Building a Better World for All of Us®

MEMORANDUM

TO: Michelle Metteer

FROM: Parsa Kolahi, PE

DATE: October 10, 2024

RE: Recommended Bellm Bridge Improvements
SEH No. MINTU 178861

Dear Ms. Metteer,

This memorandum is intended to provide the Town of Minturn (Town) with the engineer's recommendations for the Bellm Bridge improvements.

Overview

Short Elliott Hendrickson Inc. (SEH) was selected to perform a feasibility study with a life-cycle cost analysis on Bellm Bridge (Taylor St over Eagle River) located in Minturn, CO.

A preliminary evaluation of the collected data was performed, and five bridge Alternatives were developed for the bridge improvements. See Attachment 1 for the proposed bridge alternatives.

A preliminary construction cost estimate was then developed for each alternative with a life-cycle cost analysis for the anticipated service life of each alternative. The estimate costs are summarized in the table presented in Attachment 2 for comparison.

Additionally, a Decision Matrix was developed comparing the performance of the five alternatives in several different categories (key factors) as listed below. See Attachment 3 for the Decision Matrix.

- Construction Cost
- ROW Impacts
- Aesthetics
- Hydraulic Parameters
- Channel / Environmental Impacts
- Longevity
- Constructability
- Construction Duration
- Maintenance Costs
- Load Capacity and Safety

The matrix includes an Overall Ranking calculated for each alternative, which was the primary basis for the recommended actions below.

Recommended Improvements

A major bridge rehabilitation option was considered in order to improve the safety and service life of Bellm Bridge. However, due to the complexity of the construction work, the estimated service life, and the estimated construction cost, the proposed bridge rehabilitation (Alternative 1) does not appear to be a viable option. Therefore, a bridge replacement option is recommended.

Limited calculations, preliminary evaluations, and coordination with the Town contributed to recommending **Bridge Alternative 2 (Prefabricated Truss Structure)** as the most feasible replacement option for Bellm Bridge. This bridge alternative offers the second lowest estimated construction cost among the replacement alternatives, a clear span that limits in-channel construction work, the shortest construction duration with an Accelerated Bridge Construction (ABC) approach, the largest freeboard improvement, and an aesthetically pleasing appearance as the Town of Minturn's gateway.

Sincerely,

SHORT ELLIOT HENDRICKSON, INC.

Parsa Kolahi, PE
Project Manager, Client Service Manager

Attachments:

1. Bridge Alternatives
2. Cost Comparison
3. Decision Matrix

Attachment 1

Bridge Alternatives

Bellm Bridge

Town of Minturn, CO

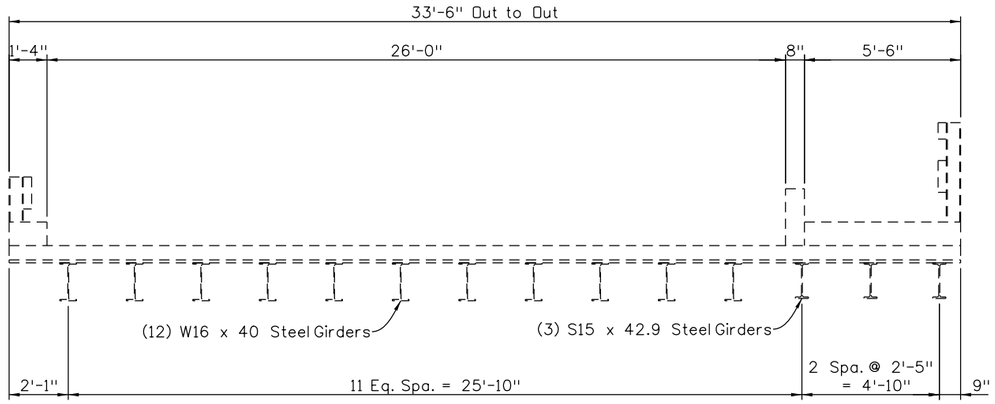
Date: 9/26/2024

Prepared by:

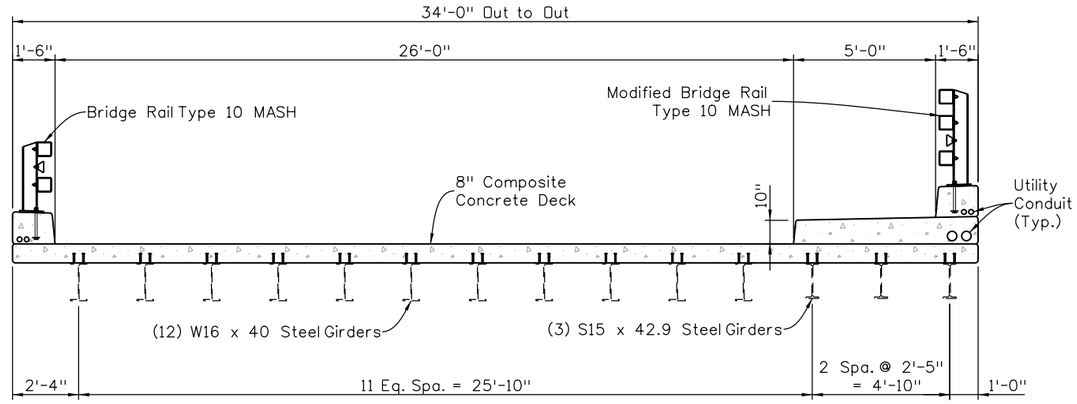
Alternative 1	**Bridge Rehabilitation:** - Replace bridge deck, bridge rails, bridge sidewalk, and approach guardrail. - Clean and repaint steel girders. - Place channel scour countermeasure around the supports' footings.

ALTERNATIVE 1

DECK REPLACEMENT

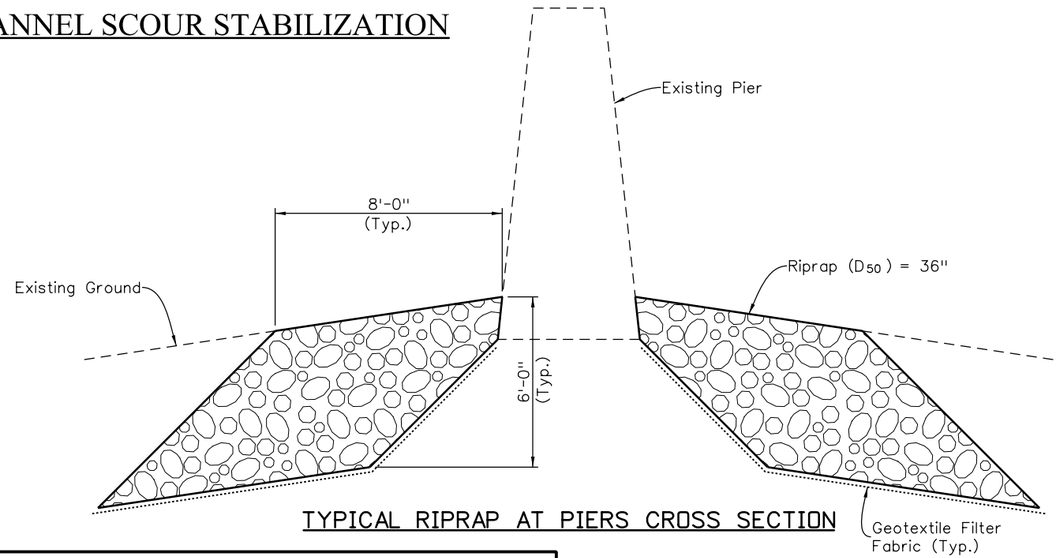


EXISTING TYPICAL SECTION
(Looking North)



PROPOSED TYPICAL SECTION
(Looking North)

CHANNEL SCOUR STABILIZATION



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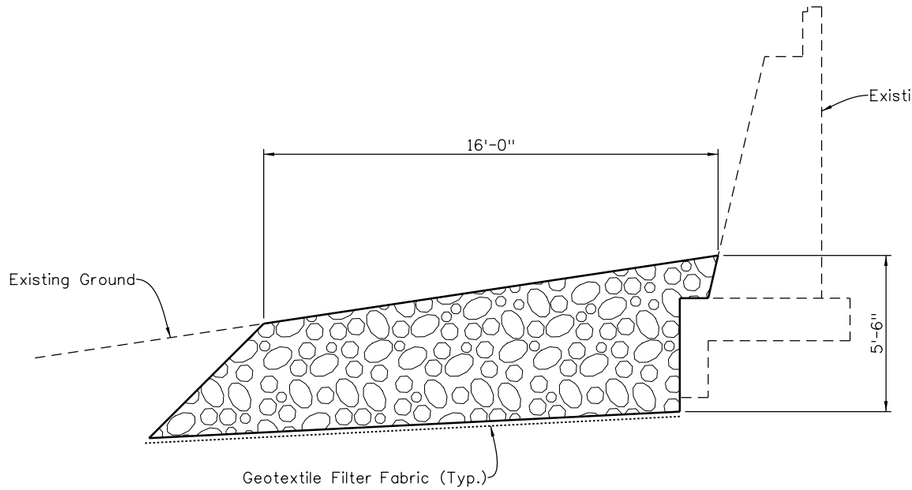

TYPICAL RIPRAP AT ABUTMENTS CROSS SECTION

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Unit Information Unit Leader Initials			Void:
Short Elliott Hendrickson Inc., Colorado Center Tower One, Suite 6000, 2000 South Colorado Boulevard, Denver, CO 80222-7900, Tele. (720) 540-6800, (800) 490-4966, Fax (720) 540-6801			

ALTERNATIVE 1				Project No./Code
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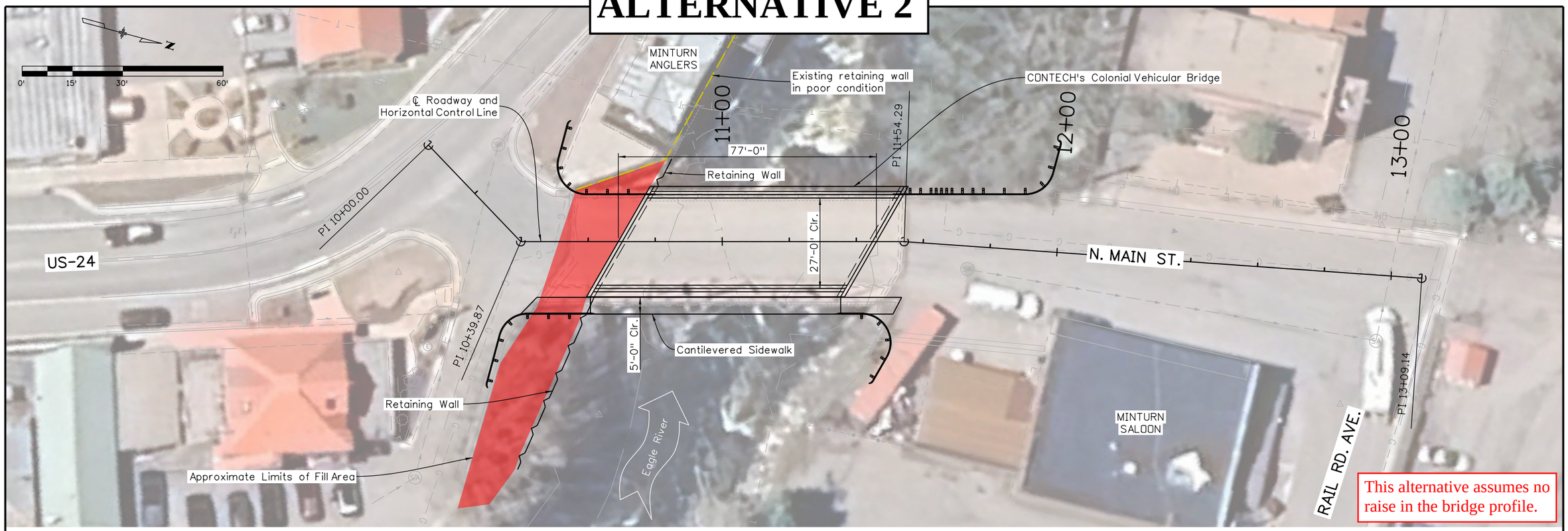
Alternative 2	**Bridge Replacement:** - Remove the existing bridge and replace it with a **single span prefabricated truss** bridge.

ALTERNATIVE 2



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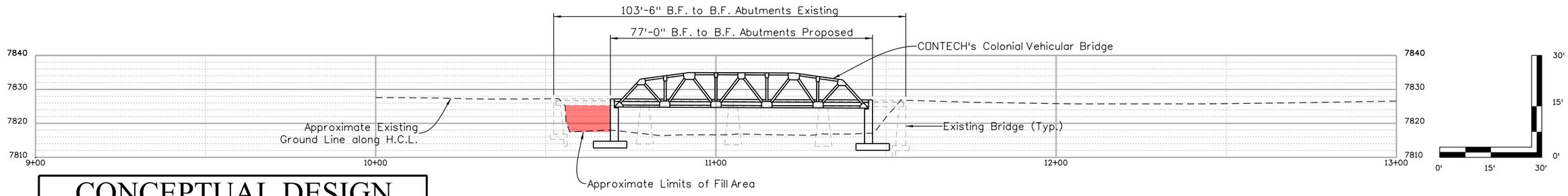

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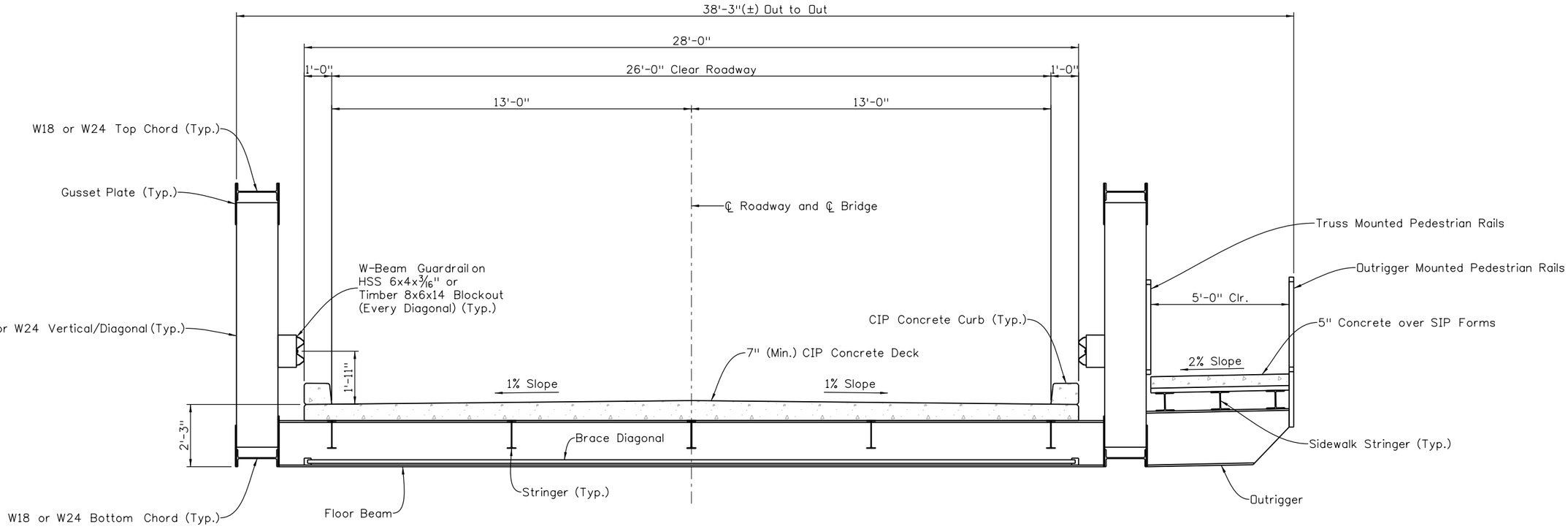

ALTERNATIVE 2 - BRIDGE TYPICAL SECTION

(Looking North)

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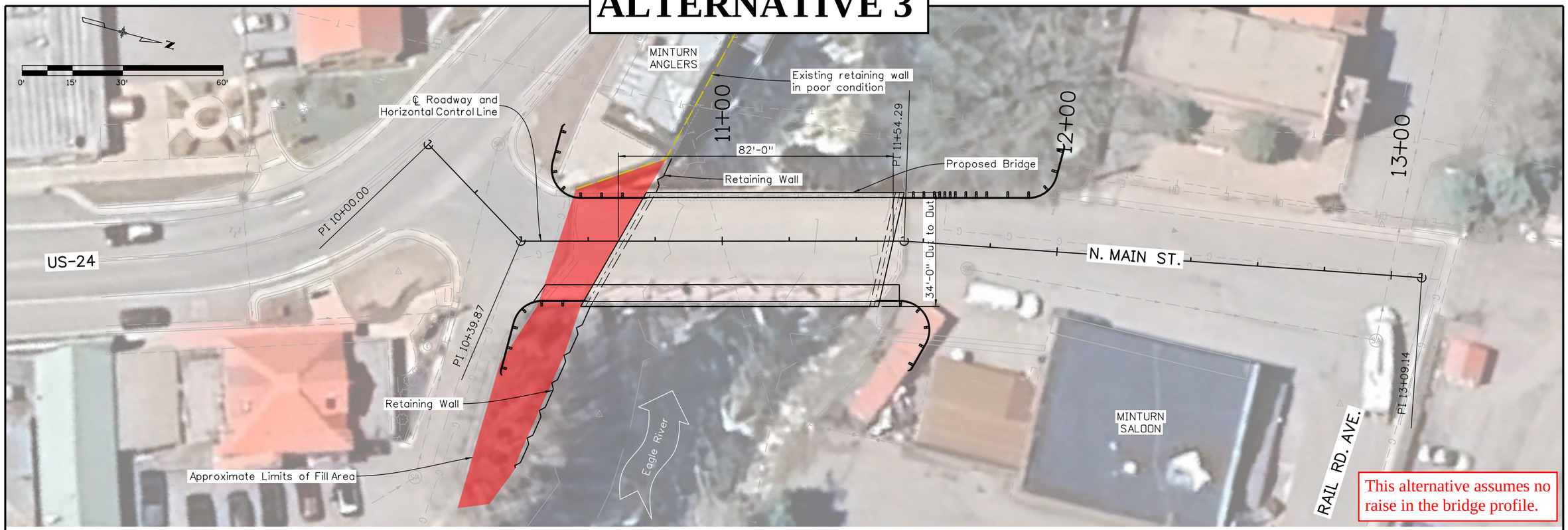
Alternative 3

Bridge Replacement:

- Remove the existing bridge and replace it with a **single span steel girder** bridge.

ALTERNATIVE 3



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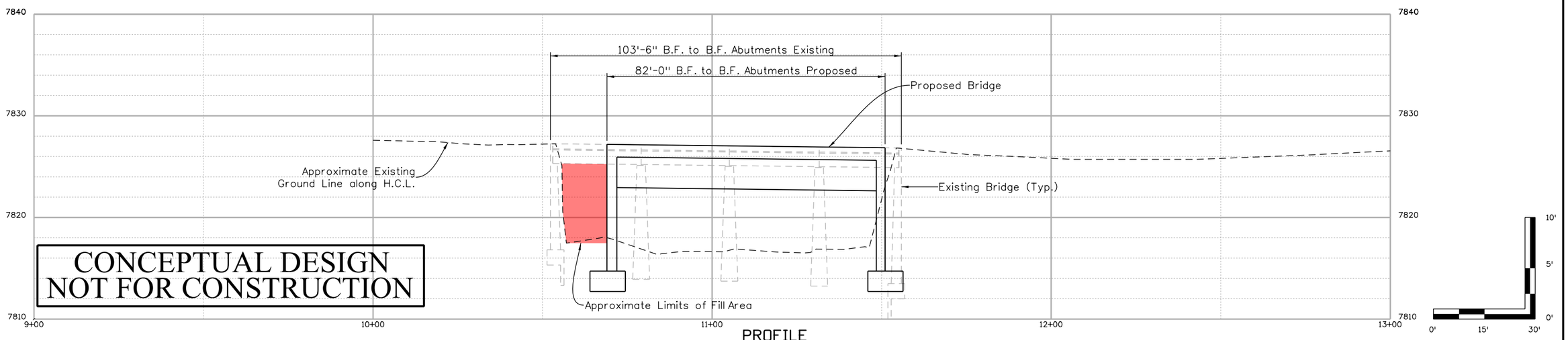

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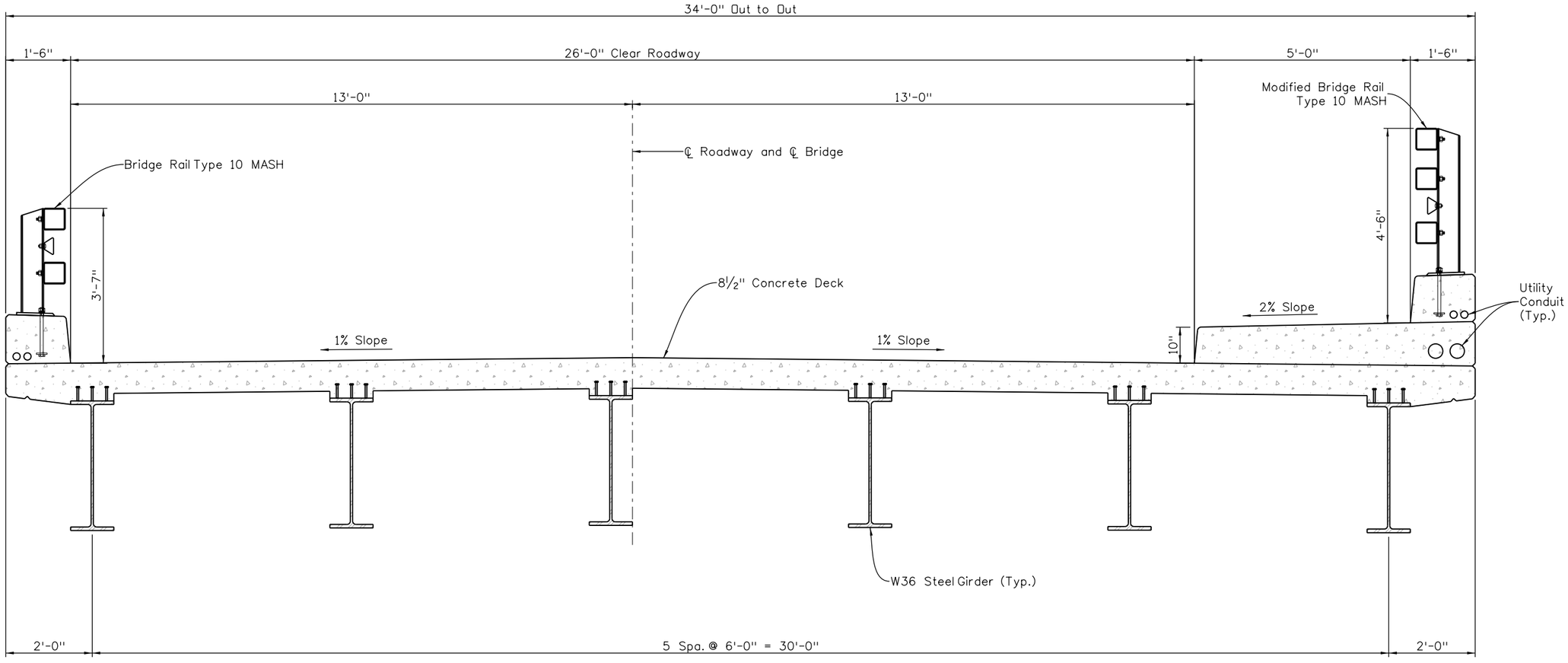

ALTERNATIVE 3 - BRIDGE TYPICAL SECTION

(Looking North)

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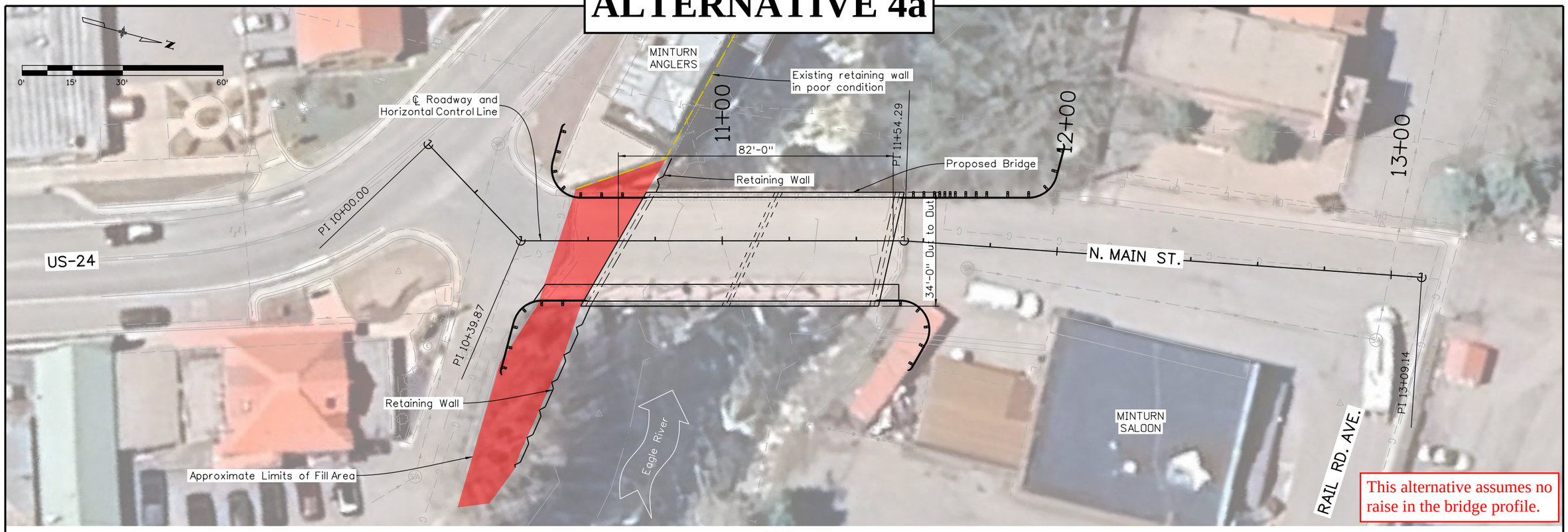
Alternative 4a

Bridge Replacement:

- Remove the existing bridge and replace it with a **two-span steel girder** bridge.

ALTERNATIVE 4a



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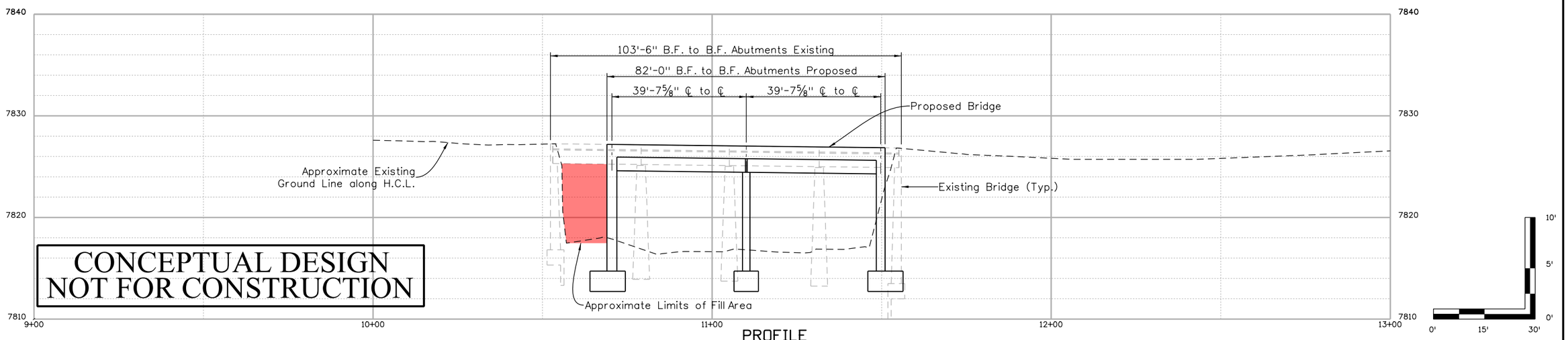

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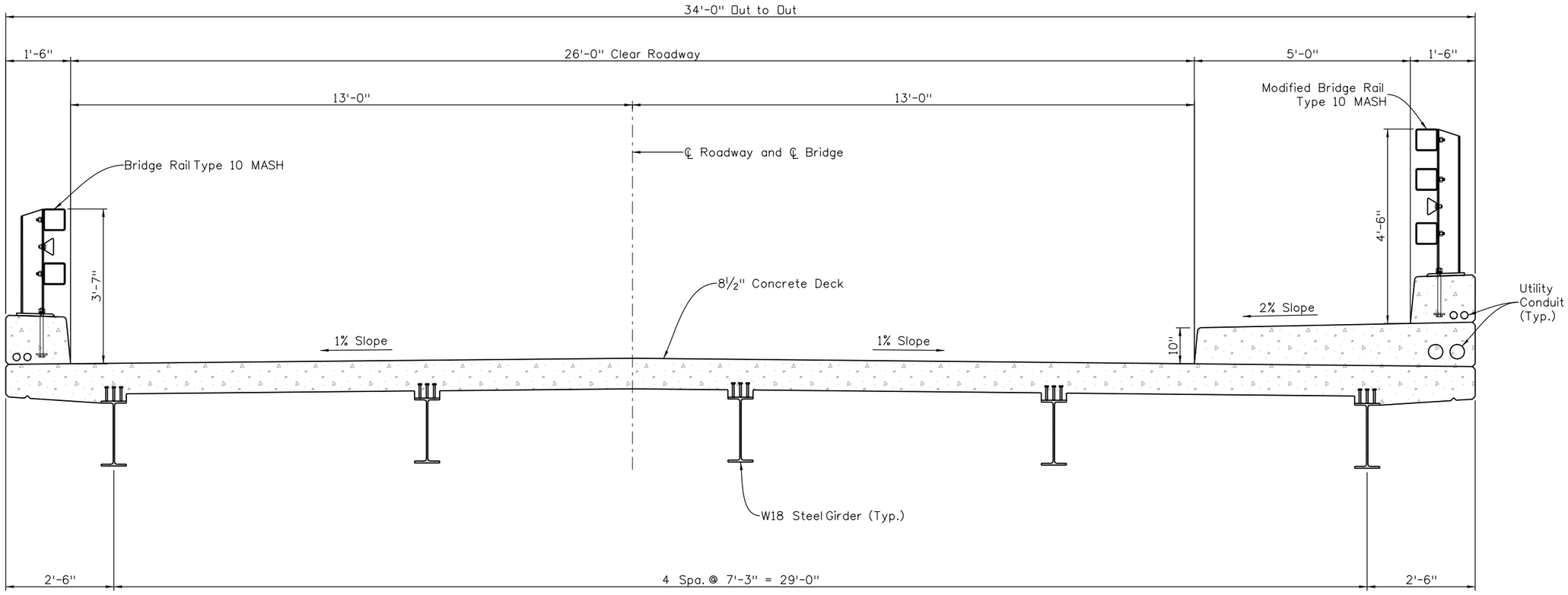

ALTERNATIVE 4a - BRIDGE TYPICAL SECTION
(Looking North)

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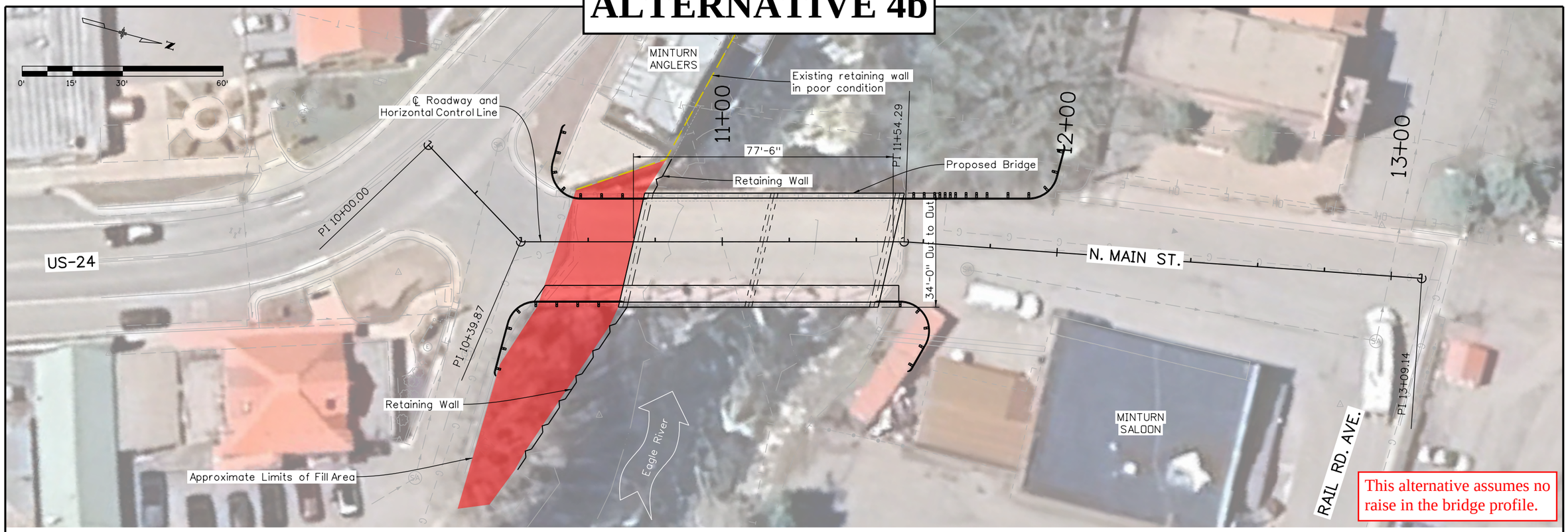
Alternative 4b

Bridge Replacement:
- Remove the existing bridge and replace it with a **two-span prestressed concrete girder** bridge.

ALTERNATIVE 4b



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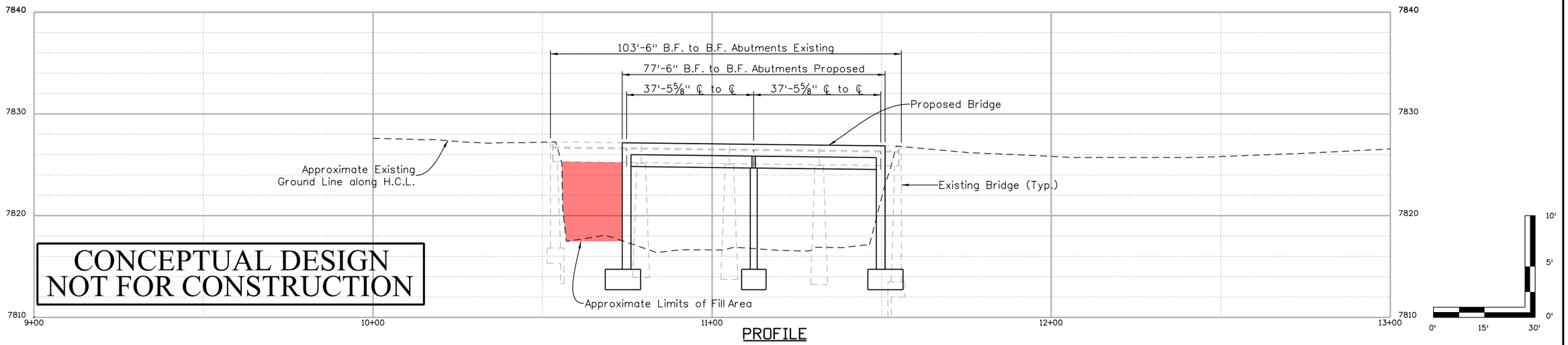

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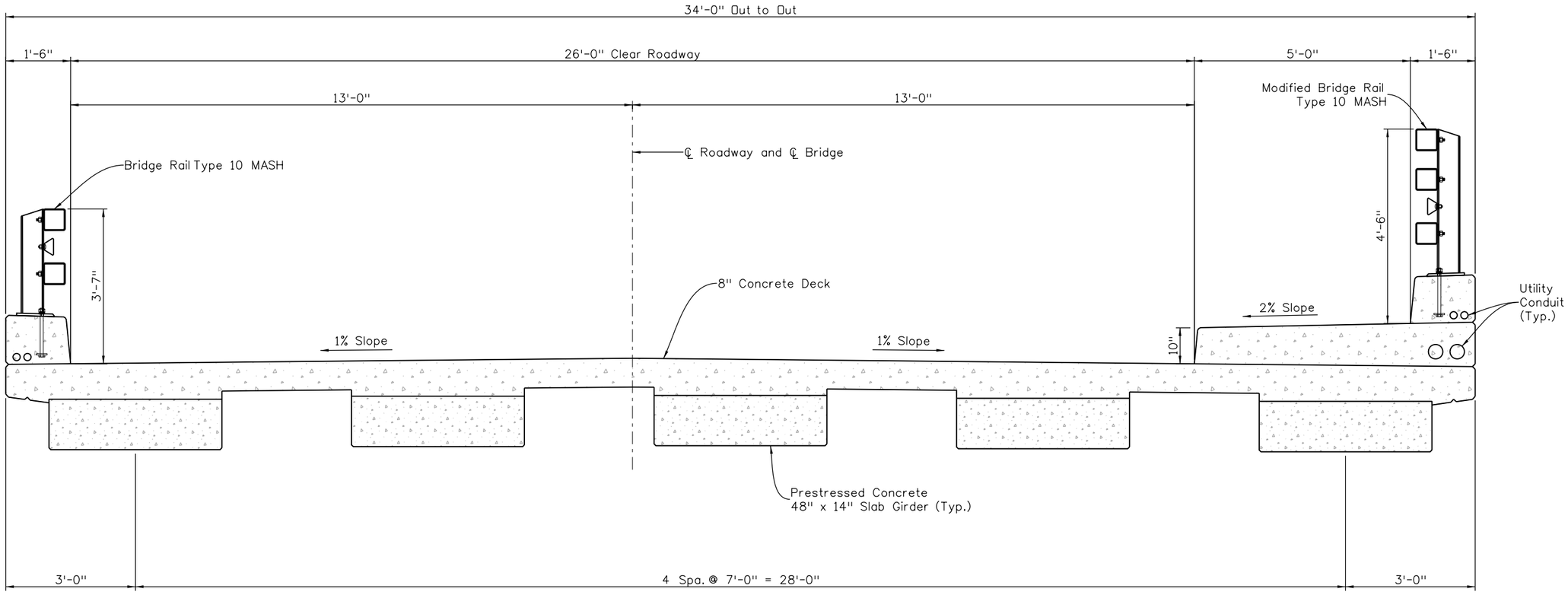
ALTERNATIVE 4b



ALTERNATIVE 4b - BRIDGE TYPICAL SECTION
(Looking North)

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Attachment 2

Bridge Alternative Cost Comparison

Bellm Bridge

Town of Minturn, CO

Date: 9/26/2024

Prepared by:

Anticipated average annual inflation rate	4.00%
Maintenance cost increase per year due to aging	3.00%
Anticipated Rehabilitation Service Life	13
Anticipated Replacement Service Life	75
Years Until 1st Construction Phase	2
Years Until 2nd Construction Phase	14

	Alternative 1 Rehab	**Alternative 2** Truss	**Alternative 3** Single Span Steel	**Alternative 4a** Two-Span Steel	**Alternative 4b** Two-Span Concrete
Estimated SEH Design Cost (in 2025)*	$ 327,470	$ 347,220	$ 514,110	$ 575,610	$ 440,820
Bridge Only Construction Cost	$ 1,913,601	$ 3,114,823	$ 3,346,441	$ 3,341,461	$ 2,810,184
Erosion Control Cost	$ 133,952	$ 155,741	$ 167,322	$ 167,073	$ 140,509
Traffic Control Cost	$ 229,632	$ 373,779	$ 501,966	$ 501,219	$ 337,222
Town Utility Protection/Relocation Cost	$ 10,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000
Mobilization Cost	$ 287,040	$ 467,223	$ 501,966	$ 501,219	$ 421,528
Construction Engineering Cost	$ 325,312	$ 373,779	$ 501,966	$ 501,219	$ 421,528
Contingency Cost	$ 434,931	$ 540,641	$ 604,759	$ 603,863	$ 498,117
Current Construction Cost (in 2024)	$ 3,334,468	$ 5,045,986	$ 5,644,421	$ 5,636,054	$ 4,649,088
Total Construction Cost (in 2026)	**$ 3,606,560**	**$ 5,457,738**	**$ 6,105,006**	**$ 6,095,956**	**$ 5,028,453**
Total Construction Cost (in 2038)	N/A	$ 8,738,015	$ 9,774,311	$ 9,759,822	$ 8,050,715
Maintenance Cost / Year (in 2024)	$ 25,000	$ 10,000	$ 10,000	$ 10,000	$ 7,000
Maintenance Cost after Rehab / Year (in 2024)	$ 12,000	N/A	N/A	N/A	N/A
Maintenance Costs at the end of year 2	$ 54,080	N/A	N/A	N/A	N/A
Maintenance Costs at the end of year 14	$ 433,194	$ 360,995	$ 360,995	$ 360,995	$ 252,696

		Projected Const. + Maint. Costs in 2038	**Approx. Remaining Service Life in 2038**	**Scenario Description**
Scenario 1	Alternative 1	$ 4,093,834	1 years	Construction in 2026 + Maint. Costs Until 2038
Scenario 2	Alternative 2	$ 5,872,813	63 years	Construction in 2026 + Maint. Costs Until 2038
Scenario 3	Alternative 3	$ 6,520,081	63 years	Construction in 2026 + Maint. Costs Until 2038
Scenario 4	Alternative 4a	$ 6,511,031	63 years	Construction in 2026 + Maint. Costs Until 2038
Scenario 5	Alternative 4b	$ 5,335,229	63 years	Construction in 2026 + Maint. Costs Until 2038
Scenario 6	Alternative 1 + Alternative 2	$ 12,777,768	75 years	Rehab in 2026 + Maint. Costs Until 2038, Replace in 2038
Scenario 7	Alternative 1 + Alternative 3	$ 13,814,065	75 years	Rehab in 2026 + Maint. Costs Until 2038, Replace in 2038
Scenario 8	Alternative 1 + Alternative 4a	$ 13,799,576	75 years	Rehab in 2026 + Maint. Costs Until 2038, Replace in 2038
Scenario 9	Alternative 1 + Alternative 4b	$ 12,090,469	75 years	Rehab in 2026 + Maint. Costs Until 2038, Replace in 2038

*Design costs are preliminary and intended for informational purposes only. Design costs include project management, structure design, hydraulic design, erosion control design, SWMP, utility locating and coordination, environmental permitting, geotechnical investigation, services during bidding, and Other Direct Costs (ODCs).

Attachment 3

Bridge Alternative Decision Matrix

Bellm Bridge (Taylor St over Eagle River)
Town of Minturn, CO
Date: 10/10/2024

Prepared by:

Weight (Typ.) 1 - 10 based on importance

	Alternatives	8	Construction Cost	5	ROW Impacts	9	Aesthetics	6	Hydraulic Parameters	3	Channel / Environmental Impacts	7	Longevity	8	Constructability	7	Construction Duration	8	Maintenance Costs	10	Load Capacity and Safety	Overall Ranking (33-100)
Rehabilitation	**Alternative 1** **Deck Replacement Scour Repair**	Green	Lowest construction cost compared to the replacement options, because this Alternative does not include bridge removal or new substructure and superstructure, which are typically high-value items.	Green	No ROW impacts are anticipated for this alternative.	Yellow	A new bridge deck, sidewalk, and rails as well as a fresh paint on the girders can significantly improve the new bridge appearance while the existing piers represent the historical characteristic of the structure.	Red	The existing bridge has the lowest freeboard[1] value and the least desirable hydraulic conveyance due to the piers' layout. This alternative does not significantly alter the geometric characteristics of the channel, hydraulic opening, or existing piers.	Red	Debris containment criteria during deck replacement and in-water construction activities will likely require additional permits and clearances. Additional permits may also increase project duration and/or agency review times. This alternative requires the most in-channel construction work.	Red	The proposed rehabilitation work is intended to improve superstructure service life and address scour in channel. Substructure is believed to significantly reduce the overall service life of the bridge. No improvements to the substructure seem economically justified at this time. This alternative does not address the adjacent concrete retaining wall at southwest corner of bridge that is currently in poor condition.	Red	This rehabilitation scope includes deck replacement which requires a temporary containment system preventing construction debris from falling into channel. Scour repair may require extensive earthwork within channel, maintaining structural stability of the piers during excavation, and complete dewatering of the river prior to construction, which can be challenging and costly.	Red	An accurate estimate of the construction duration for bridge rehabilitation projects is challenging due to frequent unexpected issues that often arise during construction. This inherent uncertainty, the extensive in-channel construction work, and potential need for multiple dewatering/diversion phases are the reasons for the low score assigned to this factor.	Red	Higher maintenance costs are expected even after a bridge rehabilitation due to the age of steel girders and the concrete substructure.	Yellow	New bridge rails and sidewalk provide safer conditions for pedestrian and vehicular traffic using the structure. However, the load capacity of the girders are limited to the existing members, unless additional structural improvements are added to the rehabilitation scope.	**54.5**
Replacement	**Alternative 2** **Pre-fabricated Steel Truss**	Yellow	Second lowest construction cost among the replacement options due to shorter construction duration and lower superstructure costs (pre-fabricated steel segments delivered to construction site vs on-site assembly of bridge members).	Yellow	Due to the congested construction site and surrounding buildings and obstacles, ROW impacts seem inevitable for this proposed alternative.	Green	Visible truss structure provides aesthetic element with open framework of members. Weathering steel is known for its unique, rustic appearance thanks to a natural patina that is developed over time, blending harmoniously with nature and the surrounding environment.	Green	This alternative proposes the most ideal hydraulic parameters for the following reasons: - No intermediate piers. - Shallower structure depth leading to the largest freeboard improvement without raising the roadway profile.	Green	Single span bridges often involve less in-water construction activity, reducing the disturbance to aquatic habitats and water quality during construction. With fewer piers, there is less long-term impact on the riverbed and aquatic ecosystems.	Green	The design life of a new bridge is 75 years, according to the AASHTO LRFD Bridge Design Specifications. All replacement options address the adjacent concrete retaining wall at southwest corner of bridge that is currently in poor condition.	Green	These bridges are designed for rapid on-site assembly due to the pre-fabrication of components. Pre-fabricated components can be large and heavy, requiring careful planning for transportation and lifting. Replacement alternatives may require temporary shoring and precise utility coordination.	Green	CONTECH's truss products qualify as an Accelerated Bridge Construction (ABC) method because they are pre-fabricated and modular, allowing for rapid on-site assembly and installation. This approach significantly reduces construction time and minimizes traffic disruptions. This option also has no intermediate piers, reducing construction time in channel.	Green	Generally lower than traditional steel bridges due to the use of weathering steel, which forms a protective rust layer that reduces the need for painting and other maintenance.	Green	All new structures are designed according to the latest AASHTO LRFD Specifications and CDOT Bridge Design Manual.	**93.9**
	Alternative 3 **Single Span Steel Girder**	Red	Alternatives 3 and 4a have the highest construction costs due to higher cost of structural steel and longer construction duration for on-site assemblies. This alternative includes an intermediate concrete pier supported on deep foundation that also contributes to total construction cost.	Yellow	Due to the congested construction site and surrounding buildings and obstacles, ROW impacts seem inevitable for this proposed alternative.	Yellow	Girder bridges are often considered less aesthetically pleasing than trusses because they lack the intricate and open framework. However, a newly constructed bridge, regardless of structure type, will certainly improve the appearance at this crossing.	Red	Although offers no intermediate supports within channel, this alternative has the largest structure depth which significantly reduces the bridge freeboard. If the profile of the road could be raised, this option may be more feasible, but because of the approach alignment raising the road does not appear to be feasible.	Green	Single span bridges often involve less in-water construction activity, reducing the disturbance to aquatic habitats and water quality during construction. With fewer piers, there is less long-term impact on the riverbed and aquatic ecosystems.	Green	The design life of a new bridge is 75 years, according to the AASHTO LRFD Bridge Design Specifications. All replacement options address the adjacent concrete retaining wall at southwest corner of bridge that is currently in poor condition.	Yellow	Steel girders typically require precise alignment and connection of girders. Transporting long steel girders can be challenging, and on-site welding requires skilled labor and safety precautions. Replacement alternatives may require temporary shoring and precise utility coordination.	Yellow	Longest anticipated construction duration. Steel girder bridges often require more extensive on-site assembly and welding, which can extend the construction timeline. This option also has no intermediate piers, reducing construction time in channel.	Yellow	Higher than pre-fabricated truss bridges, especially if not using weathering steel. Regular painting and protective coatings are necessary to prevent corrosion. The use of galvanized steel can reduce maintenance costs for a higher upfront cost of material.	Green	All new structures are designed according to the latest AASHTO LRFD Specifications and CDOT Bridge Design Manual.	**69.5**
	Alternative 4a **Two-Span Steel Girder**	Red	Alternatives 3 and 4a have the highest construction costs due to higher cost of structural steel and longer construction duration for on-site assemblies. This alternative includes an intermediate concrete pier supported on deep foundation that also contributes to total construction cost.	Yellow	Due to the congested construction site and surrounding buildings and obstacles, ROW impacts seem inevitable for this proposed alternative.	Yellow	Girder bridges are often considered less aesthetically pleasing than trusses because they lack the intricate and open framework. However, a newly constructed bridge, regardless of structure type, will certainly improve the appearance at this crossing.	Yellow	An intermediate support in the channel divides the bridge into two shorter spans which allows for shallower girders compared to a clear span of the same structure type.	Yellow	Bridges with intermediate piers involve more construction activity within the channel causing disturbance to aquatic habitats. This may require temporary dewatering and/or diversion and monitoring the water quality during construction.	Green	The design life of a new bridge is 75 years, according to the AASHTO LRFD Bridge Design Specifications. All replacement options address the adjacent concrete retaining wall at southwest corner of bridge that is currently in poor condition.	Red	Steel girders typically require precise alignment and connection of girders. Transporting long steel girders can be challenging, and on-site welding requires skilled labor and safety precautions. Replacement alternatives may require temporary shoring and precise utility coordination. Alternatives 4a and 4b will likely require temporary dewatering and/or diversion for pier construction.	Red	Longest anticipated construction duration. Steel girder bridges often require more extensive on-site assembly and welding, which can extend the construction timeline. Intermediate pier increases construction duration due to in-channel work including dewatering and/or diversion.	Red	See Alternative 3. Additionally, the intermediate pier can increase the potential for scour and erosion and create more opportunities for debris accumulation.	Green	All new structures are designed according to the latest AASHTO LRFD Specifications and CDOT Bridge Design Manual.	**60.1**
	Alternative 4b **Two-Span PS Concrete Girder**	Yellow	Lowest construction cost among the replacement options due to shorter construction duration and lower superstructure fabrication costs.	Yellow	Due to the congested construction site and surrounding buildings and obstacles, ROW impacts seem inevitable for this proposed alternative.	Yellow	Girder bridges are often considered less aesthetically pleasing than trusses because they lack the intricate and open framework. However, a newly constructed bridge, regardless of structure type, will certainly improve the appearance at this crossing.	Yellow	An intermediate support in the channel divides the bridge into two shorter spans which allows for shallower girders compared to a clear span of the same structure type.	Yellow	Bridges with intermediate piers involve more construction activity within the channel causing disturbance to aquatic habitats. This may require temporary dewatering and/or diversion and monitoring the water quality during construction.	Green	The design life of a new bridge is 75 years, according to the AASHTO LRFD Bridge Design Specifications. All replacement options address the adjacent concrete retaining wall at southwest corner of bridge that is currently in poor condition.	Red	Prestressed concrete girders are pre-fabricated, transported to site, and lifted into place, which requires heavy lifting equipment. Transporting and handling heavy concrete girders require planning and specialized equipment. Replacement alternatives may require temporary shoring and precise utility coordination. Alternatives 4a and 4b will likely require temporary dewatering and/or diversion for pier construction.	Yellow	Prestressed concrete girders can be pre-fabricated off-site and then transported to the construction site for quick assembly, reducing on-site construction time. In contrast, steel girder bridges often require more extensive on-site assembly and welding, which can extend the construction timeline. Intermediate pier increases construction duration due to in-channel work including dewatering and/or diversion.	Yellow	Maintenance cost is typically lower than steel bridges due to the durability of concrete and resistance to corrosion. Also requires less frequent maintenance compared to steel bridges. However, the intermediate pier can increase the potential for scour and erosion and create more opportunities for debris accumulation.	Green	All new structures are designed according to the latest AASHTO LRFD Specifications and CDOT Bridge Design Manual.	**70.9**

Green	Best performance of the design alternative for the decision matrix criteria.	**Green = 3**
Yellow	Intermediate performance between green and red of the design alternative for the decision matrix criteria.	**Yellow = 2**
Red	Worst performance of the design alternative for the decision matrix criteria.	**Red = 1**

Overall Ranking = Total weighted score for the proposed Alternative

Example calculation of the Overall Ranking (**Alternative 1**)

Step (1) the weight (Construction Cost Weight = 8) is converted to a percentage: (weight / sum of all weights) x 100 = (8 / 71) x 100 = 11.27%
Step (2) the calculated percentage is multiplied by the assigned score (Construction Cost Score = 3 for Green): 11.27 x 3 = 33.8
Step (3) previous steps are repeated for all other key factors and the sum of results is calculated: 33.8 + 21.1 + 25.4 + 8.5 + 4.2 + 9.9 + 11.3 + 9.9 + 11.3 + 28.2 = 163.4
Step (4) then the value calculated in Step (3) is divided by the highest possible score (3 for Green) to calculate the **Overall Ranking** between 33 and 100: 163.4 / 3 = **54.5**

[1] Freeboard is the vertical distance between the design water surface elevation (typically for the 100-year flood event) and the lowest point of the bridge superstructure, typically referred to as "bridge low chord". This clearance is crucial for accommodating hydrologic uncertainties, wave action, ice, and debris. Freeboard for the 100-year flood event with the existing bridge conditions is estimated to be -0.76. The negative amount means that the water surface elevation of the 100-year event is higher than bridge low chord.