US 550 South Connection to US 160
Structure Selection Report

STRUCTURE NOS.
P-05-BB (Livestock Overpass)
P-05-AZ (Gulch A)
P-05-BA (Gulch B)

Prepared for:

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COLORADO
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1. PROJECT BACKGROUND

1.1. PROJECT DESCRIPTION

The Colorado Department of Transportation (CDOT) has been planning and building improvements for US Highway 550 from the New Mexico state line to Durango, and for US Highway 160 from Bayfield to Durango, for close to 20 years. Various projects are in the planning, permitting, design, construction, or completed stages. One critical project is the south connection of US 550 to US 160. CDOT has already built the first phase of the Grandview interchange, which is their proposed connection point for US 550 and US 160.

In March 2015, CDOT issued the *US 550 South Connection to US 160: Independent Alternatives Analysis* report. This report suggested a refined preferred alternative alignment called Revised G Modified 6 (RGM 6). This alignment has been carried forward in CDOT's planning efforts.

In April 2015, FHWA signed the *Record of Decision for the US 550 South Connection to US 160 Supplemental Final Environmental Impact Statement/Section 4(f) Evaluation to the US Highway 160 from Durango to Bayfield EIS* clearing the way for the RGM 6 alignment to be designed and constructed.

The proposed RGM 6 alignment diverges from the current US 550 alignment just south of County Road 220 and traverses along the edge of Florida Mesa for 1.7 miles before connecting to the existing Grandview interchange.

The proposed alignment for US 550 includes three bridge crossings which are the subjects of this report. Two bridges carry US 550 over Gulches A and B. The Gulch A and B bridges will also provide for large animal crossings below US 550. A third bridge provides a livestock crossing over US 550 to provide connectivity of an otherwise severed part of the Webb Ranch west of proposed US 550.

Figure 1 - Project Site Plan

The current US 550 ADT is 7900 and the projected future ADT is 21,600 vehicles.[1] The roadway typical section for US 550 at Gulch A and Gulch B bridges includes four 12-foot lanes, 10-foot exterior shoulders and 8-foot interior shoulders.

See **Figure 1** for an overview of the proposed roadway alignment and location of structures.

1 US 550 South Connection to US 160: Independent Alternatives Analysis Report, March 2015

1.2. STRUCTURE SERVICE LIFE, DATA AND DESIGN CRITERIA

The following structure service life, data and design criteria are applicable to the proposed structure alternatives:

1.2.1. Structure Service Life Criteria[2]

TABLE 1 – STRUCTURE SERVICE LIFE CRITERIA

Livestock Overpass (P-05-BB) Bridge

Strategy Determination Parameters

- Bridge is in Southwest Transportation Planning Region.
- Bridge will connect two pieces of private land. The projected ADT and future use of the bridge is unknown. Future development of this area is likely to change the traffic patterns. Therefore, consider Tier 1 Strategies.

Gulch A (P-05-AZ) and Gulch B (P-05-BA) Bridges

Strategy Determination Parameters

- Bridges are in Southwest Transportation Planning Region.
- The current ADT is 7900 vehicles.[3]
- ADT is greater than 1400 vehicles.
- Use Tier 1 Strategies.

Tier 1 Strategies

Concrete	Reinforcing Steel	Structural Steel	Design Detailing
• AASHTO/CDOT design guidelines • Bituminous waterproofing membrane (Livestock Overpass Bridge will not carry roadway traffic initially and will have 4 inches of seeded ABC (Class 6) placed over a waterproofing membrane) • Concrete sealers for non-abrasion surfaces • Precast deck panels	• Epoxy coated reinforcing	• Zinc-rich paints and primer coating • Weathering steel girders	• Reduce skew angle of substructures

2 Colorado Bridge Enterprise – Strategies for Enhancing Bridge Service Live, June 2015

3 US 550 South Connection to US 160: Independent Alternatives Analysis Report, March 2015

1.2.2. Structure Data Criteria

TABLE 2 – STRUCTURE DATA CRITERIA			
Structure Data	**P-05-BB**	**P-05-AZ**	**P-05-BA**
Crossing	Livestock Overpass	Gulch A	Gulch B
Overall Bridge Width (Out-to-Out)	31’-0”	89’-0”	89’-0”
Roadway Width	28’-0”	2 @ 42’-0”	2 @ 42’-0”
Number of Striped Traffic Lanes	2 (Future)	4	4
Number of Design Lanes*	2	7	7
Lane Width	12’-0”	12’-0”	12’-0”
Interior Shoulder Width	Not Applicable	8’-0”	8’-0”
Median Barrier Width (CDOT Type 9 Barrier, Style CC)	Not Applicable	2’-0”	2’-0”
Exterior Shoulder Width	2’-0”	10’-0”	10’-0”
Pedestrian Walkway	Not Applicable	Not Applicable	Not Applicable
Bridge Rail (CDOT Type)	1’-6”, Type 7	1’-6”, Combination	1’-6”, Combination
Deck	CIP Concrete	CIP Concrete	CIP Concrete
Deck Protection (Wearing surface with waterproofing membrane)	4” ABC	3” Asphalt	3” Asphalt
Approach Slabs[4]	Not Required	Provide	Provide

***** Based on clear roadway width measured curb-to-median barrier and median-to-curb.

1.2.3. Structure Design Criteria

TABLE 3 – STRUCTURE DESIGN CRITERIA	
Specifications	AASHTO LRFD Bridge Design Specifications, 8th Edition and CDOT Bridge Design Manual
Design Methodology	Load and Resistance Factor Design (LRFD)
Design Live Load	HL93 and Colorado Permit Vehicle (Owner Specified Vehicle)
Livestock Load	Equivalent to pedestrian loading in AASHTO LRFD Guide Specifications for Design of Pedestrian Bridges. Shall not be considered to act concurrently with vehicular loading
Live Load Deflection	L/800
Design Dead Load	Wearing Surface (Asphalt 36 psf & ABC 44.33 psf), Future Utility Allowance (10 psf)
Utilities	Two 2-inch conduits in each curb for future utilities
Hydraulics: Floodplain	Not Applicable
Hydraulics: Freeboard	Not Applicable
Seismic[5]	Zone 1

4 CDOT Bride Design Manual, Section 2.13
5 Preliminary Foundation Recommendations 22420 US550/160 – Bridges 1and 2

1.3. ENVIRONMENTAL CONSTRAINTS

In April 2015, FHWA signed the *Record of Decision* for the *US 550 South Connection to US 160 Supplemental Final Environmental Impact Statement/Section 4(f) Evaluation to the US Highway 160 from Durango to Bayfield EIS (2015 SFEIS).* RGM 6 (Preferred Alternative) was determined as having the least environmental impact for the Grandview Section of the project corridor. Section 8, Table 2, of the *ROD* lists 39 mitigation commitments for the RGM 6 alignment. Four of these measures pertain specifically to the bridges, including Mitigation Commitment Nos. #23, #24, #34 and #35. The mitigation commitments are summarized as follows:

#23 Fish and Wildlife - Eight-foot-high wildlife exclusionary fencing in conjunction with large animal underpasses will be used to reduce collisions and provide road crossing opportunities.

#24 Fish and Wildlife - Revised G Modified Alternative 6 includes five 48-inch small mammal crossings, one concrete box culvert (CBC) doubling as a small-mammal crossing, and two bridges doubling as large-animal underpasses along US 550.

#34 Visual Resources/Aesthetics - Project development and design within the Grandview Area will be coordinated with the City of Durango's Landscape Planner and Arborist to assure consistency with context sensitive design goals of the Grandview Area Plan.

#35 Visual Resources/Aesthetics – Construction of cut-and-fill slopes will be minimized, and the cut line blended into the existing terrain. Retaining walls and bridge structures will include design features to add to the scenic quality of the built area. Architectural design guidelines will be developed to maintain consistent architectural and aesthetic treatments throughout the study area.

In addition to the mitigation measures called out in the *2015 SFEIS*, the *2012 SFEIS*, Section 4 Farmland, Subsection 4.2.6 Mitigation, calls for one underpass to accommodate access for farm equipment, livestock crossing to seasonal calving grounds, crop production and natural gas production.

In conformance with the environmental mitigation requirements, adequate openings will be provided beneath the Gulch A and B bridges for wildlife passage. Wildlife fencing will be installed along the roadway approaches tying into the bridge openings. Livestock overpass and underpass alternatives will be evaluated to accommodate access for livestock, farm equipment and natural gas production equipment over or under US 550.

1.4. GEOTECHNICAL SUMMARY

1.4.1. Livestock Overpass Bridge (Structure P-05-BB)

Three borings were drilled at the proposed Livestock Overpass bridge location, one at each abutment and one at the pier. The borings encountered very stiff to hard clay, with sand; and medium dense silty sand in the first 37 feet. These soils overlaid very dense terrace alluvium composed of cobbles in a sand and gravel matrix, with boulders. Moderately weathered claystone bedrock was encountered at a depth of 67 feet at Abutment 1 and claystone bedrock in the bottom few inches at Pier 2. Bedrock was not encountered at Pier 3. Groundwater was not encountered at the time of drilling.

Foundation recommendations for the abutments are H-piles penetrating the terrace alluvium. For the pier it is a spread footing constructed on terrace alluvium.

1.4.2. Gulch A Bridge (Structure P-05-AZ)

Fifteen borings were drilled within the vicinity of the proposed bridge. The borings generally consisted of 5 to 20 feet of clayey sand soil or clayey sand and gravel over a dense alluvial terrace gravel or claystone/shale bedrock. Near Abutment 1 the borings encountered silty sand over sandy gravel with cobbles and boulders. Bedrock was encountered at approximately 90 feet.

Borings drilled near the proposed pier locations encountered 5 to 10 feet of sandy gravel slope wash deposits over highly weathered to unweathered bedrock. The bedrock consists of claystone, sandstone and interbedded claystone/sandstone/shale. The upper 20 to 30 feet is highly weathered to unweathered bedrock and should be considered Intermediate Geo Material (IGM) as defined in AASHTO. Below the IGM is hard sandstone and shale.

Abutment 5 borings encountered medium dense to dense terrace alluvium below 5 feet of slope wash deposits. The slope wash consists of gravel in a sandy clay matrix, cobbles and boulders, whereas, the terrace alluvium consists of a gravel in a silty sand matrix, cobbles and scattered boulders. Bedrock, an interbedded sandstone and claystone is encountered approximately 15 feet below the surface.

A landslide area is mapped on the south side slope of Gulch A and is one of several mapped on the side slopes of Gulches A and B. Unstable slopes are prevalent along the edges of the mesa. The slide area generally consists of colluvium from surficial soils and terrace gravel that overlay the Animas Formation bedrock. Seepage has been observed near the toe of the unstable slope, indicating groundwater is migrating along the colluvium/bedrock contact. The shallow colluvium is gradually moving down the south side slope of Gulch A. Abutment No. 1 and Pier No. 2 are in the mapped landslide area. Landslide mitigation is required for long term stabilization of the slope to support foundation loads.

Foundation recommendations for abutments and piers are spread footings and drilled caissons. Due to the depth to bedrock and gravel with cobbles and boulders it is recommended Abutment 1 be founded on a spread footing.

1.4.3. Gulch B Bridge (Structure P-05-BA)

Four borings were drilled within the vicinity of the proposed bridge. The borings generally consisted of 4 to 8 feet of slope wash deposits of sandy clay soil or sand and gravel, overlying moderately weathered to hard claystone, sandstone and shale. The upper 13 to 26 feet should be considered an IGM for foundation design. Below the IGM is a slightly weathered to hard interlayered sandstone and claystone bedrock.

A potential landslide was identified near Abutment 1. It consists of slope wash deposits overlying bedrock. The proposed roadway cut removes most of the upper portion of the landslide feature reducing the driving forces improving the long-term stability of the slope.

Foundation recommendations for abutments and piers are spread footings and drilled shafts.

1.5. HYDRAULIC SUMMARY

The proposed US 550 alignment traverses along the south western edge of a mesa as it begins its north easterly decent cutting 40 feet into the hillside making its way down to the Grandview interchange. As US 550 approaches the Grandview Interchange it crosses over two small drainages Gulch A and Gulch B. Gulch A and B drainage basins are mapped Zone X (unshaded) by FEMA. Zone X (unshaded) is outside the 500-year floodplain with minimal flood hazard. The top of the mesa is partially utilized as irrigated farmland. The hill side of the mesa is sloping more than 10% and is sparsely covered with woody vegetation and trees. No known floods have caused significant damage and no estimation of discharge has been recorded for the gulches.
Gulch A is an intermittent stream conveying flows from localized rainfall and runoff from farmland irrigation. Its drainage basin is 94 acres sloping 15.6%. The 100-year peak discharge is 84 cubic feet per second (cfs) at a depth of flow of 1.5 feet. Gulch B is an ephemeral stream with a drainage basin of 9 acres sloping 17.6%. The 100-year peak discharge is 12 cfs at a depth of flow of 0.7 feet.

Proposed Gulch A and B bridges are elevated approximately 100 feet and 60 feet, respectively above the channel bottoms. The span lengths and waterway openings are not driven by hydraulic freeboard requirements. Scour was not evaluated during preliminary design and is expected to minimal.

1.6. CONSTRUCTION PHASING

No detours or phased construction schemes are required to construct the bridges. Temporary access roads can be pioneered to construct the bridges concurrently with roadway construction, including access roads to construct piers and set girders from below in the gulches. Impacts to the traveling public during construction will be limited to construction traffic access points off US 160 and US 550.

1.7. UTILITIES

There are no utilities located within the immediate vicinity of the proposed bridge sites. The bridges will accommodate future utilities across the bridges. Each curb will house two 2-inch diameter conduits for future utilities.

1.8. ARCHITECTURAL REQUIREMENTS

In accordance with the *2015 SFEIS* retaining walls and bridge structures will include design features to add to the scenic quality of the built area. Project development and design will be coordinated with the City of Durango's Landscape Planner and Arborist to assure consistency with context sensitive design goals of the Grandview Area Plan. Architectural design guidelines for the bridge will be developed during final design to maintain consistent architectural and aesthetic treatments throughout the Grandview corridor. See **Appendix D** for Grandview Interchange typical architectural details.

2. STRUCTURE ALTERNATIVES EVALUATION CRITERIA

2.1. CONSTRUCTION COST

Construction costs for the bridge structures are an important consideration in the structure selection process. For comparison purposes, detailed cost estimates were prepared for the major items of each structure type. Results are shown in Error! Reference source not found.**,** ***Table 12*** **and** ***Table 6*****. These costs do not encompass the total project cost and should be used for comparison purposes only.**

Unit costs were derived from CDOT published cost data from 2013 to 2016. Additionally, three contractors reviewed the bridge concepts and provided input on constructability and cost. The unit costs numbers in this evaluation are a combination of CDOT historic data and contractor input. A 20% contingency has been included in the estimates to account for preliminary design and items not included.

2.2. CONSTRUCTABILITY

The proposed bridge sites at Gulches A and B present design and construction challenges warranting careful consideration during preliminary design. The potentially biggest risk associated with Gulches A and B is constructing foundations and piers in mapped landslides, and seepage and shallow slumping ground failures observed in the area. This is further complicated by limited accessibility, depth and steepness of the gulches. Having a sound plan for accessing and stabilizing the slopes in the gulches is key to constructability.

The bridges will be constructed on horizontally curved alignments and curved vertical profiles spanning deep gulches with steep side slopes. Site access for construction equipment and girders into the bottom of the gulches for constructing foundations, piers and erecting girders will be difficult. Protected wetlands present near the bottom of Gulch A could potentially add to the complexity of accessing this site.

An additional consideration is the delivery of precast girders over Wolf Creek Pass. Multiple calls placed to Denver based precast suppliers and a main trucking company that ships girders from Denver to Durango all stated the maximum precast girder length that can comfortably be shipped over Wolf Creek Pass is 150 feet. According to one precast supplier, an 8-hour road closure is required to haul 150-foot long BT girders over Wolf Creek Pass. As an alternative, precast girders (non-CDOT standard shapes) may be supplied from New Mexico and Utah.

2.3. RIGHT-OF-WAY

Structure type alternatives should consider additional right of way or easements that may be needed to construct the bridges.

2.4. MAINTENANCE AND INSPECTION

All structure types carried forward for evaluation are low maintenance structures.

2.5. SCHEDULE

The bridges will be constructed off line with minimal impacts to stakeholders and the traveling public simplifying construction. However, constructing the bridges concurrently with the roadway will be challenging with all three bridge sites located in a large cut. Access to Gulch A and Gulch B locations will be difficult and could potentially impact schedule.

3. STRUCTURE NO. P-05-BB, LIVESTOCK OVERPASS OVER US 550

3.1. BRIDGE DESCRIPTION

The proposed bridge alternative is located on a tangent alignment intersecting US 550 at Station 999+90.53. The future use of the bridge according to the *2012 SFEIS*, Section 4 Farmland, Subsection 4.2.6 Mitigation, calls for providing access for farm equipment, livestock crossing to seasonal calving

grounds, crop production and natural gas production. Due to the uncertainty of the bridge's future use the width of the bridge was established by matching a nearby twenty-eight-foot wide frontage road. The new bridge will accommodate two twelve-foot lanes, two-foot shoulders, and one-foot six-inch wide Type 7 bridge railings totaling twenty-eight feet curb-to-curb and thirty-one feet out-to-out. The typical section is on a normal crown. The vertical profile is on a 0.5% grade. An 8 inch concrete deck will be overlaid with a waterproofing membrane and 4 inches of seeded aggregate base course (ABC).

3.2. SPAN CONFIGURATIONS

The *2012 SFEIS* called for one underpass to accommodate access for farm equipment, livestock crossing to seasonal calving grounds, crop production and natural gas production. A single cell 28' x 14'-6" x 174' concrete box culvert (CBC) underpass alternative was evaluated. Since US 550 is in a cut, the depth of the CBC below US 550 is very deep. The grades down to the invert of the CBC get long and steep. The entrance grade transition on the east side of the highway would impact a historic irrigation ditch that would require relocation. To the west an additional 250-foot long, 0.5% profile grade transition is required to the west of the CBC to accommodate drainage of the structure. This further divides the remainder parcel of 4(f) farmland to the west of US 550.

To minimize the impacts to the historical ditch and surrounding 4(f) properties, a two-span overpass bridge alternative was considered over the US 550 roadway cut. The location of the bridge was determined by considering multiple factors, including the lay of the land, minimizing impacts to the severed piece of 4(f) farmland to the west of US 550, vertical clearance over US 550 and center pier location. The selected location addresses all these factors. Pushing the bridge to the far north end of the divided 4(f) parcel over a deep roadway section cut requires minimal amounts of cut and fill while providing adequate vertical clearance over US 550. The center pier also falls in the roadway median at this location. The bridge is skewed 27º 09' to match the terrain and minimize cut/fill depths at the bridge approaches.

The span configurations considered in this report are shown below in **Table 4**.

TABLE 4 – LIVESTOCK OVERPASS SPAN CONFIGURATIONS

2-Span Overpass, 120' and 130' 	• Fits the topography and spans proposed roadway cut section providing plenty of vertical clearance. • Minimizes impacts to divided parcel of 4(f) farmland west of proposed US 550. • Doesn't further sub-divide remainder property with deep cuts. • Doesn't impact historical irrigation ditch. • Requires less right-of-way.
Single Cell 28' x 14.5' x 170' CBC 	• Common cost-effective underpass structure. • Buried under a proposed 20–30 foot roadway cut. • Further divides severed parcel of 4(f) farmland. Cuts a drainage path through the center of the remainder parcel of property. • Path impacts historical irrigation ditch. • Requires more right-of-way.

3.3. STRUCTURE TYPE ALTERNATIVES

Concrete and steel structure type alternatives were considered for the livestock crossing structure. A concrete box culvert (CBC) and three prestressed concrete structure types were considered. These included 28-foot by 14.5-foot by 170-foot CBC, precast bulb-tee girders, precast decked bulb-tee girders and cast-in-place box girders cast on grade and excavated. Cast-in-place box girders cast on grade have the advantage of eliminating costly falsework, however, after speaking with contractors the cost of detailed formwork is too expensive and this alternative was eliminated from further consideration.

A two-span steel structure was considered. A welded plate girder is the most economical steel structure type for the span ranges under consideration.[6] Welded plate girders have the advantage of being lighter compared to precast concrete girders and are easier to transport and erect. Extrapolating data from the Gulch A work, the steel girder bridge was estimated to be too expensive and was eliminated from further consideration. See **Appendix A** for structure type alternative typical sections. Structure type in conjunction with span configuration was assessed as follows:

TABLE 5 – LIVESTOCK OVERPASS STRUCTURE TYPE ALTERNATIVES

Alternative No.	No. of Spans	Structure Type	Max Span/ CBC Length (ft)	No. of Girder Lines	Girder Spacing	Deck Overhang	Deck Thickness (in)
1	2	BT 63	130	4	8’ – 0”	3’ – 6”	8”
2	2	Decked BT	130	5	7’ – 9 “	3’ – 6”	5”
3	1	CBC 28’x14.5’	170	N/A	N/A	N/A	N/A

3.4. SUBSTRUCTURE CONSIDERATIONS

3.4.1. Layout

The proposed livestock crossing over US 550 spans a 254-foot wide, 20 to 30-foot deep roadway cut section. The general orientation of the bridge is skewed 27º 09’ relative to US 550. The cut slopes are 2:1. The livestock overpass is laid out to best fit the terrain minimizing impacts to adjacent farmland. Moving the proposed structure north, to a natural highpoint over a deeper road cut section, minimizes bridge approach impacts to the adjacent farmland while meeting the vertical clearance requirements for US 550. The already divided farmland is not further subdivided and the historical irrigation ditch isn’t disrupted by the approach roadway profile.

The abutments are oriented to fit the lay of the land and minimize the structure length. The pier located in the center median of US 550 is placed parallel to the abutments. The 2:1 spill slopes are located outside the clear zone eliminating the need for guardrail along the shoulders of US 550.

6 FHWA’s Steel Bridge Design Handbook, Selecting the Right Bridge Type, November 2012, 20

3.4.2. Abutments

To minimize maintenance concerns at the abutments jointless construction will be implemented. The recommended abutment type for the Livestock Overpass Bridge is integral with swept back cantilever walls. Approach slabs are not required but will be detailed with pavement rest notches.[7]

3.4.3. Pier

A single hammerhead pier, in the median, will be protected by guardrail.

3.5. Structure Evaluation and Recommendation

This selection procedure is intended to identify a structure that best encompasses the established project criteria in this report:

3.5.1. Construction Cost

During initial structure type alternative cost comparisons geotechnical borings had not been obtained and foundation type costs were based on assumed conditions. Preliminary alternative cost comparisons did not clearly identify a preferred alternative. Per CDOT direction structure type costs were not updated and are excluded from **Table 6** and **Appendix B**. See **Appendix A** for typical sections and profiles.

TABLE 6 – LIVESTOCK OVERPASS STRUCTURE TYPE ALTERNATIVES COST COMPARISON	
Alternative 1: Two-Span Precast Concrete BT63	
• Two-span prestressed concrete BT63 girders with eight-inch composite deck, four girder lines spaced at 8'-0" with 3'-6" overhangs.	
Alternative 2: Two-Span Precast Concrete 65" Decked Bulb-Tee	
• Two-span prestressed concrete 65" Decked Bulb-Tee girders with five inch concrete deck topping, four girder lines spaced at 6'-0" with 3'- 6" overhangs.	
Alternative 3: Single Cell Concrete Box Culvert	
• Single Cell 28' x 14'-6" x 174' Concrete Box Culvert	

3.5.2. Environmental and Right-of-Way Impacts

Alternatives 1 and 2 better fit the lay of the land and do not impact a nearby historical irrigation ditch and do not further divide the remainder parcel of 4(f) land west of the highway, whereas Alternative 3 does.

3.5.3. Recommendation

Based on a better fit of the lay of the land and minimalizing environmental and right-of-way impacts the design team recommends proceeding to final design with Alternative 1. See **Appendix C** for general layouts.

7 CDOT Bridge Design Manual, Section 2.13 Approach Slabs

4. STRUCTURE NO. P-05-AZ, US 550 OVER GULCH A

4.1. BRIDGE DESCRIPTION

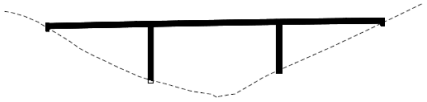
The proposed Gulch A Bridge is located at Station 1016+61.49 on a horizontally curved section of the alignment on a curved vertical profile. The radius of the horizontal curve is 4000-feet and the typical section is superelevated 3.2% left to right. The vertical profile is on 2100-foot vertical curve with an entering grade of 2.50% and an exit grade of –3.00%. The proposed bridge will accommodate two 42'-0" clear roadway sections, four 12-foot lanes, 10-foot exterior shoulders, 8-foot interior shoulders, a 2-foot median barrier and 1-foot 6-inch wide combination railings (Modified Type 10M bridge rails) totaling 86 feet curb-to-curb and 89 feet out-to-out. In addition, the structure provides for large animal crossing below US 550.

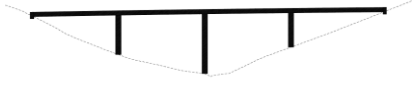
4.2. SPAN CONFIGURATIONS

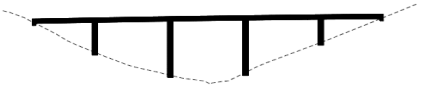
Several span configurations are possible for Gulch A ranging from a single span bridge up through a five-span bridge. The longer single and two span configurations require the less commonly constructed more expensive superstructure types, such as a deck arch, cast-in-place concrete box girders, precast spliced girders and balanced cantilever box girders. With no other criteria driving a long span bridge layout, single and two span configurations are too expensive to construct and have been dropped from further consideration.

Shorter three, four and five-span bridge configurations are the most feasible for Gulch A. All three of the span configurations can accommodate commonly constructed precast concrete and steel girder types. The span configurations considered in this report are shown below in **Table 7**.

TABLE 7 – GULCH A SPAN CONFIGURATION

3-Span, 145' – 180' – 145'
 
	• Common cost effective long-span structure type.
	• Concrete Girders:
	  ○ Most risk. Larger, longer and heavier girder sections are more difficult to ship, access the site and erect.
	  ○ Girder lengths exceed 150 ft. and very difficult to ship over Wolf Creek Pass.
	• Spliced Concrete Girders:
	  ○ Moderate risk: Shorter girder segments easier to ship, access site and erect.
	  ○ Erect temporary shoring in landslide area.
	• Steel Girders:
	  ○ Less risk. Lighter, shorter segments easier to ship, access site and erect.
	• Least number of tall piers.
	• Two foundations constructed in landslide area.

4-Spans, 4 @ 117' – 6" 	• Common cost effective medium-span structure type. • More risk. Larger, longer and heavier girder sections more difficult to ship, access site and erect. • Intermediate number of tall piers required. • Two foundations constructed in landslide area.

5-Spans, 82’ – 3 @102’ – 82’ 	• Common cost effective short-span structure type. • Less risk. Smaller, shorter and lighter girder sections are easier to ship, access the site and erect. • Most number of tall piers. • Three foundations constructed in landslide area.

4.3. SUPERSTRUCTURE TYPE ALTERNATIVES

Several viable concrete and steel structure type alternatives were considered for three, four and five-span configurations with the maximum span length ranging from 100 to 200-feet. Five prestressed concrete structure types were considered.[8] These included precast bulb-tee (BT) girders, precast span-by-span box girders, cast-in-place box girders on falsework, precast spliced BT and U-girders and precast decked BT girders. The precast span-by-span box girder, cast-in-place box on falsework, precast spliced U-girder and precast decked BT alternatives were eliminated from further consideration as follows:

- Precast span-by-span box girder: Too expensive. Lacks economies of scale.
- Cast-in-place box on falsework: Too expensive to construct falsework in a deep gulch with the potential for local landslides.
- Precast spliced U-Girder: Girders are too heavy. Girders are twice as heavy as precast bulb-tee girders. More difficult to transport and erect. Overall more expensive compared to bulb-tee options.
- Precast decked bulb-tee: Chorded girder lines cannot accommodate variable overhang on horizontally curved alignment.

A three-span steel structure was considered. The welded plate girder is the most economical steel structure type for the span ranges under consideration.[9] Spliced welded plate girders have the advantage of being lighter compared to precast concrete girders and are easier to transport and erect. Temporary pier brackets could be used eliminating the need to erect expensive temporary shoring towers.[10]

A three-span spliced bulb-tee girder bridge would allow the use of shorter girder segments, which are easier to ship and erect than longer precast concrete segments. In all, there would be 5 girder segments per line with a pier segment straddling each interior pier and 3 drop in segments. Erection could be accommodated with either a combination of temporary erection towers and strong-backs, or an integral connection made at the piers with strong-backs. The segments would be chorded between splice points.

The precast concrete bulb-tee (BT), spliced precast BT and steel welded plate girder (Steel I) alternatives were carried forward for further consideration, see **Appendix A** for typical sections. Structure types in conjunction with span configurations were assessed as follows:

8 FHWA Post-Tensioned Box Girder Design Manual, 2015, 2
9 FHWA Steel Bridge Design Handbook, Selecting the Right Bridge Type, 2012, 20
10 FHWA Steel Bridge Design Handbook, Selecting the Right Bridge Type,2012, 21

TABLE 8 – GULCH A STRUCTURE TYPE ALTERNATIVES								
Alternative No.	**No. of Spans**	**Chorded/ Curved**	**Girder Type**	**Max Span Length (ft)**	**No. of Girder Lines**	**Girder Spacing**	**Deck Overhang (Max.)**	**Deck Thickness (in)**
1	4	Chorded	BT 72	118	8	11' – 8"	4' – 1"	8"
2	3	Curved	Steel I	180	7	13' – 5"	4' – 3"	9"
3	3	Chorded	Spliced BT 84	180	9	10' – 3"	4' – 1"	8"
4	5	Chorded	BT 63	102	8	11' – 8"	4' – 1"	8"

4.4. SUBSTRUCTURE CONSIDERATIONS

4.4.1. Layout

The proposed crossing at Gulch A is approximately 480-feet wide and 120-feet deep at its deepest point below proposed profile grade. The north and south sloped faces of the gulch roughly parallel each other. The general orientation of the gulch is skewed 75^{o} relative to the roadway alignment. The north face slopes approximately 1.5:1 and the south face slopes approximately 2:1.

To simplify the substructure layout relative to the roadway alignment, perpendicular abutment and pier configurations were considered. Due to the skew of the gulch this required either cutting the abutments back into the slopes or partially filling in the slopes. Cutting into the slope increased the length of the bridge approximately 30 feet. Filling in the slope reduces the bridge length similarly but requires variable height abutment walls to retain the embankment. Skewing the abutments and piers is recommended to match the orientation of the gulch side slopes optimizing the bridge length while maintaining constant depth abutments and minimizing differential column lengths at each pier.

4.4.2. Abutments

To minimize maintenance concerns at the abutments jointless construction will be implemented. The recommended abutment type must accommodate the high lateral stiffness of the recommended drilled shaft foundation type. The preferred use of integral abutments is eliminated from consideration due to the 476-foot structure length exceeding the limiting structure length for integral abutments.[11] The recommended abutment type for Gulch A Bridge is semi-integral with expansion bearings and swept back cantilever walls.

Approach slabs will be installed at the abutments.[12] To accommodate 3 1/2 inches of expansion and contraction of the bridge, 0 – 4" expansion devices are recommended to be installed at the approach slab and sleeper slab joint. The preferred strip seal joint alternative is recommended for this project.[13]

4.4.3. Piers

Piers will be constructed in difficult steep sloping terrain. Pier 2 will be constructed in a mapped landslide area. Columns will vary in height transversely due to the pier skews not being perfectly parallel with the hillside and the steep sloping terrain, and longitudinally due to the span configuration.

11 CDOT Bridge Design Manual, Table 11-1 Limiting Structure Lengths for Integral Abutments
12 CDOT Bridge Design Manual, Section 2.13 Approach Slabs
13 CDOT Bridge Design Manual, Section 14.4.4 Strip Seal Expansion Joints

To conform to the Grandview Interchange architecture, the piers will be a multi-column frame. The columns will be rectangular and fixed at the base supported on a concrete cap on drilled shafts. With no vertical clearance constraints cast-in-place concrete pier caps are recommended. Preliminary design is based on solid rectangular columns. Hollow column sections can be evaluated in more detail during final design.

4.5. FOUNDATION TYPE ALTERNATIVES

Abutment 1 and Pier 2 are in a mapped landslide area.[14] Abutment 1 is near the top and Pier 2 is near the bottom of the slide. Subsurface material consists of silty sand overlaying sandy gravel with cobles and boulders. Depth to weathered and fractured bedrock at Abutment 1 is 90 feet. Placement of foundations in slope wash material is discourage because of the potential for long term differential settlement.[14]

Lengthening the bridge to locate the abutment beyond the slide area was considered. The revised span configuration for the added bridge length introduced a second pier into the slide area with one of the piers being near the previous abutment location. Foundation conditions being similar, the decision was made to stabilize the landslide and construct the shorter bridge with Abutment 1 in the slide area as opposed to constructing a longer, more expensive bridge and having to stabilize the slide area for a pier foundation. Pier 2 near the bottom of the slide area and will be designed to handle the lateral forces of a landslide.

Deep foundations for Abutment 1 are eliminated from consideration due to the difficulty and cost of installing h-piles and caissons through deep subsurface material with cobles and boulders. A spread footing foundation is recommended for Abutment 1 founded on the alluvial terrace deposit in conjunction with stabilizing the landslide deposit.

Abutment 5 and Piers 2, 3 and 4 are in 15 feet and 5 to 10 feet respectively of slope wash material overlying highly weathered to unweathered bedrock. The upper 20 to 30 feet of bedrock is weathered and weak. Over the long term, the claystone is expected to break down and have soil properties similar to clay soil. The bedrock is suitable for both shallow and deep foundations. The poor condition of the bedrock and low nominal bearing pressure resulted in large spread footings foundations. Due to higher comparable costs the spread footing foundation alternative is eliminated from consideration for Abutment 5 and Piers 2, 3, and 4.

The spread footing alternative was carried forward for Abutment 1, and the caisson alternative for Abutment 5 and piers 2, 3 and 4 for further consideration, see **Appendix A** for typical sections.

4.6. STRUCTURE EVALUATION AND RECOMMENDATION

This selection procedure is intended to identify a structure that best encompasses the established project criteria in this report:

4.6.1. Construction Cost

During initial structure type alternative cost comparisons geotechnical borings had not been obtained and foundation type costs were based on assumed conditions. Preliminary alternative cost comparisons did

14 US 550 S Connection to US 160 D-B Bridge Foundations

not clearly identify a preferred alternative. Per CDOT direction structure type costs were not updated and are excluded from **Table 9** and **Appendix B**. See **Appendix A** for typical sections and profiles.

TABLE 9 – GULCH A STRUCTURE TYPE ALTERNATIVES COST COMPARISON	
Alternative 1: Precast Concrete BT72, Chorded (4-Span, 8 Girder Lines)	
• Four-span prestressed concrete BT72 girders with eight-inch composite deck, eight girder lines spaced at 11'-8" with 3'-8" average overhangs. • Three piers with two 7-6" by 10'-0" rectangular columns.	
Alternative 2: Spliced Precast Concrete BT84, Chorded (3-Span, 9 Girder Lines)	
• Three-span splice prestressed concrete BT84 girders with eight-inch composite deck, nine girder lines spaced at 10'-3" with 3'-6" average overhangs. • Two piers with two 7'-6" by 10'-0" rectangular columns.	
Alternative 3: Steel Welded Plate I-Girder, Curved (3-Span, 7 Girder Lines)	
• Three-span steel curved welded plate girders with nine-inch composite deck, seven girder lines spaced at 13'-5" with an overhang of 4'-3". • Two piers with 7'-6" by 10'-0" rectangular columns.	
Alternative 4: Precast Concrete BT63, Chorded (5-Span, 8 Girder Lines)	
• Five-span prestressed concrete BT63 girders with eight-inch composite deck, eight girder lines spaced at 11'-8" with 3'-8" average overhangs. • Four piers with two 7'-6" by 10'-0" rectangular columns.	

4.6.2. Constructability

All four alternatives are common superstructure types that are economical and relatively easy to construct. Site access for construction equipment and girders into the bottom of the gulch for constructing foundation, piers and erecting girders is similar. All the girder segments for the structure type alternatives under consideration are under 150-feet long and can be transported over Wolf Creek Pass.

4.6.3. Recommendation

Based on the complexity of building in a slide area, the use of a commonly constructed structure type, and meeting recommended girder lengths for shipping the design team recommends proceeding to final design with Alternative 1. See **Appendix C** for General Layout.

5. STRUCTURE NO. P-05-BA, US 550 OVER GULCH B

5.1. BRIDGE DESCRIPTION

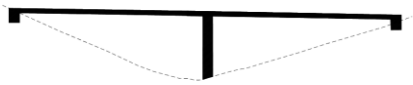
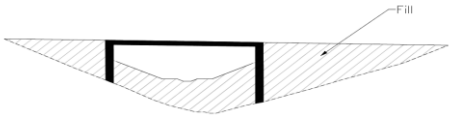
The proposed bridge is located at Station 1030+85.04 on a horizontally curved section of the alignment on a curved vertical profile. The radius of the curve is 4000 feet and the typical section is superelevated 3.2% right to left. The vertical profile is on a 2100-foot vertical curve with an entering grade of 2.50% and an exiting grade of –3.00%. The proposed bridge will accommodate two 42'-0" clear roadway sections, four 12-foot lanes, 10-foot exterior shoulders, 8-foot interior shoulders, a 2-foot median barrier and 1-foot 6-inch wide combination railings (Modified Type 10M bridge rails totaling 86 feet curb-to-curb and 89 feet out-to-out. In addition, the structure provides for large animal crossing below US 550.

5.2. SPAN CONFIGURATIONS

Three span configurations are reasonable for Gulch B ranging from a single-span bridge up through a three-span bridge. A longer single-span configuration requires less commonly constructed, more expensive superstructure types, such as a deck arch or cast-in-place concrete box girders. With no other criteria driving the need for a long-span bridge layout, the single long-span configuration was considered too expensive and has been dropped from further consideration.

The shorter one, two and three-span bridge configurations are the most feasible for Gulch B. All three can accommodate commonly constructed precast concrete and steel structure types. The span configurations considered in this report are shown below in **Table 10**.

TABLE 10 – GULCH B SPAN CONFIGURATIONS

2-Spans, 2 @ 117'-6" (Maximum Length) 	• Common cost effective medium-span structure type. • Moderate risk. Larger, longer and heavier girder sections are more difficult to ship, access the site and erect. • Lesser number of tall piers.
3-Span, 3 @ 78' (Maximum Length) 	• Common cost effective short-span structure type • Less risk. Smaller, shorter, and lighter girder sections are easier to ship, access the site and erect. • Two piers required.
1-Span, 98' 	• Place fill in gulch for potentially large cost savings. • Common cost effective short-span structure type. • Easy to access site and erect. • No piers required. • Excessive settlement of fill material is a risk. o Numerous design and construction requirements. o Long term maintenance issues.

The single span alternative, backfilling Gulch B with excess excavated road cut materials, was evaluated as a possible cost savings opportunity. Based on the *DRAFT Geotechnical Evaluation for Pre-FIR US 550/US 160, Durango, Colorado, FSA 5501-021, 19378 Report* the perceived cost savings of filling the gulch will be offset by potentially numerous design and construction requirements along with long term maintenance issues associated with large fills. Based on the preliminary geotechnical evaluation, the single-span backfill gulch option has been eliminated from further consideration at this time. After borings are obtained and a final geotechnical report is prepared, this concept can be reevaluated.

Two and three-span bridge configurations are possible for Gulch B and are carried forward for consideration in the structure type selection.

5.3. SUPERSTRUCTURE TYPE ALTERNATIVES

Concrete and steel structure type alternatives were considered for two and three-span configurations with the maximum girder length ranging from approximately 80 to 122 feet. Three prestressed concrete

structure types were considered.[15] These included precast bulb-tee girders, cast-in-place box on falsework and precast decked bulb-tee girders. The cast-in-place box on falsework and precast decked bulb-tee alternatives were eliminated from further consideration as follows:

- Cast-in-place box on falsework: Too expensive to construct falsework in a deep gulch with the potential for local landslides.
- Precast decked bulb-tee: Chorded girder lines cannot accommodate variable overhang on horizontally curved alignment.

A single span steel structure was considered. The welded plate girder is the most economical steel structure type for the span ranges under consideration.[16] Welded plate girders have the advantage of being lighter compared to precast concrete girders and are easier to transport and erect. Extrapolating data from the Gulch A work, the steel girder bridge was estimated to be too expensive and was eliminated from further consideration.

The precast concrete bulb-tee (BT) girder alternatives were carried forward for further consideration, see **Appendix A** for typical sections. Structure types in conjunction with span configurations were assessed as follows:

TABLE 11 – GULCH B STRUCTURE TYPE ALTERNATIVES

Alternative No.	No. of Spans	Chorded/ Curved	Girder Type	Max Girder Length (ft)	No. of Girder Lines	Girder Spacing	Deck Overhang (Max.)	Deck Thickness (in)
1	2	Chorded	BT 72	122	8	11’ – 8”	4’ – 2”	8”
2	3	Chorded	BT 54	80	8	11’ – 8”	3’ – 10”	8”

5.4. SUBSTRUCTURE CONSIDERATIONS

5.4.1. Layout

The proposed crossing at Gulch B is approximately 250-feet wide and 55-feet deep below the proposed profile grade. The north and south sloped faces of the gulch do not parallel each other. The south face of the gulch is perpendicular to the roadway alignment while the north face is skewed approximately 50-degrees relative to the roadway. The large difference in the orientation of the gulch slopes relative to one another complicates the north abutment layout. Both faces are sloped 2:1.

Multiple variations of perpendicular and skewed north abutment and pier layouts were evaluated while holding the south abutment perpendicular to the roadway. To simplify the substructure layout relative to the roadway alignment, perpendicular abutment and pier configurations were considered first. The skew of the north gulch slope required either cutting the abutment back into the slope or partially filling in the slopes. Cutting into the slope increased the length of the bridge approximately 60 feet while filling it in reduced the bridge length similarly but required a maximum 38-foot variable height abutment wall to retain the embankment.

15 FHWA Post-Tensioned Box Girder Design Manual, 2015, 2
16 FHWA’s Steel Bridge Design Handbook, Selecting the Right Bridge Type, November 2012, 20

Next a fully skewed north abutment matching the orientation of the bank was considered. This requires a large skew producing high shear stresses at acute corners and increasing the potential for bearing failures. For this reason, a fully skewed north abutment was eliminated from further consideration.

The decision was made to reduce the skew angle at the north abutment by splitting the angle between perpendicular and fully skewed reducing the amount of cut compared to a perpendicular layout and reducing the shear stresses compared to the fully skewed option. The orientation of the skewed pier was determined by again splitting the angles between the north and south abutments.

5.4.2. Abutments

To minimize maintenance concerns at the abutments jointless construction will be implemented. The recommended abutment type must accommodate the high lateral stiffness of the recommended fixed spread footing and drilled shaft foundation types. The preferred alternative is an integral abutment eliminating the need for bearings and expansion devices. However, due to the stiffness of the drilled shaft foundations, the recommended abutment type for Gulch B Bridge is a semi-integral with expansion bearings and swept back cantilever walls.

Approach slabs will be installed at the abutments.[17] The 240-foot bridge length is less than 250 feet long, therefore, expansion joints are not required.[18]

5.4.3. Piers

Piers will be constructed in difficult steep sloping terrain. Columns will vary in height transversely due to steep sloping terrain, and longitudinally due to the span configuration.

To conform to the Grandview Interchange architecture, the pier will be a multi-column frame. The columns will be rectangular and fixed at the base supported on a footing on drilled shafts. With no vertical clearance constraints cast-in-place concrete pier caps are recommended. Preliminary design is based on solid rectangular columns. Hollow column sections can be evaluated in more detail during final design.

5.5. FOUNDATION TYPE ALTERNATIVES

Pier and abutments are in 4 to 8 feet of slope wash material overlying moderately weathered to hard claystone. The upper 15 to 25 feet of bedrock is lightly weathered interlayered sandstone and claystone. Over the long term the claystone is expected to break down and have soil properties similar to clay soil. The bedrock is suitable for both shallow and deep foundations. The poor condition of the bedrock and low nominal bearing pressure resulted in large spread footings foundations. Due to higher comparable costs the spread footing foundation alternative is eliminated from further consideration.

The caisson alternative was carried forward for both the pier and abutments for further consideration, see **Appendix A** for typical sections.

17 CDOT Bridge Design Manual, Section 2.13 Approach Slabs
18 CDOT Bridge Design Manual, Section 14.4.2 Design Guideline and Selection

5.6. STRUCTURE EVALUATION AND RECOMMENDATION

This selection procedure is intended to identify a structure that best encompasses the established project criteria in this report:

5.6.1. Construction Cost

During initial structure type alternative cost comparisons geotechnical borings had not been obtained and foundation type costs were based on assumed conditions. Preliminary alternative cost comparisons did not clearly identify a preferred alternative. Per CDOT direction structure type costs were not updated and are excluded from **Table 12** and **Appendix B**. See **Appendix A** for typical sections and profiles.

TABLE 12 – GULCH B, STRUCTURE TYPE ALTERNATIVES COST COMPARISON	
Alternative 1: Two-Span Precast Concrete BT72, Chorded	
• Two-span prestressed concrete BT72 girders with eight-inch composite deck, eight girder lines spaced at 11'-8" with maximum 4'-2" overhangs. • One pier with two 5'-6" by 10'-0" columns.	
Alternative 2: Three-Span Precast Concrete BT54, Chorded	
• Three-span prestressed concrete BT54 girders with eight-inch composite deck, eight girder lines spaced at 11'-8" with maximum 4'-2" overhangs • One pier with two 5'-6" by 10'-0" columns.	

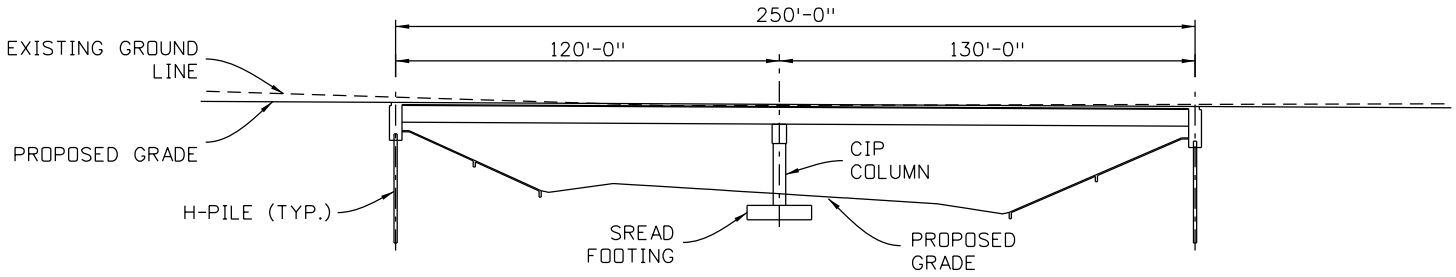
5.6.2. Constructability

Both alternatives are common superstructure structure types that are economical and relatively easy to construct. Site access for construction equipment and girders into the bottom of the gulch for constructing foundations, piers and erecting girders is similar. All the girders for the structure type alternatives under consideration are under 150-feet long and can be transported over Wolf Creek Pass.

5.6.3. Recommendation

Based on meeting recommended girder lengths for shipping and expensive substructure construction costs the design team recommends proceeding to final design with Alternative 1. See **Appendix C** for the general layouts.

APPENDIX A: TYPICAL SECTIONS AND PROFILES



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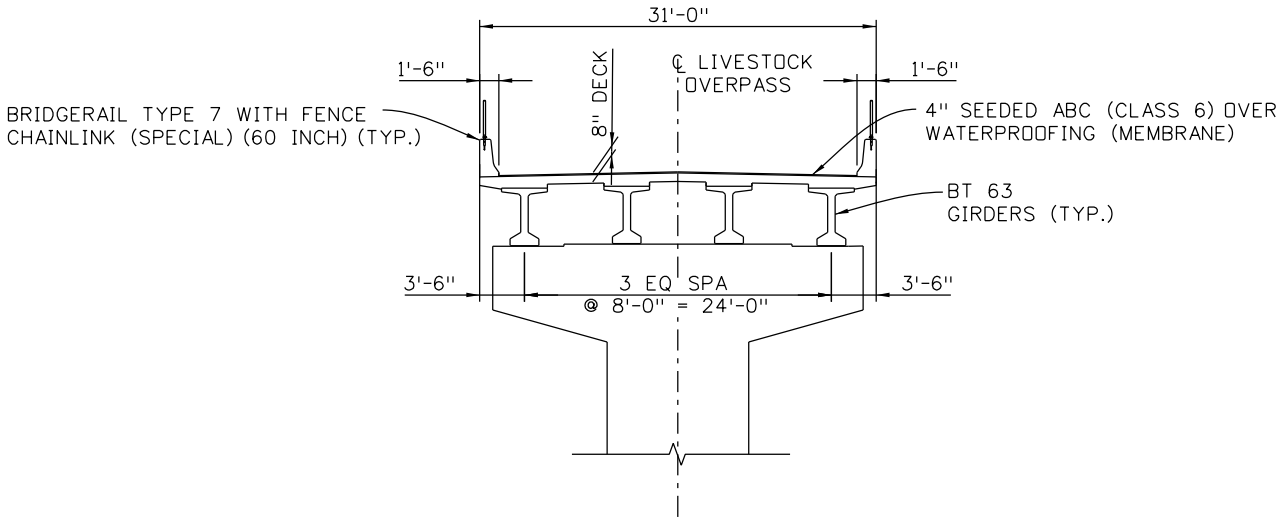

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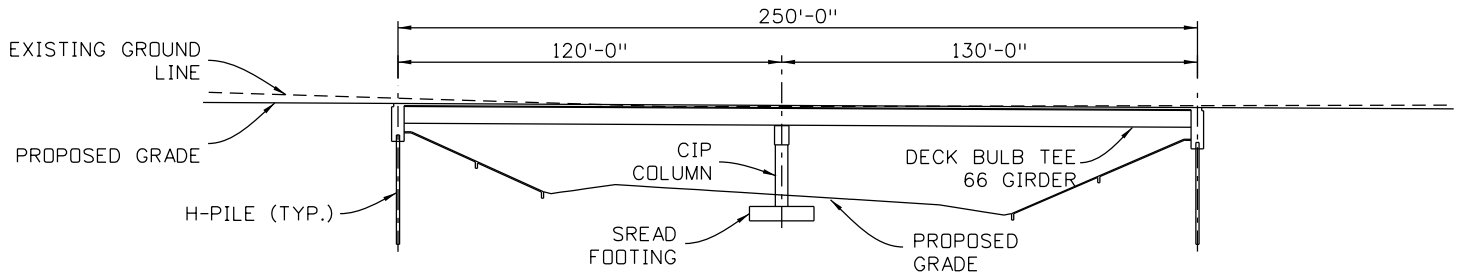

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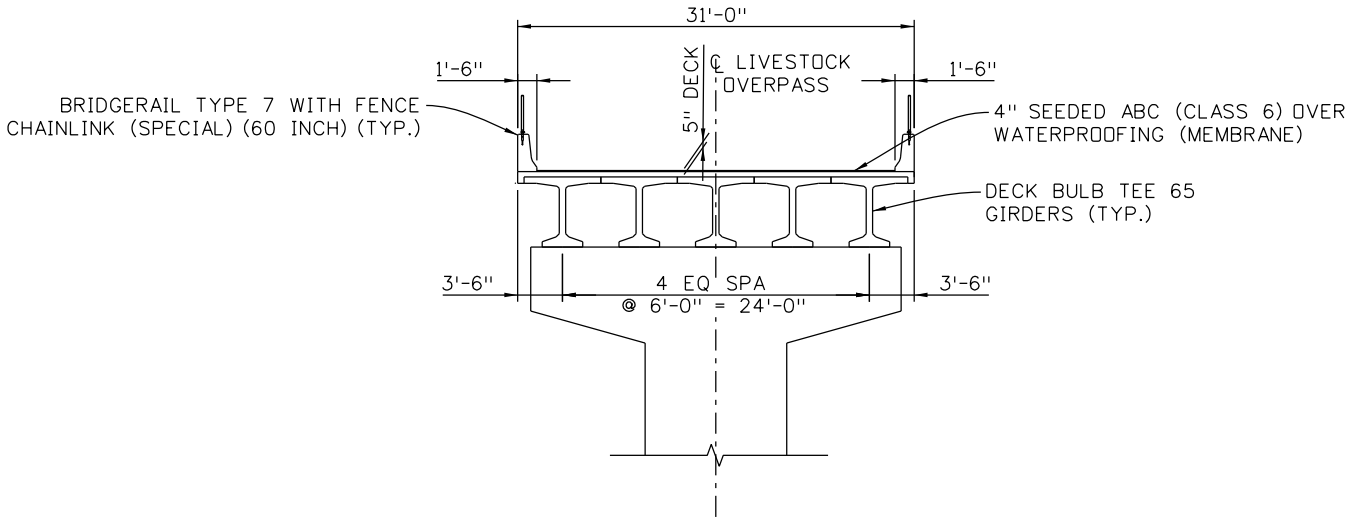

TYPICAL SECTION
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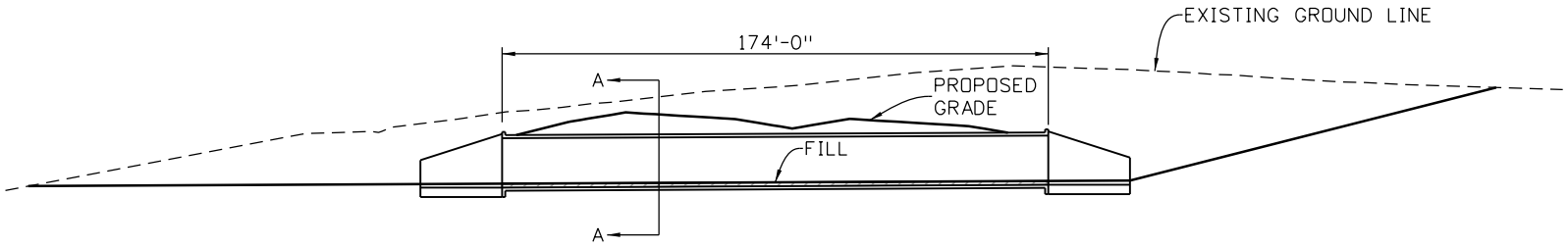

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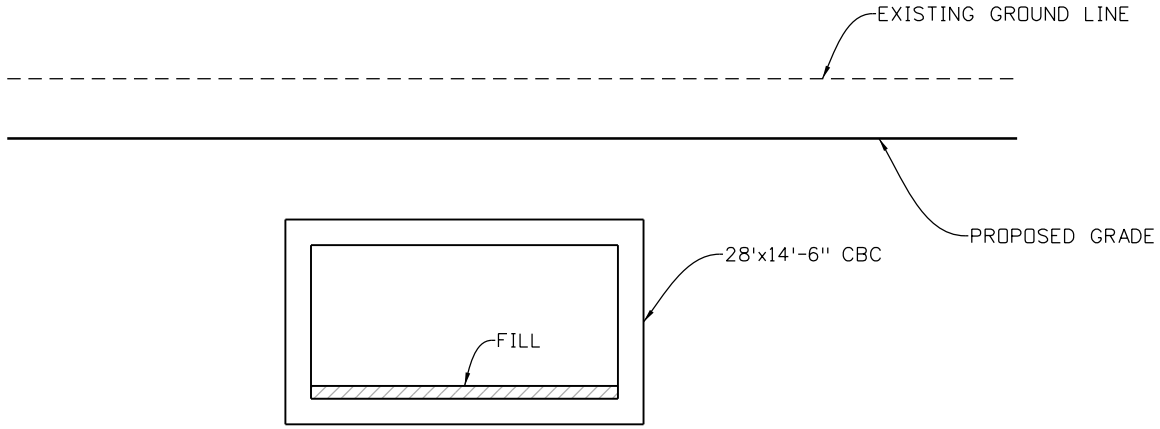

SECTION A-A
(N.T.S.)

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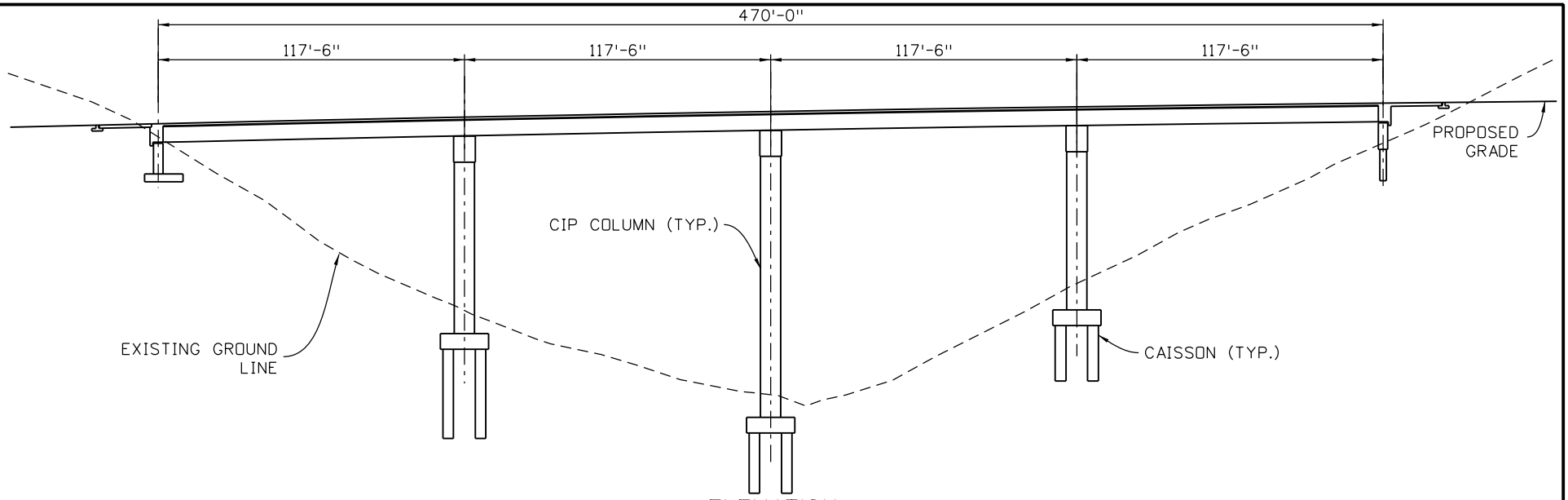

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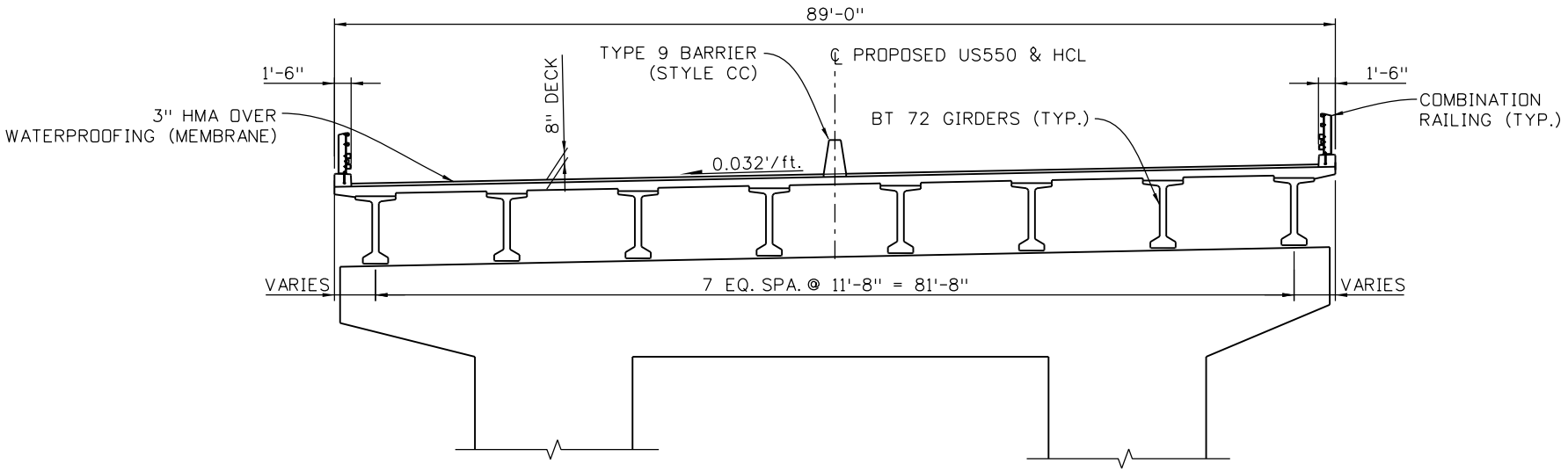

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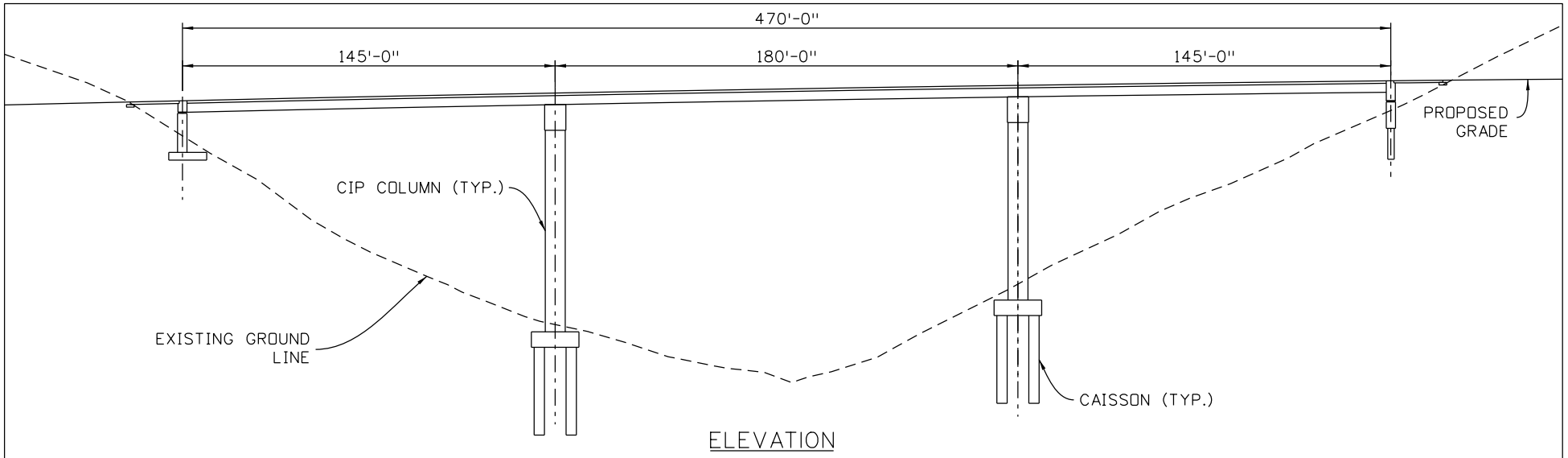

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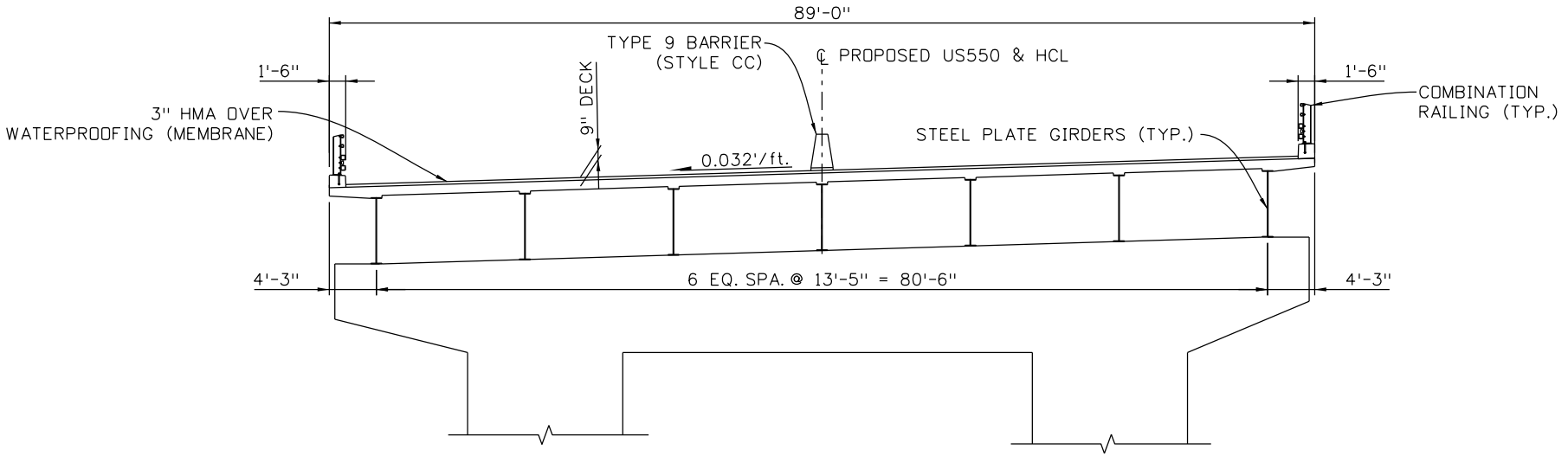

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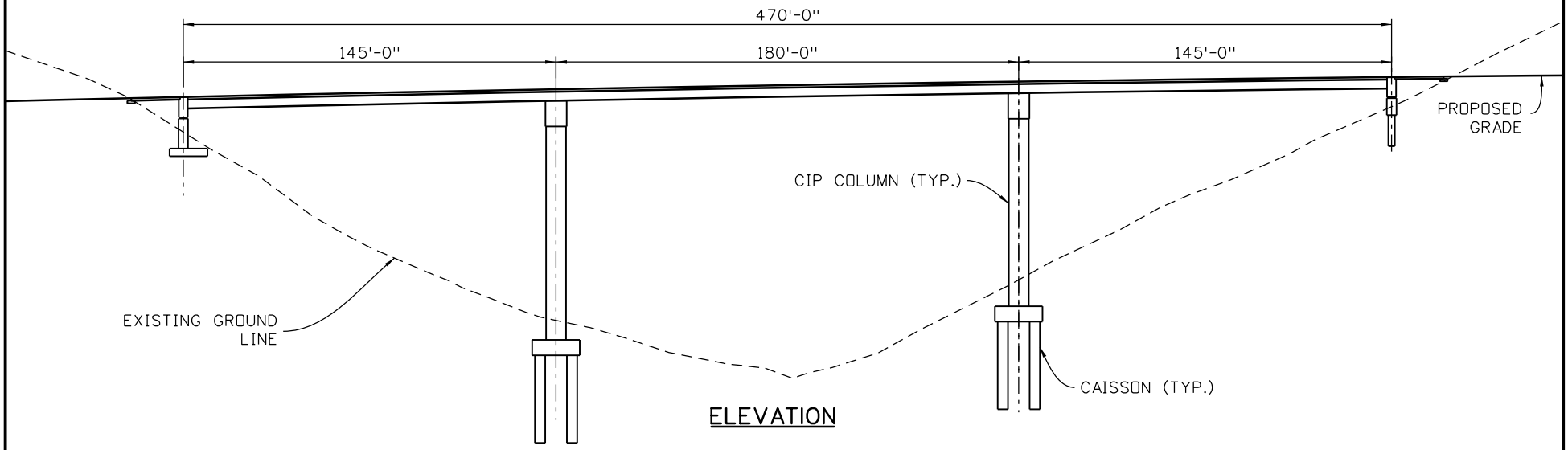

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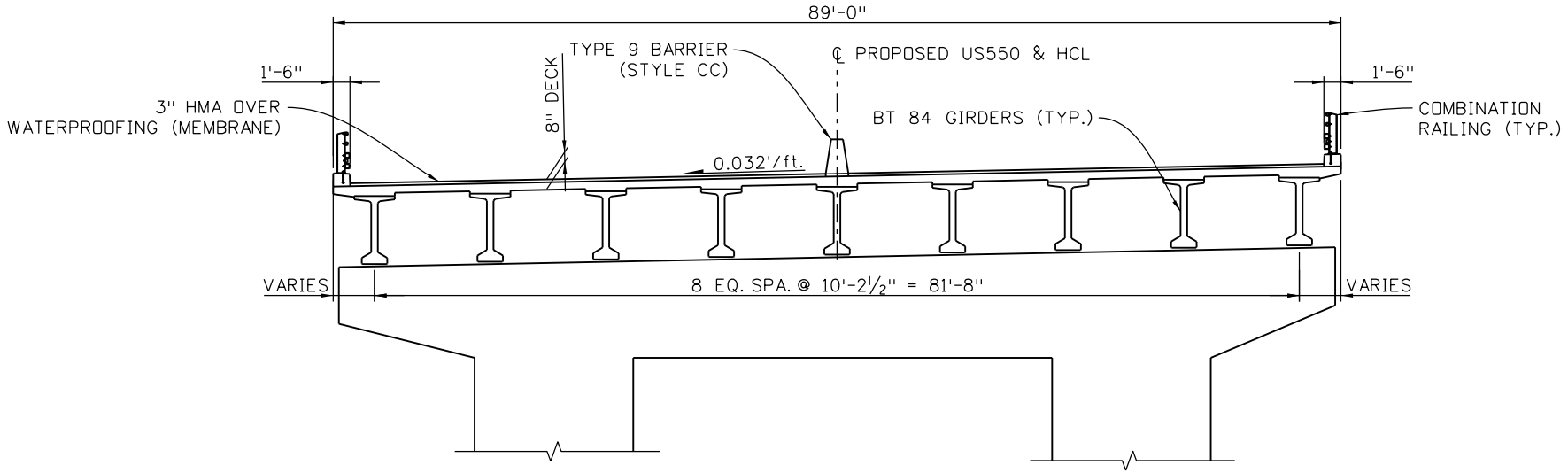

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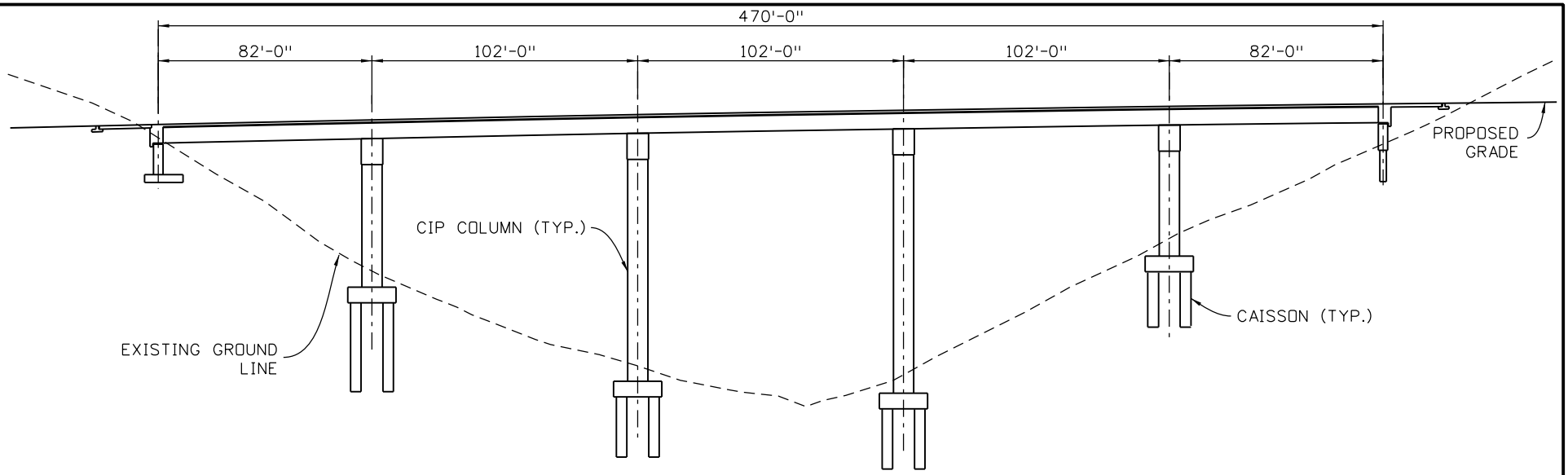

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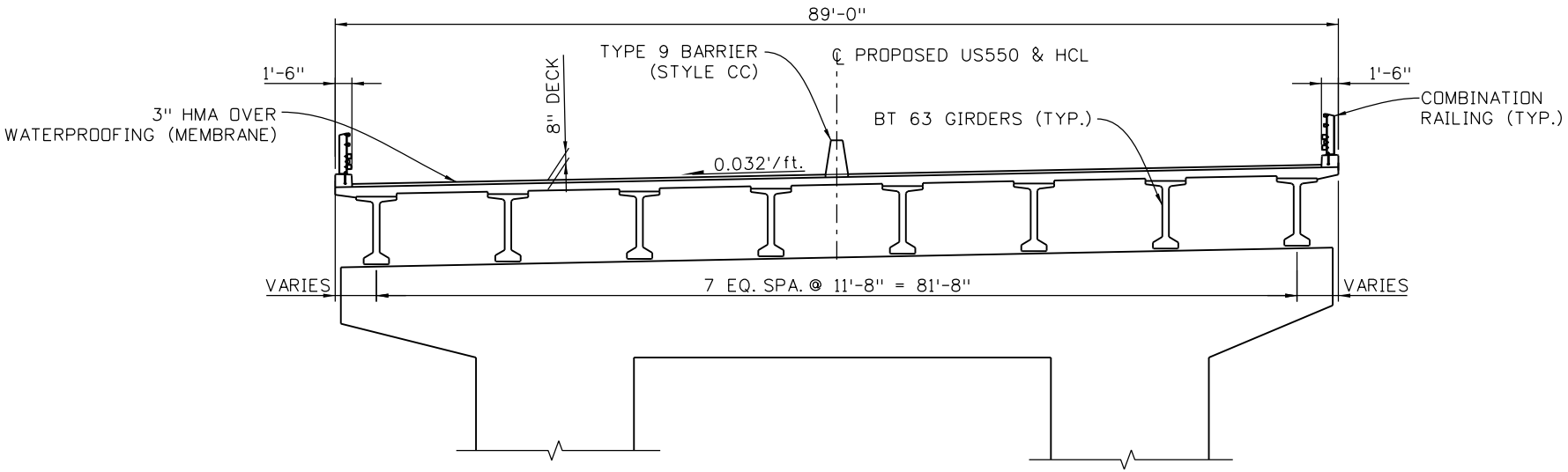

TYPICAL SECTION
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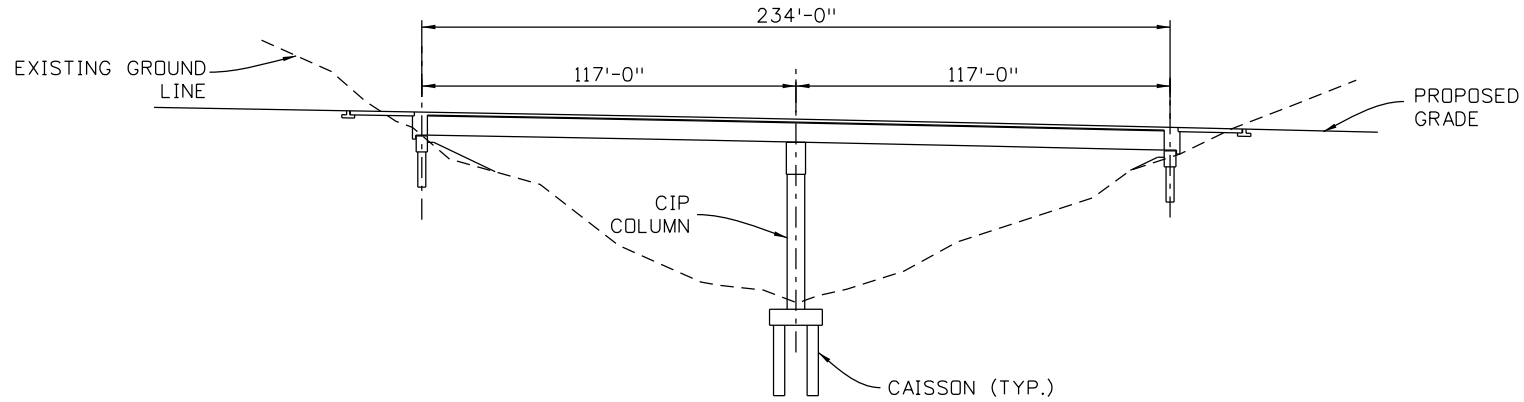

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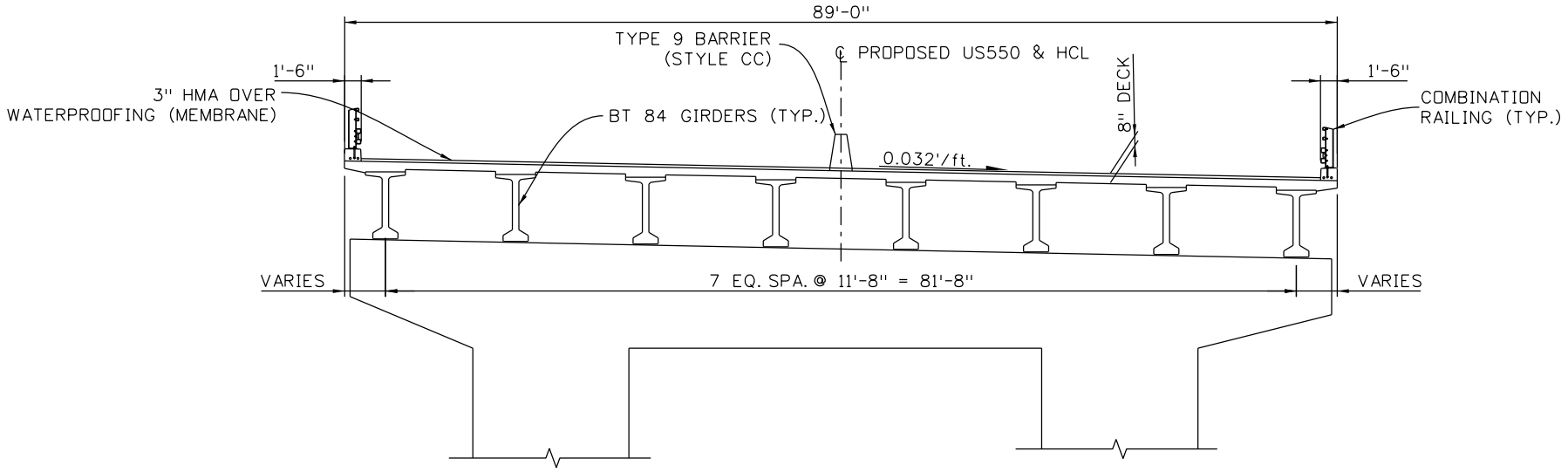

TYPICAL SECTION
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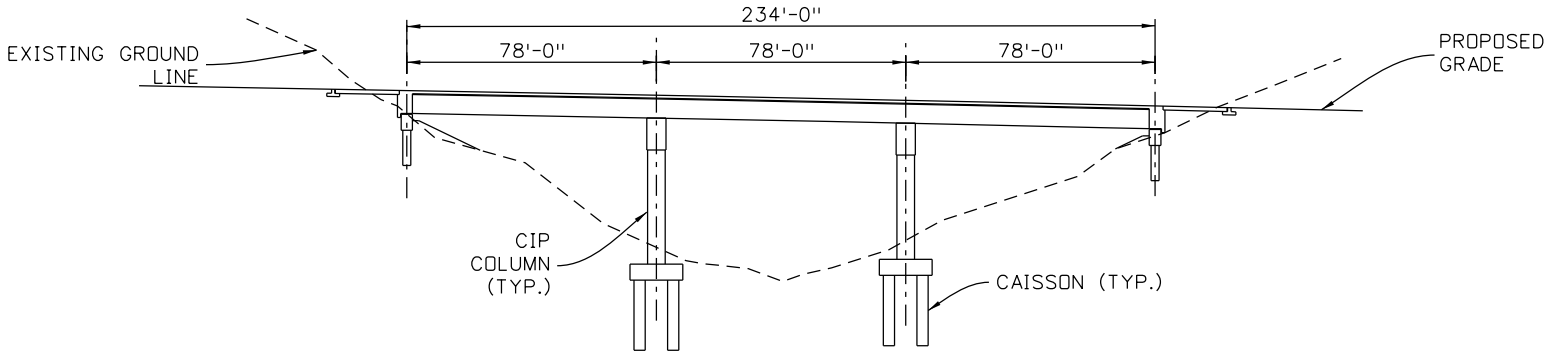
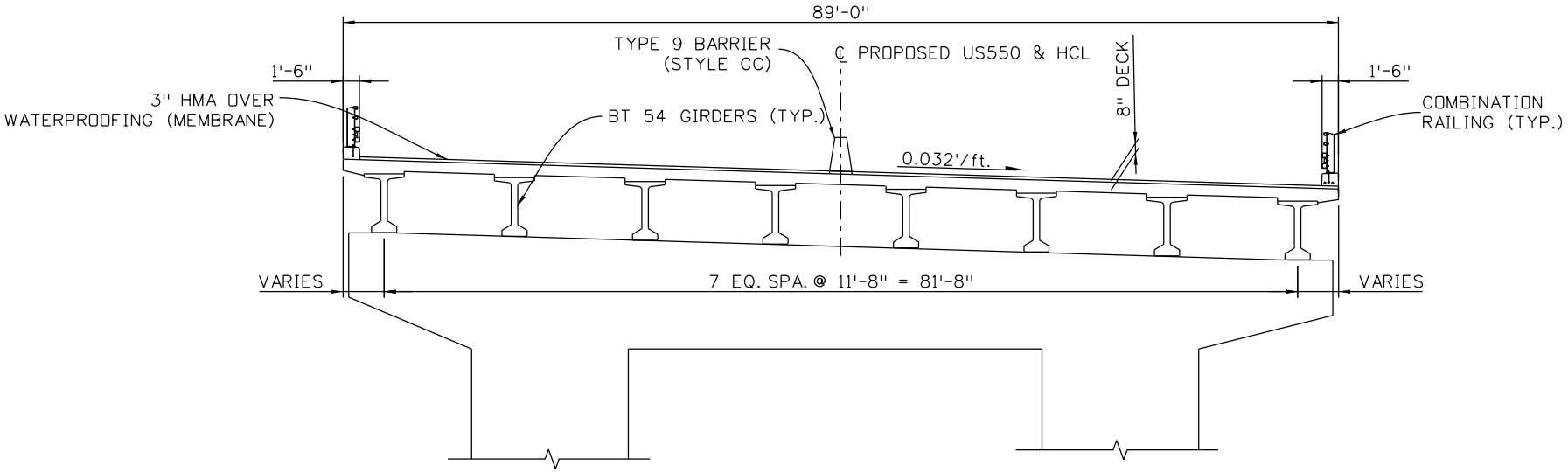
Horiz. Scale: 1:60 Vert. Scale: As Noted					22420
Staff Bridge Branch - Unit 0221 STW	Designer: JB		Region: R5		
wood.	Detailer: TF	CDOT	Unit Leader: DRV		Sheet Number
	Sheet Subset: SSR		Sheet: 1 of 2		



ELEVATION

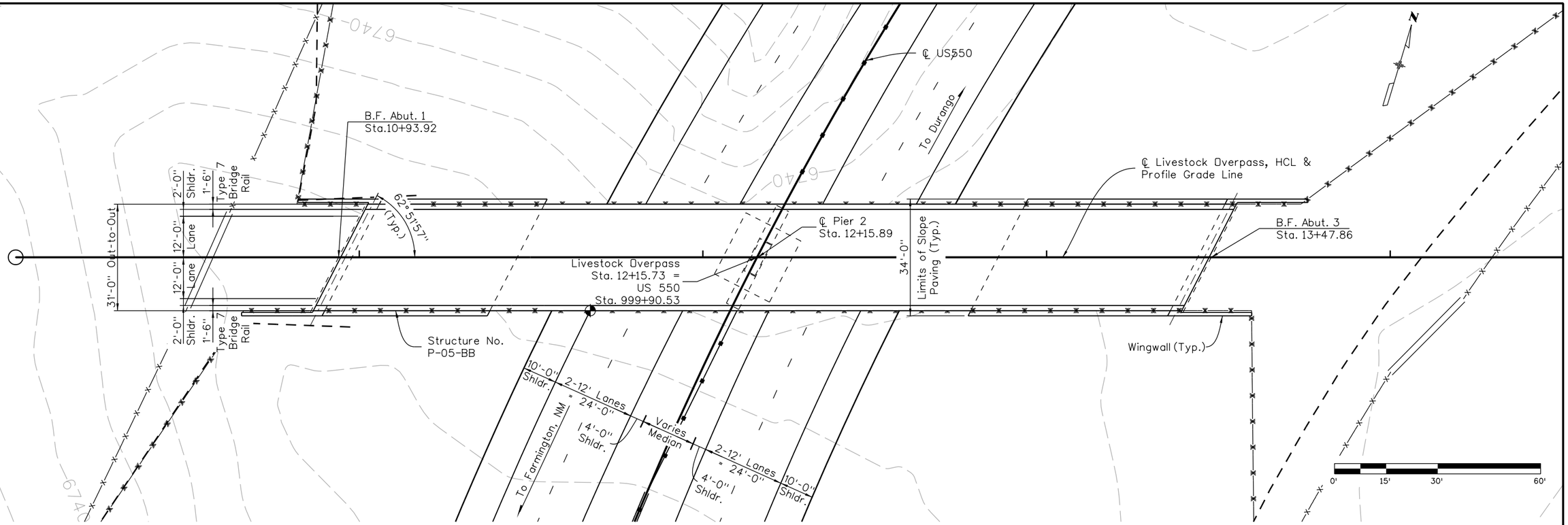


TYPICAL SECTION
(N.T.S.)

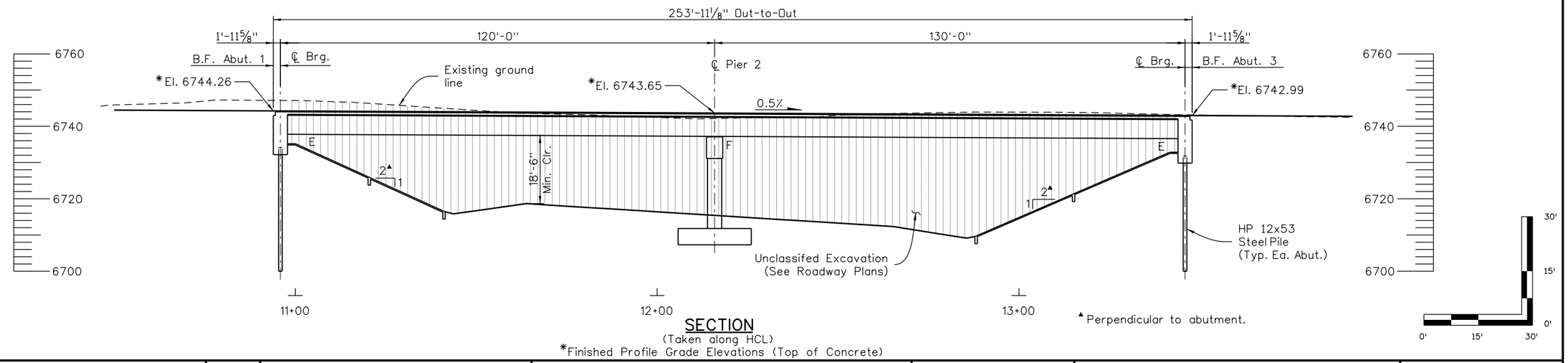
Print Date: 2/26/2019	US550 BRIDGE OVER GULCH B ALTERNATIVE 2 THREE SPAN CHORDED BT 54 GIRDERS				Project No./Code
File Name: Gulch B_Alt 2.dgn					Project Number
Horiz. Scale: 1:60 Vert. Scale: As Noted					22420
Staff Bridge Branch - Unit 0221 STW	Designer: JB		Region: R5		
wood.	Detailer: TF	CDOT	Unit Leader: DRV		Sheet Number
	Sheet Subset: SSR		Sheet: 2 of 2		

APPENDIX B: COST ESTIMATES – EXCLUDED

APPENDIX C: GENERAL LAYOUTS



PLAN



SECTION

(Taken along HCL)

*Finished Profile Grade Elevations (Top of Concrete)

Design	INITIAL	DATE
Designed By	XXX	MM/YY
Checked By	XXX	MM/YY

Detail	INITIAL	DATE
Detailed By	XXX	MM/YY
Checked By	XXX	MM/YY

Quantities	INITIAL	DATE
Quantities By	XXX	MM/YY
Checked By	XXX	MM/YY

Print Date: 2/26/2019
File Name: 22420_StockOverpass_PnP.dgn
Horiz. Scale: 1:30 Vert. Scale: As Noted
Staff Bridge Branch - Unit 0221 STW

wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation
3803 North Main Avenue
Durango, CO 81301
Phone: 970-385-1440 FAX: 970-385-8365
Region 5 DRV

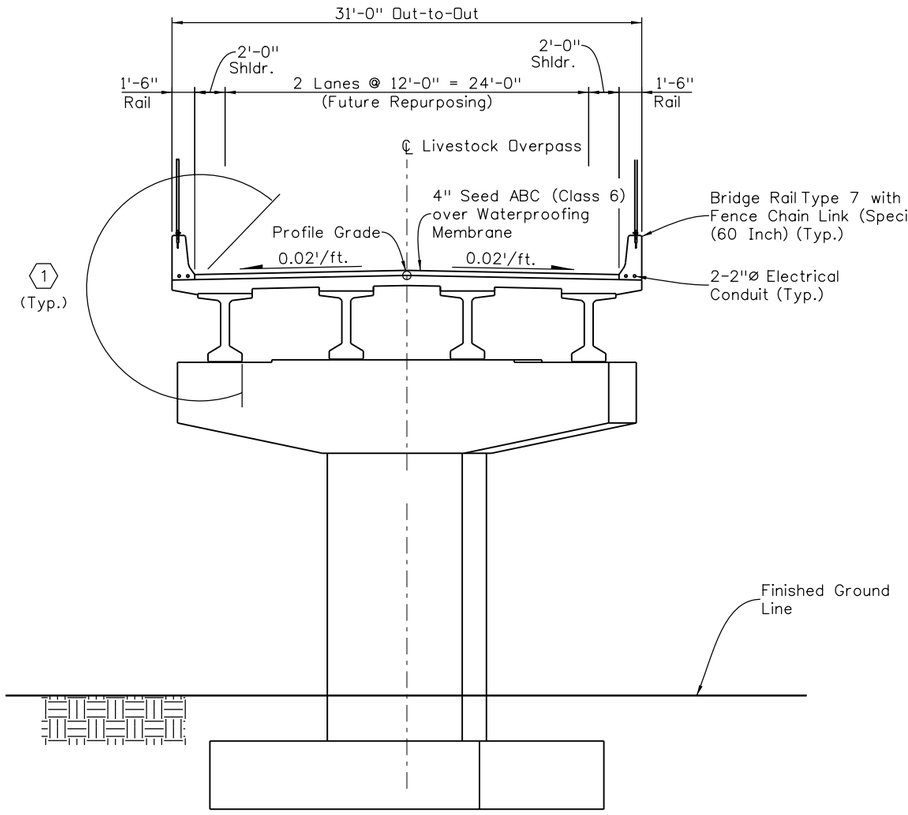
As Constructed
No Revisions:
Revised:
Void:

LIVESTOCK OVERPASS
GENERAL LAYOUT

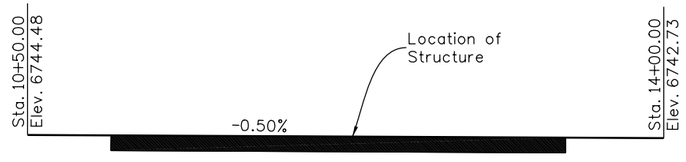
Designer:	J. Broadus	Structure Numbers	P-05-BB
Detailer:	J. Broadus		
Sheet Subset:	Bridge	Subset Sheets:	B5 of 10

Project No./Code
NHPP 5501-029
22420
Sheet Number

P:\Project\Transportation\CDOT R5\2017 CDOT R5 US 550 DB PM sub to HDR\9.0 CADD\9.1 Bridge\22420_StockOverpass_PnP.dgn
john.broadus 2:34:45 PM
2/26/2019



TYPICAL SECTION
(N.T.S.)



PROFILE GRADE
(N.T.S.)

KEY NOTES

1 Limits of Structural Concrete Coating

Design			Detail			Quantities		
	INITIAL	DATE		INITIAL	DATE		INITIAL	DATE
Designed By	XXX	MM/YY	Detailed By	XXX	MM/YY	Quantities By	XXX	MM/YY
Checked By	XXX	MM/YY	Checked By	XXX	MM/YY	Checked By	XXX	MM/YY

Print Date: 2/26/2019
File Name: 22420_StockOverpass_TypSect.dgn
Horiz. Scale: 1:10.0001 Vert. Scale: As Noted
Staff Bridge Branch - Unit 0221 STW

wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222

Sheet Revisions		
Date:	Comments	Init.

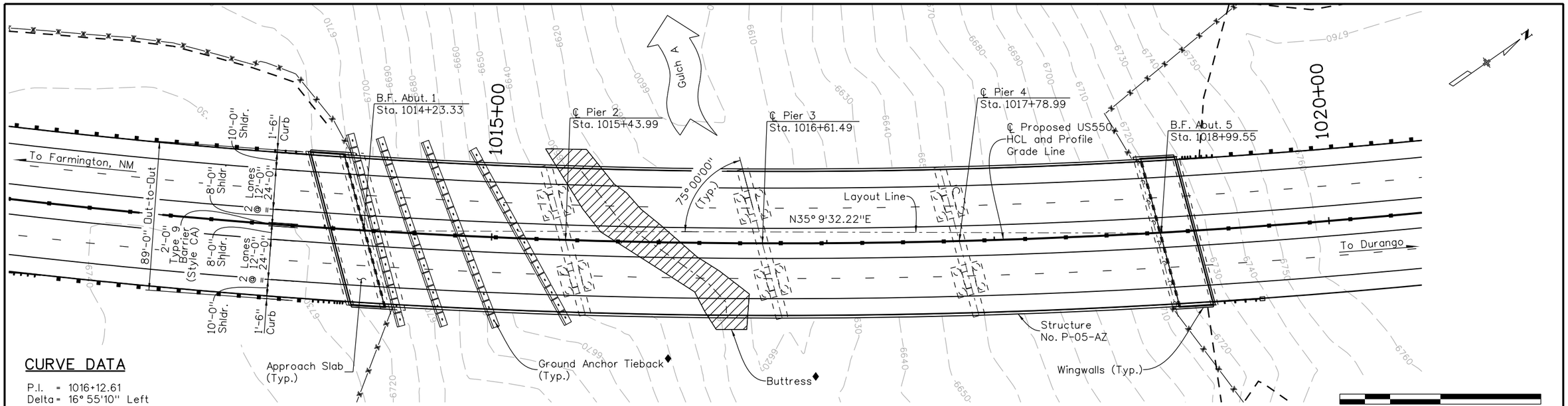
Colorado Department of Transportation
3803 North Main Avenue
Durango, CO 81301
Phone: 970-385-1440 FAX: 970-385-8365
Region 5 DRV

As Constructed
No Revisions:
Revised:
Void:

LIVESTOCK OVERPASS
TYPICAL SECTION

Designer: J. Broadus
Detailer: J. Broadus
Sheet Subset: Bridge
Structure Numbers: P-05-BB
Subset Sheets: B6 of 10

Project No./Code
NHPP 5501-029
22420
Sheet Number

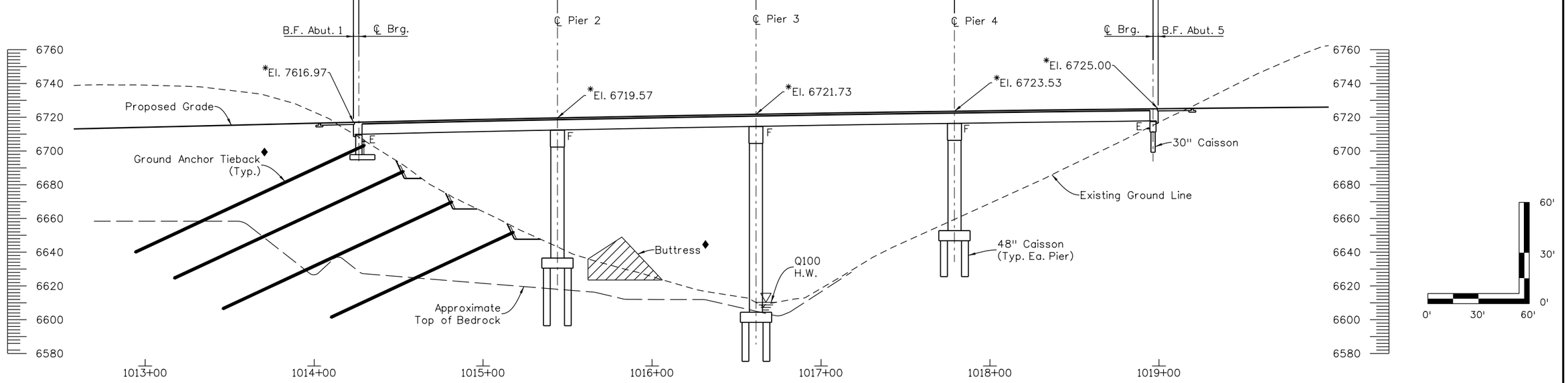


PLAN

♦ See Landslide Mitigation Details

CURVE DATA

P.I. = 1016+12.61
Delta = 16° 55'10" Left
Dc = 1° 25'57"
Tc = 594.93'
Lc = 1181.19'
Rc = 4000.00'



SECTION

(Taken along HCL)
*Finished Profile Grade Elevations (Top of HMA)

Design			Detail			Quantities		
	INITIAL	DATE		INITIAL	DATE		INITIAL	DATE
Designed By	XXX	MM/YY	Detailed By	XXX	MM/YY	Quantities By	XXX	MM/YY
Checked By	XXX	MM/YY	Checked By	XXX	MM/YY	Checked By	XXX	MM/YY

Print Date: 2/26/2019
File Name: 22420_Gulch A_PnP.dgn
Horiz. Scale: 1:60 Vert. Scale: As Noted
Staff Bridge Branch - Unit 0221 STW

wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222

Sheet Revisions

Date:	Comments	Init.

Colorado Department of Transportation
3803 North Main Avenue
Durango, CO 81301
Phone: 970-385-1440 FAX: 970-385-8365
Region 5 DRV

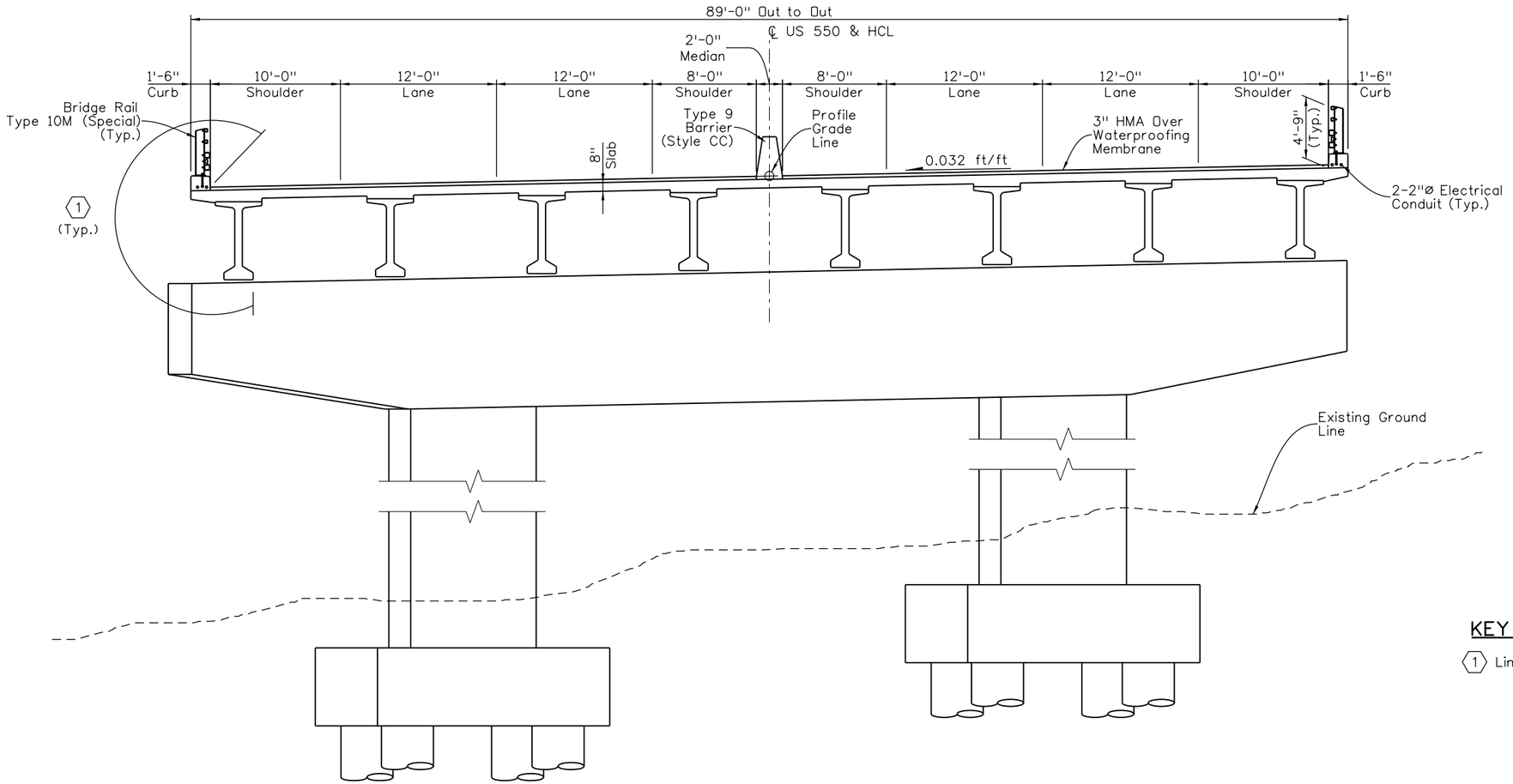
As Constructed
No. Revisions:
Revised:
Void:

GULCH A GENERAL LAYOUT

Designer:	J. Broadus	Structure Numbers	P-05-AZ
Detailer:	J. Broadus		
Sheet Subset:	Bridge	Subset Sheets:	B7 of 10

Project No./Code: NHPP 5501-029
22420
Sheet Number

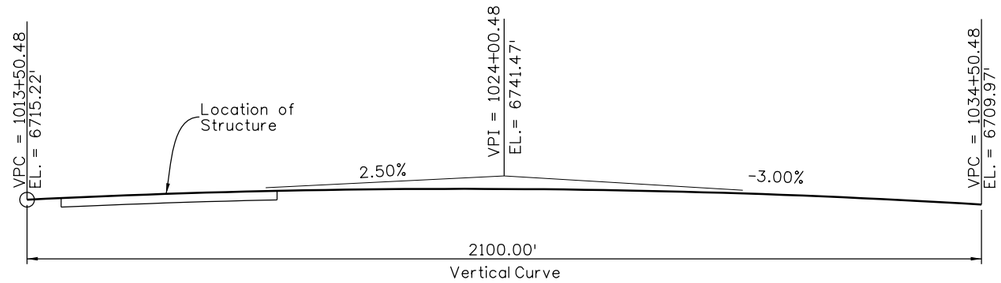
john.broadus 2:39:31 PM P:\Project\Transportation\CDOT R5\2017 CDOT R5 US 550 DB PM sub to HDR\9.0 CADD\9.1 Bridge\22420_Gulch A_PnP.dgn
2/26/2019



KEY NOTES

1 Limits of Structural Concrete Coating

TYPICAL SECTION



PROFILE GRADE

(N.T.S.)

Design			Detail			Quantities		
	INITIAL	DATE		INITIAL	DATE		INITIAL	DATE
Designed By	XXX	MM/YY	Detailed By	XXX	MM/YY	Quantities By	XXX	MM/YY
Checked By	XXX	MM/YY	Checked By	XXX	MM/YY	Checked By	XXX	MM/YY

Print Date: 2/26/2019
File Name: 22420_Gulch A_TypSect.dgn
Horiz. Scale: 1:10 Vert. Scale: As Noted
Staff Bridge Branch - Unit 0221 STW

wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation
3803 North Main Avenue
Durango, CO 81301
Phone: 970-385-1440 FAX: 970-385-8365
Region 5 DRV

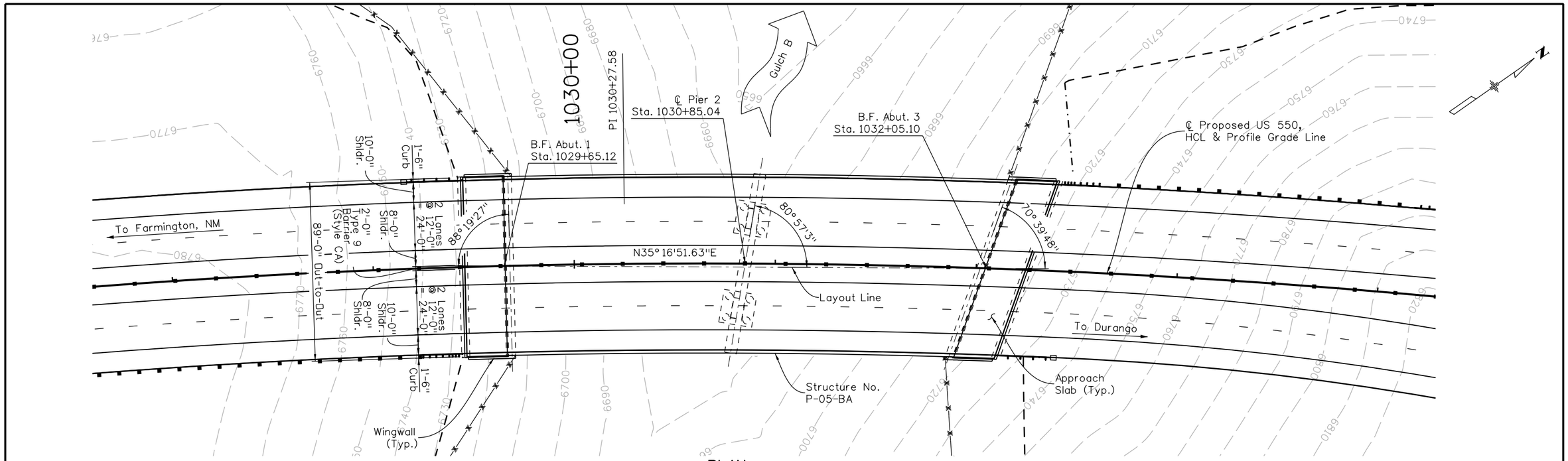
As Constructed
No Revisions:
Revised:
Void:

GULCH A
TYPICAL SECTION

Designer: J. Broadus
Detailer: J. Broadus
Sheet Subset: Bridge
Structure Numbers: P-05-AZ
Subset Sheets: B8 of 10

Project No./Code
NHPP 5501-029
22420
Sheet Number

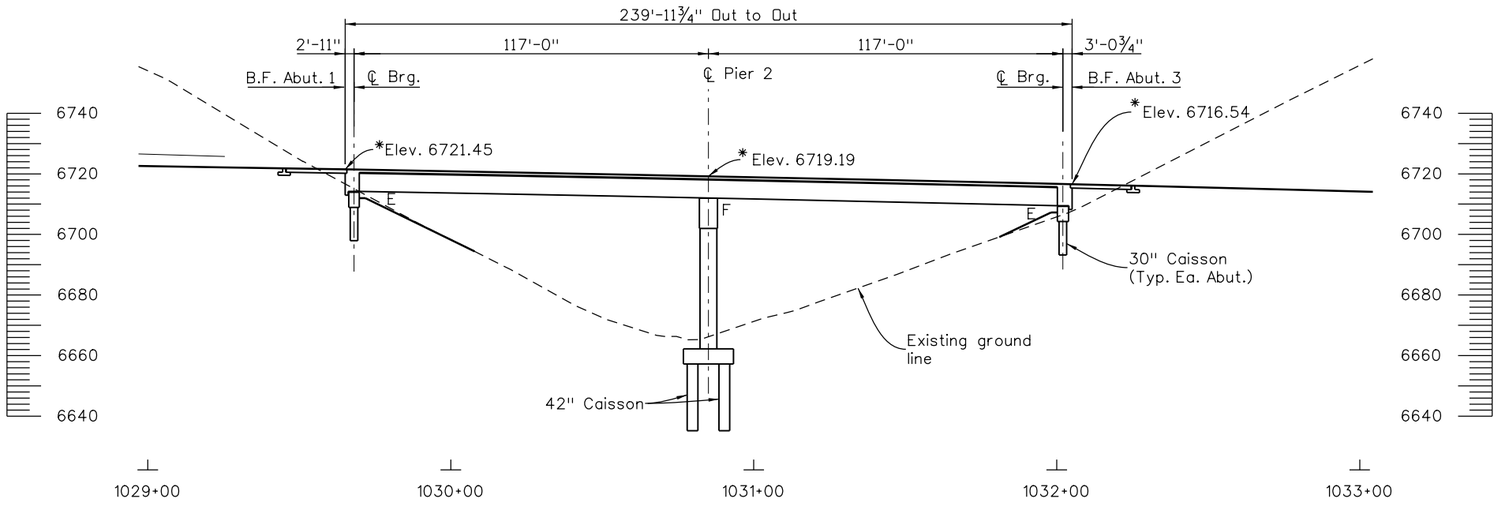
john.broadus 2:41:31 PM P:\Project\Transportation\CDOT R5\2017 CDOT R5 US 550 DB PM sub to HDR\9.0 CADD\9.1 Bridge\22420_Gulch A_TypSect.dgn
2/26/2019



PLAN

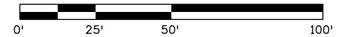
CURVE DATA

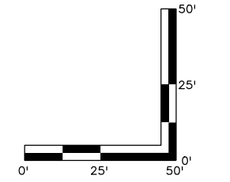
P.I. = 1030+27.58
Delta = 13°55'28" Right
Dc = 1°25'57"
Tc = 488.46
Lc = 972.11
Rc = 4000.00'



SECTION

(Taken Along HCL)
* Finished Profile Grade Elevations (Top of HMA)





Design	INITIAL	DATE
Designed By	XXX	MM/YY
Checked By	XXX	MM/YY

Detail	INITIAL	DATE
Detailed By	XXX	MM/YY
Checked By	XXX	MM/YY

Quantities	INITIAL	DATE
Quantities By	XXX	MM/YY
Checked By	XXX	MM/YY

Print Date: 2/26/2019
File Name: 22420_Gulch B_PnP.dgn
Horiz. Scale: 1:50.0003 Vert. Scale: As Noted
Staff Bridge Branch - Unit 0221 STW

wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation
3803 North Main Avenue
Durango, CO 81301
Phone: 970-385-1440 FAX: 970-385-8365
Region 5 DRV

As Constructed
No Revisions:
Revised:
Void:

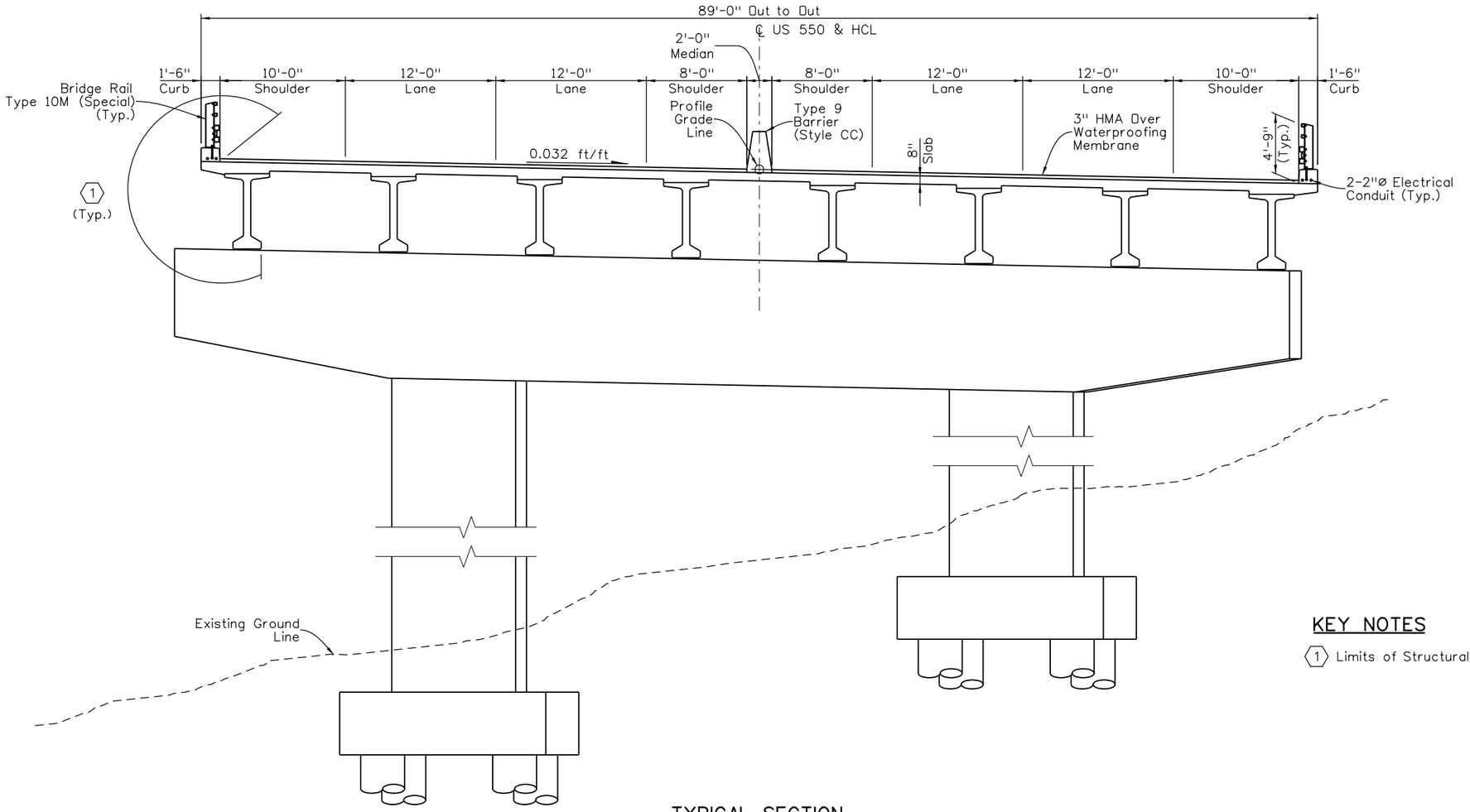
GULCH B
GENERAL LAYOUT

Designer:	J. Broadus	Structure Numbers	P-05-BA
Detailer:	J. Broadus		
Sheet Subset:	Bridge	Subset Sheets:	B9 of 10

Project No./Code
NHPP 5501-029
22420
Sheet Number

2/26/2019

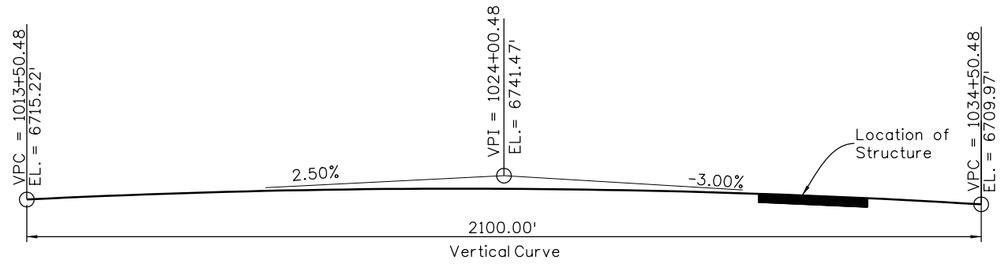
john.broadus 2:44:23 PM P:\Project\Transportation\CDOT R5\2017 CDOT R5 US 550 DB PM sub to HDR\9.0 CADD\9.1 Bridge\22420_Gulch B_PnP.dgn



KEY NOTES

1. Limits of Structural Concrete Coating

TYPICAL SECTION



PROFILE GRADE

(N.T.S.)

Design			Detail			Quantities		
	INITIAL	DATE		INITIAL	DATE		INITIAL	DATE
Designed By	XXX	MM/YY	Detailed By	XXX	MM/YY	Quantities By	XXX	MM/YY
Checked By	XXX	MM/YY	Checked By	XXX	MM/YY	Checked By	XXX	MM/YY

Print Date: 2/26/2019	
File Name: 22420_Gulch B_TypSect.dgn	
Horiz. Scale: 1:10.0001	Vert. Scale: As Noted
Staff Bridge Branch - Unit 0221	STW

wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation
3803 North Main Avenue
Durango, CO 81301
Phone: 970-385-1440 FAX: 970-385-8365
Region 5 DRV

As Constructed
No Revisions:
Revised:
Void:

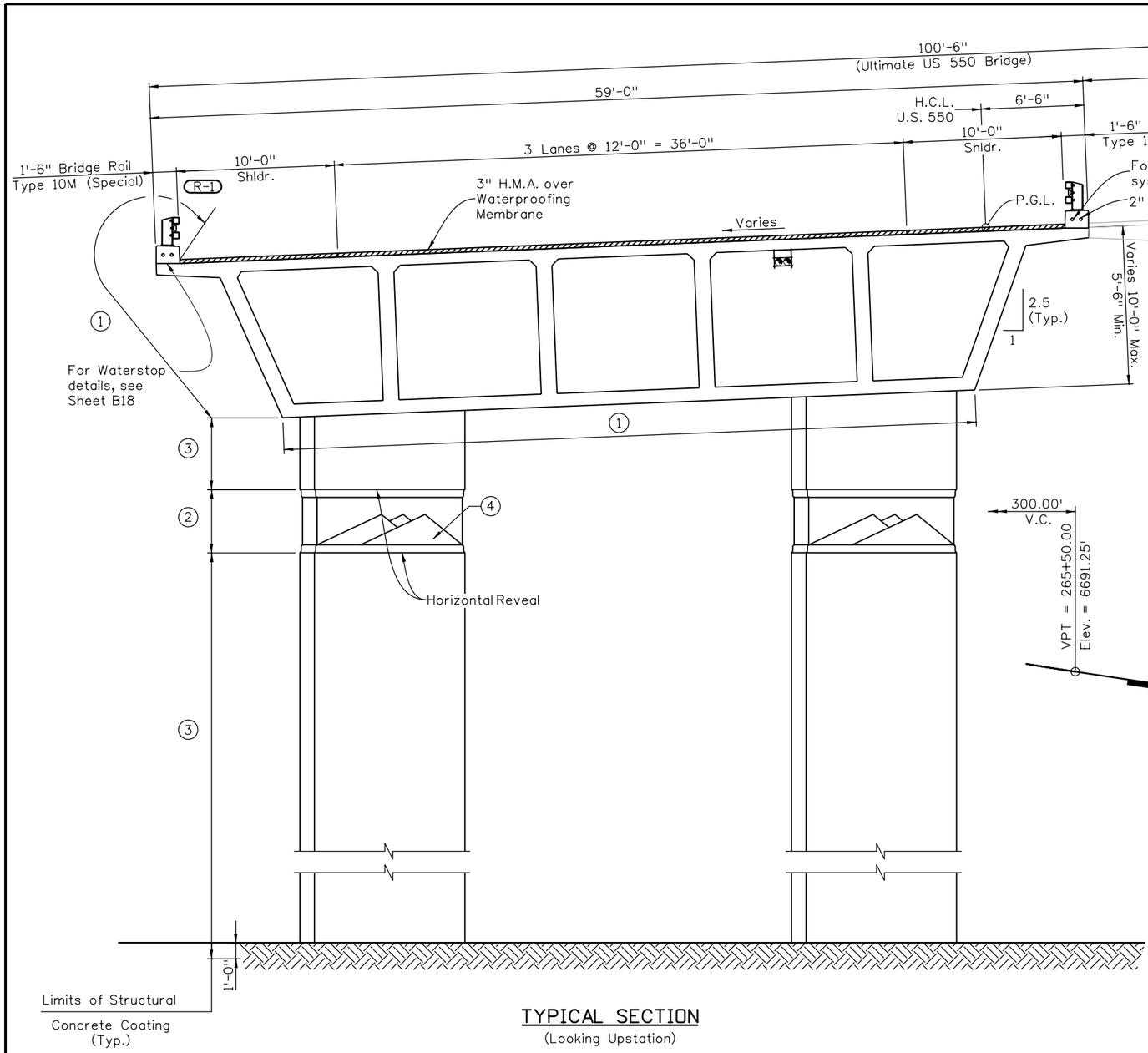
GULCH B
TYPICAL SECTION

Designer:	J. Broadus	Structure Numbers	P-05-BA
Detailer:	J. Broadus		
Sheet Subset:	Bridge	Subset Sheets:	B10 of 10

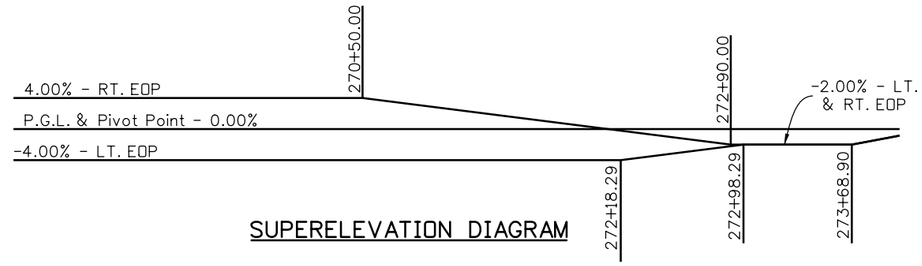
Project No./Code
NHPP 5501-029
22420
Sheet Number

john.broadus 2:46:26 PM P:\Project\Transportation\CDOT R5\2017 CDOT R5 US 550 DB PM sub to HDR\9.0 CADD\9.1 Bridge\22420_Gulch B_TypSect.dgn
2/26/2019

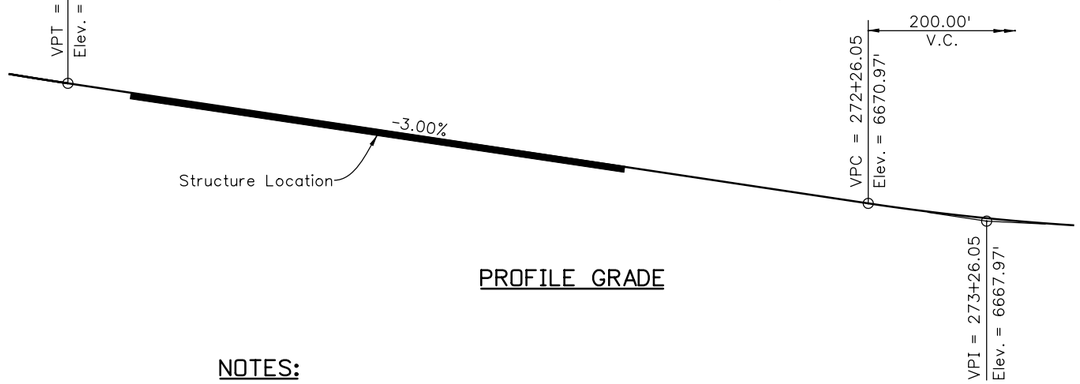
APPENDIX D: GRANDVIEW INTERCHANGE / AESTHETIC BRIDGE DETAILS



TYPICAL SECTION
(Looking Upstation)



SUPERELEVATION DIAGRAM



PROFILE GRADE

NOTES:

A colored structural concrete coating finish is required, as shown on the Plans, on all exposed concrete surfaces including piers, abutments, and wingwalls. Color numbers correspond to paint numbers as described by Diamond Vogel Paints. Coating shall extend to 1'-0" below ground surface.

(1) #8513 (Superstructure)

(2) #8515 (Banner Background)

(3) #8513 (Column)

(4) #8511 (Mountains)

Design			Detail			Quantities		
	INITIAL	DATE		INITIAL	DATE		INITIAL	DATE
Designed By	AML	08/08	Detailed By	RGA	08/08	Quantities By	AML	08/08
Checked By	GWK	08/08	Checked By	GWK	08/08	Checked By	GWK	08/08

Print Date: 9/22/2010
File Name: 16042AG_TypSection_01.dgn
Horiz. Scale: 1:1 Vert. Scale: As Noted
Unit Information 0221 Unit Leader STW

SEMA CONSTRUCTION | WILSON & COMPANY

Sheet Revisions		
Date:	Comments	Init.

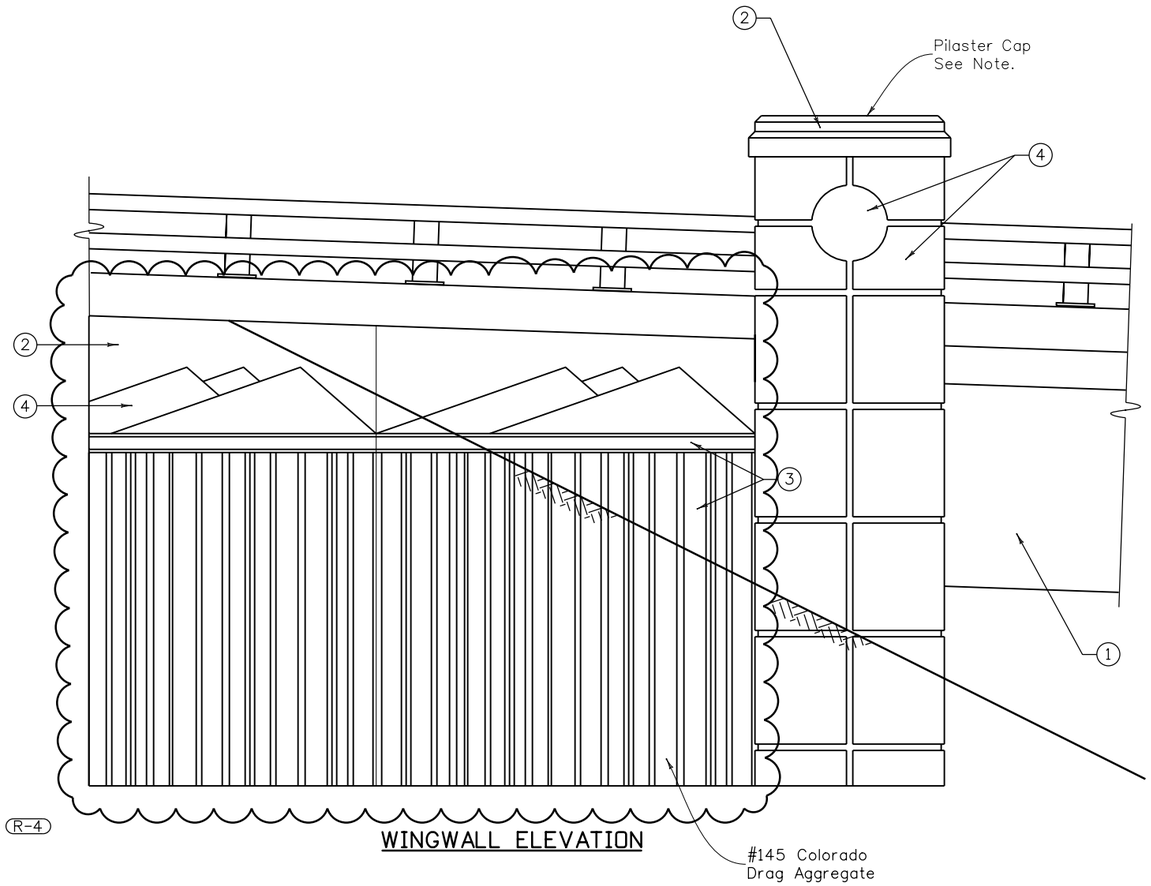
Colorado Department of Transportation
DOT DEPARTMENT OF TRANSPORTATION
3803 North Main Avenue
Suite 200
Durango, CO 81301
Phone: 970-385-1440 FAX: 970-385-8365
Region 5 EJA

As Constructed	
No Revisions: 9/10	
Revised:	
Void:	

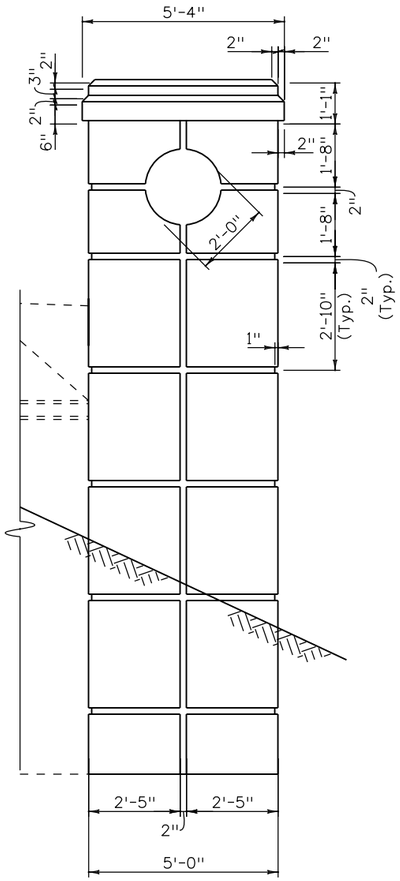
US 550 OVER US 160
TYPICAL SECTION

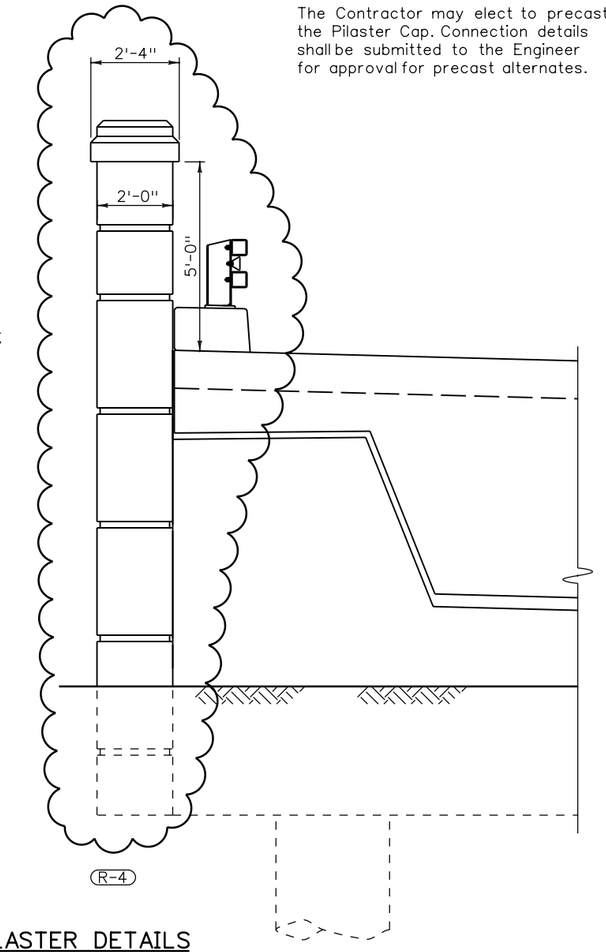
Designer:	A. Leifheit	Structure Numbers	P-05-AG
Detailer:	R. Artman		
Sheet Subset:	Bridge	Subset Sheets:	B4 of B38

Project No./Code
NH 1602-114
16042
Sheet Number



WINGWALL ELEVATION





PILASTER DETAILS

NOTE:

The Contractor may elect to precast the Pilaster Cap. Connection details shall be submitted to the Engineer for approval for precast alternates.

NOTES:

A colored structural concrete coating finish is required, as shown on the Plans, on all exposed concrete surfaces including piers, abutments, and wingwalls. Color numbers correspond to paint numbers as described by Diamond Vogel Paints. Coating shall extend to 1'-0" below ground surface.

(1) #8513

(2) #8515

(3) #8513

(4) #8511

Design	INITIAL	DATE
Designed By	AML	08/08
Checked By	MJN	08/08

Detail	INITIAL	DATE
Detailed By	RGA	08/08
Checked By	MJN	08/08

Quantities	INITIAL	DATE
Quantities By	AML	08/08
Checked By	MJN	08/08

Print Date: 9/22/2010
File Name: 16042AG_ArchDet_01.dgn
Horiz. Scale: 1:1 Vert. Scale: As Noted
Unit Information 0221 Unit Leader STW

SEMA CONSTRUCTION
WILSON & COMPANY

R-4

Sheet Revisions

Date:	Comments	Init.
9/29/08	Monument Revisions	BJA

Colorado Department of Transportation
DEPARTMENT OF TRANSPORTATION
3803 North Main Avenue
Suite 200
Durango, CO 81301
Phone: 970-385-1440 FAX: 970-385-8365
Region 5 EJA

As Constructed

No Revisions: 9/10
Revised:
Void:

US 550 OVER US 160
ARCHITECTURAL DETAILS

Designer:	A. Leifheit	Structure Numbers	P-05-AG
Detailer:	R. Artman		
Sheet Subset:	Bridge	Subset Sheets:	B34 of B38

Project No./Code
NH 1602-114
16042
Sheet Number