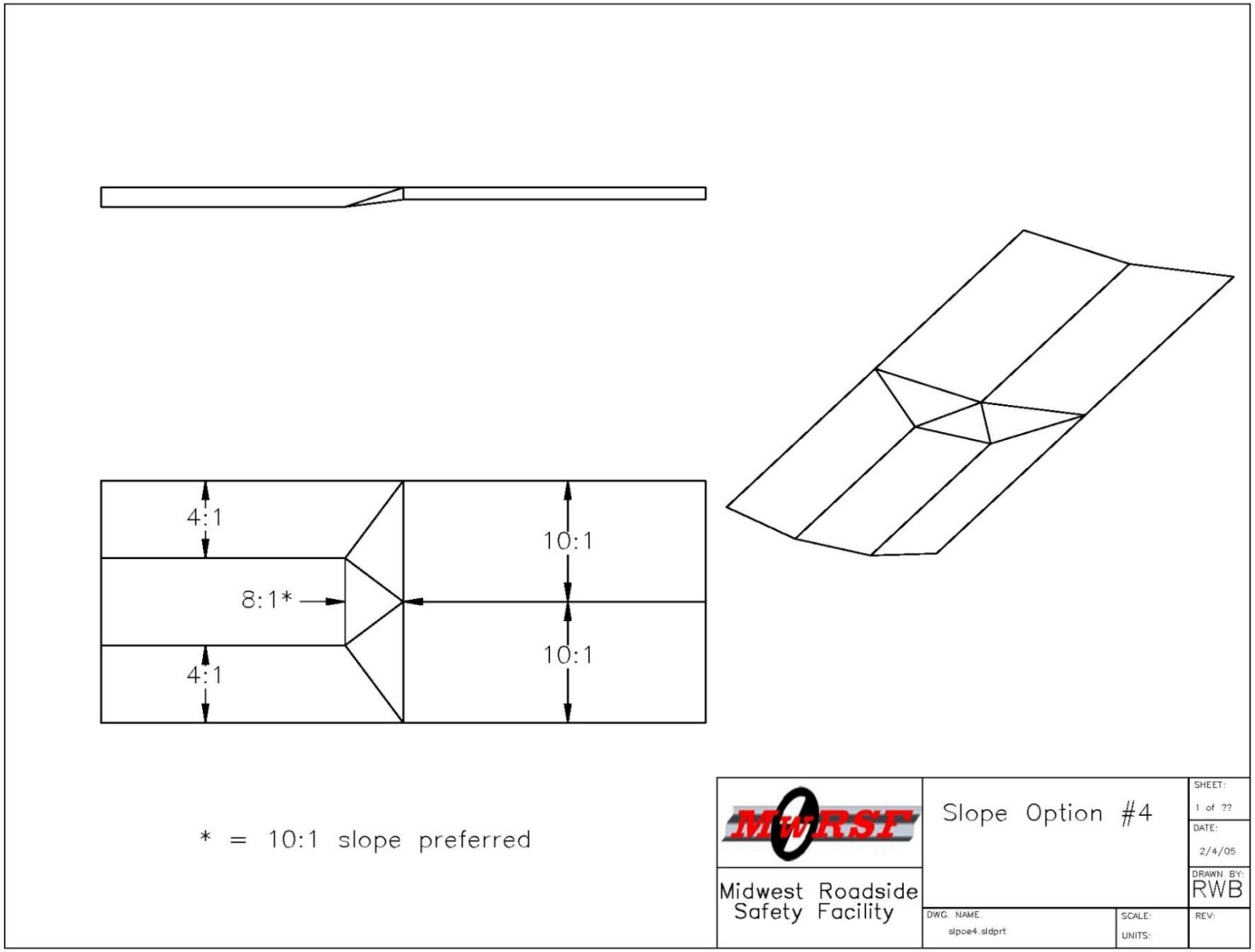


Figure C-4. Thrie-Beam Bullnose Ditch Grading Schematic, Option 4

Appendix D. Alternative Post Installation Method

Coring holes for each post is an acceptable alternate installation method for UBSPs. The method is as follows:

1. Core 3’ diameter holes for each post
2. Install the posts
3. Backfill and tamp holes

Soil material classification: A compacted, coarse, crushed limestone material, alternatively classified as well-graded gravel by the Unified Soil Classification System, that meets American Association of State Highway and Transportation Officials (AASHTO) standard soil designation M147 Grade B, as recommended by the Manual for Assessing Safety Hardware, Second Edition (MASH 2016).

Note that individual states may have different soil conditions and auguring, backfill, and tamping procedures. Follow the procedures according to the state DOT guidelines.

END OF DOCUMENT