MDT Activity 114

FINAL TYPE, SIZE, AND LOCATION REPORT

April 15, 2022

Prepared for :

MONTANA DEPARTMENT OF TRANSPORTATION

I-90 STRUCTURES-W OF ALBERTON

NHPB 90-1(239)65

UPN 9786000

Prepared by:

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engineers • surveyors • planners • scientists

INTRODUCTION

The following includes individual Type, Size, and Location Reports, as well as additional supporting information, for each of the three structures within the proposed I-90 Structures – W of Alberton project. Through initial screenings, foundation reuse analyses, and preliminary structure option discussions, three westbound I-90 structures will be removed and replaced at Old Highway 10 (RP 65.5), Clark Fork River (RP 66.3), and Cyr Interchange (RP 70.1).

Following the submittal and Department's review of the draft Type, Size, and Location Reports for each structure in February 2022, a meeting was held with the Department and design team on March 7, 2022, to discuss the recommended structures at each location. A summary of the decisions and discussions from this meeting is presented as meeting minutes on the following pages.

To maintain an efficient transmittal of information and minimize the additional review required, only the following updates to the Type, Size, and Location reports and supporting information were made:

1. Performance Matrices for Clark Fork and Cyr Bridges: Updated to include criteria and weighting changes discussed for each structure during the meeting. Updated matrices are provided in each report in the same location as presented in the draft reports. The recommended structure options remained the same as discussed in the draft reports and meeting.
2. Appendix A Bridge Design Criteria for all reports:
    a. Seismic Parameter Table was updated to include the latest recommendations for soil site class at the Cyr Bridge and Old Hwy 10 Bridge. All structures will conservatively be designed under seismic design class – Zone 2 as discussed in the draft reports.
    b. Temperature loading (TU) was updated to a range of 105°F to -30°F based on an analysis of the recorded historical weather data over the past 70 years according to NOAA.
3. References list:
    a. Added dates of updated Preliminary Soil Survey and Materials Reports for all sites.
    b. Deleted reference to Preliminary Hydraulics Report.
    c. Added Preliminary Foundation Design Report for Clark Fork and Cyr Bridges.

Meeting Minutes
I-90 Structures – West of Alberton
NHPB 90-1(239)65; UPN 9786000

Date: **March 7, 2022 – 12:30pm**

Attendees:

- ☒ Stephanie Brandenberger, MDT
- ☒ Bob Vossen, MDT
- ☒ Nathan Haddick, MDT
- ☒ Andy Cullison, MDT
- ☒ John Schmidt, MDT
- ☒ Bret Boundy, MDT
- ☒ Jon Rainwater, MDT
- ☒ Paul Hilchen, MDT
- ☒ Joe Weigand, MDT
- ☒ Laura McDonald, MDT
- ☒ Will Tangen, MDT
- ☒ Jim Scoles, MMI
- ☒ John Turner, DBA
- ☒ Cory Rice, SKG
- ☒ Andy Mish, M&M
- ☒ John Lynch, M&M
- ☒ Jason Millar, MMI
- ☒ Luke Carlson, MMI
- ☒ Nik Ortman, MMI
- ☒ Phill Forbes, MMI

Purpose:

A meeting was held on this date to provide an overview of the Step 2 detailed screening of structure types for the I-90 Structures – West of Alberton project and facilitate discussion on the three draft Type, Size, and Location (TS&L) Reports prepared by the Consultant. Refer to the attached presentations for an outline of the topics discussed during the meeting.

Outcome:

The Department concurred with the recommended structures at each of the three sites, with direction to advance each to Alignment Review level.

The meeting began with introductions and a brief overview of the project scope. The meeting discussion was guided with PowerPoint presentations of the common project elements, followed by details for each of the three structures. The following is intended to summarize the discussion.

Common Project Elements:

No horizontal or vertical alignment modifications to I-90 are proposed, thereby requiring crossovers to maintain traffic on the Interstate. The location and possibly number of crossovers may be affected by how the project is either phased or split for construction.

Environmental constraints affect the schedule at the two crossings of the Clark Fork River and are singularly related to avoiding and / or minimizing impacts to bull trout. The bridge over Old Highway 10 is not subject to any out of the ordinary environmental restrictions.

Access to the Clark Fork and Cyr structures for demolition of existing and construction of new structures will prove to be very difficult and was evaluated in detail for TS&L reporting. The preliminary estimated costs presented are representative of bridge construction items only. No contingency, inflation, IDC, or roadway costs were included, but it was noted that these "non-bridge" costs are similar at each respective site for all options.

Because the estimated costs of the structures at each site are so similar, the Consultant recommended using a performance matrix with weighted criteria to identify the best-value structure type for each site. During the meeting, adjustments to the scoring of the Cyr and Clark Fork structures were made but did not alter the outcomes. The adjusted performance matrices sites are attached. The matrix for the relatively straightforward Old Highway 10 crossing was not included in the TS&L report but was used by the Consultant to make its recommendation.

After the presentation of common elements, the Consultant presented highlights from the TS&L Reports. The PowerPoint slides are attached and the TS&L Reports themselves provide the detailed information. The following is intended only to capture the discussion during the meeting.

Cyr:

Spread footings were not studied in detail because of the apparent risk of scour, with computed depths sufficient to indicate the eastbound substructure may be at risk of failure. Moving the proposed main span piers outward towards the respective banks mitigates the risk. Paul Hilchen noted that the streambed appears to be pretty well armored at this location. Luke Carlson pointed out that the scour calculations do not consider the materials and / or armor layer, noting that the underlying soils are very susceptible to scour should the armoring layer fail.

Drilled shafts with permanent casing would be challenging here but are the most practical and robust foundation type for the main span piers. A qualified contractor with the proper equipment and project planning should be able to readily complete the shafts, currently estimated to be 9-ft or 10-ft in diameter. Locating new shafts apart from the existing foundations will minimize possible conflicts with existing piling.

Drilled-in pipe piles were discussed, with the Consultant noting that even 30" pipe piles would not likely be sufficient for the lateral loads.

Long-term viability and maintenance costs of weathering steel are considered by the Department to be on-par with prestressed concrete beams. John Lynch also noted that once the spliced concrete girders are post-tensioned there is no need for future tensioning, and the strands can be well-protected against corrosion.

It was agreed that the costs to advance designs for both steel and concrete would likely not prove to be cost effective. To that end, the Consultant's recommendation to advance Option 2S – Four-Span Steel Girder bridge as the best value was accepted. As part of the recommendation, the design should include lowering the profile of the I-90 eastbound on-ramp to provide 17'-0" of clearance if feasible.

Clark Fork:

In response to Jon Rainwater's question about possible channel migration, John Turner noted that the river channel is incised in argillite rock, with no discernable change since the initial construction in 1965. While migration over time is possible, the time it would take for any significant shift in the channel is expected to be much longer than the life of the new bridge.

If removal of the existing footings at this site to 3 feet below the thalweg is required, the Contractor will need to get access to the river level and the work may present difficult conditions. Potential for blasting, possibly unpredictable river hydraulics results, and in-stream work restrictions add to the difficulty. Communication about the issues associated with this part of the work with MT Fish, Wildlife & Parks well before permit application(s) should help to gain their concurrence with the most feasible solution.

While drilling at the intermediate bent locations may prove challenging, it was agreed they should be better represented in the performance matrix score for Constructability. As can be seen in the adjusted matrix, the outcome would remain the same as presented in the TS&L Report. The Consultant's recommendation to advance Option B – Three-Span Steel Girder bridge as the best value was accepted.

Old Highway 10 / Elizabeth Lane:

The retaining walls needed to support the I-90 embankments for three of the options would be approximately 9 feet tall. It was agreed that any wall installed with the new bridge should be inspected regularly to maintain the integrity of the Interstate. Avoiding a structure layout that requires a retaining wall is preferred.

The Consultant's recommendation to advance Option 3S – Three-Span Steel Girder bridge as the best value was accepted.

Conclusion:

Design documents will be prepared for Alignment Review at all three sites with the recommended structure option at each.

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OLD HIGHWAY 10 TYPE, SIZE, AND LOCATION REPORT

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MONTANA DEPARTMENT OF TRANSPORTATION

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INTRODUCTION

The proposed I-90 Structures – W of Alberton project has been nominated to remove and replace existing structures on I-90 at Old Highway 10 (RP 65.5), Clark Fork River (RP 66.3), and Cyr Interchange (RP 70.1).

The purpose of the project is to address aging infrastructure and bridges in poor condition. The project structures need to be replaced with new structures that meet current bridge design standards. The objective is to improve functionality, reliability, and safety of the bridges at each of the three sites. To control construction costs, bridges that are typical for Montana with construction familiar to area contractors are preferred.

This structure selection report outlines and discusses the site characteristics, constructability, economics, long term durability, and other determining factors that impact the selection of a structure to replace the westbound I-90 structure spanning over Old Highway 10 and Elizabeth Lane at RP 65.5.

The outcome of this report is to provide the Montana Department of Transportation with pertinent structure selection criteria and evaluations to determine the most appropriate structure type, size, and layout for the replacement of the bridge over Old Highway 10 and Elizabeth Lane.

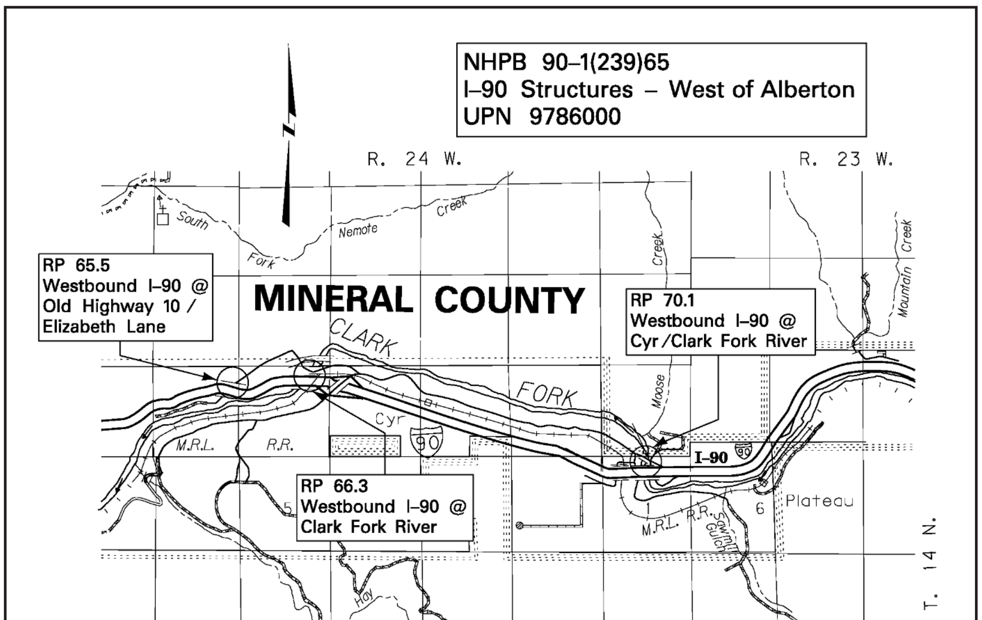

Figure 1: Project Locations Map

BACKGROUND INFORMATION

This 444.5-ft long, 28-ft wide (31.7' out-to-out) tangent bridge at RP 65.5 spans Old Highway 10 and Elizabeth Lane and was initially constructed in 1965 with Federal Aid Project No. I-90-1(26)66. The eight-span structure includes two steel wide flange girder spans over Elizabeth Lane (spans 5 and 6), and six prestressed concrete girder spans over Old Highway 10 and the historical railroad right-of-way.

Rehab projects in 1984 and 1995 were completed to modify the bridge rail, and repair / overlay the deck, respectively.

Inspection reports from May 2019 and May 2021 documented extensive rust and heavy corrosion on essentially all steel elements, as well as growing cracks in the transverse steel girders. The structure is showing increasing section loss throughout the superstructure and substructure elements, fracture critical details, and substandard elements.

Structure #01377 (NBI Structure Number I00090065+04972); New NBI ID = 000000202101377

Figure 2: Aerial view of westbound structure over Old Highway 10 and Elizabeth Lane

BRIDGE DESIGN CRITERIA

All design will be completed using AASHTO LRFD Bridge Design Specifications 9th Edition (2020). The current AASHTO LRFD Bridge Design Specifications including all subsequent Interim Specifications will apply throughout final design.

MDT Montana Structures Manual will be used. Dead load, wind load, or other typical loadings will be calculated in accordance with MDT's Montana Structures Manual and AASHTO's LRFD Bridge Design Specifications.

See Appendix A for further bridge design criteria.

RAILROAD

The existing bridge was originally built to provide adequate horizontal and vertical clearances for the Chicago Milwaukee, St. Paul and Pacific Railroad. Fifteen years later, in 1980, railroad operations ceased. The tracks, ties, and other hardware have been removed and the roadbed is now known as Elizabeth Lane, providing access from Old Highway 10 to two residential houses along the railroad bed. Currently MDT owns the right-of-way under the bridge, including the abandoned railroad bed.

No accommodations for railroad operations are needed.

LAND USE CONSTRAINTS

To shorten the new bridge (as described below), a construction permit would be required to construct that portion of Elizabeth Lane that would be built outside of existing I-90 right-of-way.

Additional right-of-way may be required for the proposed new I-90 embankment at the east abutment.

ROADWAY

I-90

The final westbound roadway width will include two 12-ft travel lanes, a 10-ft outside shoulder and a 4-ft inside shoulder, for a 38-ft face-of-barrier to face-of-barrier roadway width. The existing structure is on a horizontal tangent, with a spiral curve located approximately 40' beyond the existing east abutment.

The horizontal alignment was investigated at a high level to determine the viability of shifting the new bridge towards the median adjacent to the existing structure, thereby minimizing traffic control impacts and construction timing requirements. Adjusting the horizontal alignment at this location would require reconstruction of approximately 2,000 feet of the interstate and approximately 500 feet of Old Highway 10.

Therefore, the replacement bridge will be placed on the existing horizontal alignment as there are no apparent deficiencies in the mainline alignment. The resulting distance from the east abutment to the spiral curve will be increased with the shorter replacement bridge.

The longitudinal grade of I-90 on the bridge is -2.95%. The replacement bridge will be placed on the existing vertical alignment.

OLD HIGHWAY 10 / ELIZABETH LANE

Through preliminary design and investigation, several options for the undercrossing roadways were presented to and discussed with the Department. These options included replacing the structure at the current length thus maintaining the Old Highway 10 roadway alignment, realigning Elizabeth Lane, and realigning both Old Highway 10 and Elizabeth Lane.

In a site visit and meeting with the Missoula District, options that would remove one of the tight S-curves on Old Highway 10 under the structure were discussed and considered. The estimated cost to adjust the horizontal and vertical alignment of Old Highway 10 under the westbound I-90 structure was $800,000 to $1,000,000, due to the additional length of reconstruction of I-90, reconstruction of Old Highway 10, and longer structure requirements due to an increased skew angle. The decision was made to maintain the current alignment of Old Highway 10 and realign Elizabeth Lane as necessary to reduce the bridge length as much as practical.

VERTICAL CLEARANCE

The replacement structure will cross two under-bridge roadways, specifically Elizabeth Lane and Old Highway 10. The eastbound I-90 structure is currently the limiting constraint for vertical clearances over both Elizabeth Lane and Old Highway 10, at approximately 23-ft and 14-ft minimum clearance, respectively.

As noted in the Preliminary Traffic Report, a minimum vertical clearance of 15-ft is normally required for Old Highway 10, and if feasible 17-ft vertical clearance would be ideal to match interstate criteria. In a field review with MDT District representatives, it was decided to maintain the horizonal alignment to minimize project cost, as Old Highway 10 is a low-volume roadway. Lowering the vertical alignment of Old Highway 10 to provide 15-ft clearance under the eastbound structure was evaluated, but not advanced as being too costly and outside the scope of this project.

As a result, the new westbound structure selection will focus on options that maintain a 15-ft minimum vertical clearance for Old Highway 10, as reducing structure depth by approximately 2 feet is not feasible. By inspection, Elizabeth Lane clearance will exceed the minimum for a local road under.

No considerations for future widening are needed.

UTILITIES

Through site inspection and survey, one power pole assembly and associated overhead power lines that pass over the bridge would not likely be impacted or relocated for replacing the structure at its current length. Options that shorten the bridge would result in conflicts with the power utility facilities. Overhead power could interfere with bridge construction activities such as girder erection, pile placement, etc.

AESTHETICS

No considerations for aesthetics are needed.

PUBLIC CONSIDERATIONS

No substantive public input has been gathered to-date, but anticipated issues of concern to the public include disruption to traffic on Old Highway 10 and Elizabeth Lane, and possible negative impacts on personal recreation and commercial recreational businesses during construction.

ENVIRONMENTAL

The conclusions of evaluation of biological resources and probable construction impacts, e.g., temporary construction activities, access roads, work bridges, stormwater sediment runoff, etc., are summarized as follows:

- No permanent impacts to terrestrial resources are anticipated.
- No permanent impacts to Species Of Concern or special status species are anticipated.
- The project is expected to have "No Effect" on grizzly bear, Canada lynx, and whitebark pine.

One wildlife accommodation recommendation to reduce the potential for vehicle / wildlife collisions that affects structure layout is to provide a 3-foot-wide mid-slope bench on the east embankment of the replacement structure. The width of this bench lengthens the new bridge an equal amount over what would nominally be proposed. For this report, we have assumed the recommendation will be implemented.

HYDRAULICS

As noted above, this bridge crosses other transportation roadways. The existing grade of Elizabeth Lane is essentially flat. However, the natural topography coupled with the drainage patterns of the underlying roads result in minor drainage passing under the bridge structure. Embankment fill for the eastern bridge end will lengthen the drainage flowpath for minor runoff conveyed south along the abutment toe. A small ditch included along the toe of the new embankment fill will discharge to the existing drainage pattern conveying runoff around the eastern abutment of the existing bridge. The proposed western bridge abutment configuration will not alter existing drainage flow paths or conveyance west of Old Highway 10.

The bridge deck typical section will include a 4-foot inside shoulder and a 10-foot outside shoulder. With the bridge profile slope of -2.95%, the outside shoulder has sufficient width to contain deck drainage spread width for the full bridge length. However, runoff spread width will exceed the 4-foot inside shoulder at a drainage length of 200 feet. Scuppers will be placed to control inside shoulder spread width and discharge directly below the structure, but not onto either of the roadways below. Where scuppers discharge to the underlying ground with less than 25 feet vertical separation, erosion control features will be included to mitigate erosion.

Deck drains capturing minor runoff will be included just prior to the eastern bridge end to mitigate bridge seat freeze-thaw damage from meltwater runoff. Bridge deck runoff from larger rainfall events will be captured by embankment protectors. Flow will be routed to the fill slope toe for both the inside and outside lanes and shoulders.

GEOTECHNICAL

GENERAL SITE CONDITIONS

The existing abutment backslope at the west abutment is 1.5H:1V and does not meet an acceptable global stability. Global stability analysis at the west abutment indicates that it is possible to construct the front fill slopes as steep as 1.8H:1V to get the desired global factor of safety of 1.5. It is recommended that slopes be graded to a 2H:1V, or flatter, as soon as feasible away from the critical area that requires the steeper slope. A higher level of turf reinforcement may be required to control surface erosion and will be further studied in final design.

GEOLOGY

The Geologic Map of the Plains 30′ x 60′ Quadrangle, Western Montana indicates the uppermost geology consists of Quaternary glacial flood deposits consisting of "stratified, granule through boulder gravel, minor sands. . . interbeds of laminated silty clay and very fine-grained sand".

More in-depth information on site geology, subsurface stratigraphy, and soil and rock properties is presented in the Activity 106 Report by SK Geotechnical. For this report, it is noted that bedrock was not encountered in soil borings completed to elevation 2900, approximately 80 feet below ground surface adjacent to Elizabeth Lane.

SEISMIC

The bridge seismic performance criteria is Zone 2. Liquefaction potential is low to nonexistent, considering the mostly dense and coarse-grained soil deposits and the groundwater level was not detected in the two deep borings completed.

FEASIBLE FOUNDATIONS

Borings encountered medium dense to dense gravels and are generally considered a relatively good soil condition for foundation support. As a result, several foundation alternatives can be considered for support of the new structure, including spread footings, driven pile, and drilled shaft foundations. Spread footing foundations will be the most economical, but driven pile may be preferred, depending on the final loading conditions. Driven pile capacities can be somewhat variable and unpredictable in the gravel deposits. Drilled shafts could also be used, but some cobbles and boulders are present that can make shaft construction difficult. For preliminary design and cost estimating, driven pile foundations were used for the end abutments and intermediate bents. During final design, spread footings and driven piles will be investigated for use at the abutments and intermediate bents.

ANTICIPATED CONSTRUCTION APPROACH

ACCESS / ERECTION / REMOVAL

Construction access for removal and erection will be typical for multiple-span structures over land in Montana. No extraordinary access or erection considerations are anticipated.

Some temporary shoring may be required to protect Old Highway 10, depending on the final substructure locations. Temporary shoring may also be advantageous to limit the extent of the excavations, depending on final foundation depths. Sheetpile is the most likely method that would be used. Since the eastbound structure is over 200 feet away, shoring between these structures is not anticipated.

Crossovers will be used to place all I-90 traffic on the eastbound lanes to allow for construction of temporary works, staging, removal and replacement of the project's three bridges. If let as a single project, the sequencing of the work will greatly influence the number, length, and duration of use of the crossovers. For purposes of this report, the Clark Fork and Old Highway 10 bridges are assumed to use a single crossover layout due to their proximity to each other.

ACCELERATED BRIDGE CONSTRUCTION

As the project advances, accelerated construction approaches will be discussed with the Department. Accelerated construction elements that are likely to be studied include partial and full-depth precast concrete deck panels. Partial-depth deck panels would likely reduce the schedule by a couple weeks, eliminating deck forming requirements. Full-depth deck panels would likely reduce the schedule by approximately one month, eliminating deck forming and concrete curing requirements. While reducing the schedule could be beneficial to the project, drawbacks such as maintenance requirements, performance issues, erection challenges, and increased cost will be discussed with the Department as the project advances.

The inclusion of partial or full-depth concrete deck panels will not influence structure selection, as the schedule savings and cost increase would apply to all structure options.

The Elizabeth Lane replacement structure would see minimal benefit from accelerated construction elements, due to the traditional / typical nature of the bridge that will likely be constructed in one construction season regardless of including partial or full-depth deck panels.

STRUCTURE LAYOUT OPTIONS

This bridge alternatives analysis identifies structure types and layout options that will meet the needs of this site and comply with the Department's design criteria and preferences. Specifically, maintaining vertical clearance for Old Highway 10, construction/inspection preferences, wildlife accommodations, construction costs, construction duration, schedule, and maintenance costs were identified as important criteria for this project site.

During the preliminary site and structure examination, specialty structures were determined to provide no value and a high cost to the project and were not further considered. Due to the typical access for a dry land overpass structure at this site, weathering steel girder and prestressed concrete girder bridge types were studied in detail.

For the superstructure typical section, four girder lines were studied due to the cost-effective and efficient girder spacing and sizing for the steel girder options. To reduce the structure depth and provide an efficient superstructure, four and five girder lines were studied for the prestressed girder options. The girders will carry a cast-in-place concrete deck designed using MDT's deck design spreadsheet. All options will include two 12-ft travel lanes, 4-ft inside shoulder, 10-ft outside shoulder, and the MDT standard 36-in single slope concrete barrier on both sides.

The existing bent directly west of Old Highway 10 (Bent No. 2) will be removed and not included in structure selection options. This bent currently inhibits sight lines for westbound traffic, and it would not be preferred to exacerbate this issue. In addition, eliminating this bent could allow future straightening of Old Highway 10, with the inclusion of a retaining wall.

A preliminary construction cost estimate was completed for each of the options with the understanding that current market prices for labor and materials are extremely variable and could change significantly by the bid date of this project. Cost values include only bridge and wall items using current market prices and do not include contingencies, inflation, IDC, mobilization, roadway, CE, ICAP, traffic control, etc. Non-bridge costs are similar for all options.

As a basis for comparison, a replace-in-kind option (Option 1) was investigated to provide a planning level cost estimate with limited road work and minimal span adjustments to the existing structure. This option includes a four-span superstructure. The new structure would eliminate four intermediate bents from the existing structure and maintain the existing bridge length. The estimated construction cost of this option is $3.3 million.

For the remaining options outlined in the following sections, decreasing the bridge length by adding fill at the east abutment would increase the overall roadway and earthwork construction cost. However, replacing the existing structure with the same length bridge would result in an overall project cost being approximately $850,000 greater than the options presented below. The longer structure would also require additional long-term maintenance, which is not preferred by the Department. Therefore, the replace-in-kind option was not advanced.

The alternatives developed include the following:

- 2S. Two-span steel girder (100'-150')
- 2C. Two-span prestressed concrete girder (90'-150')
- 3S. Three-span steel girder (100'-100'-70')
- 3C. Three-span prestressed concrete girder (90'-90'-80')

CONSTRUCTION DURATION

The typical nature of this bridge replacement should allow for demolition and construction in one construction season.

MAINTENANCE OF TRAFFIC

Crossovers for traffic maintenance would be required during one construction season from spring until late fall. No crossovers are anticipated over the winter season.

LONG-TERM MAINTENANCE / INSPECTION

Maintenance and inspection will be typical for multiple-span structures over land in Montana. No special maintenance or inspections are required further than the typical MDT biannual inspections.

OPTION 2S: TWO-SPAN STEEL GIRDER (100'-150')

DESCRIPTION

Option 2S includes a two-span continuous welded steel plate girder superstructure. This option eliminates six intermediate bents from the existing structure and reduces the bridge length by approximately 195-ft.

Option 2S would require a retaining wall following the realigned Elizabeth Lane at the North side of the interstate embankment fill, as shown in the figure.

CONSTRUCTION COST

The estimated construction cost of this option is $2.3 million.

OPTION 2C: TWO-SPAN PRESTRESSED CONCRETE GIRDER (90'-150')

DESCRIPTION

Option 2C includes a two-span prestressed concrete girder superstructure. This option eliminates six intermediate bents from the existing structure and reduces the bridge length by approximately 205-ft. Beam depth and vertical clearance over Old Highway 10 were anticipated to be key design parameters. MTS-36 prestressed concrete girders would provide the required vertical clearance.

After optimizing the location of the bent between Old Highway 10 and realigned Elizabeth Lane for horizontal clearance requirements, the resulting span to the existing west abutment exceeds the maximum for the MTS-36 girders. As a result, a retaining wall on the west side of Old Highway 10 would be required to meet allowable span and provide a 2:1 abutment backslope from existing Old Highway 10.

Option 2C would require a retaining wall following the realigned Elizabeth Lane at the North side of the interstate embankment fill, as shown in the figure.

CONSTRUCTION COST

The estimated construction cost of this option is $2.4 million.

OPTION 3S: THREE-SPAN STEEL GIRDER (100'-100'-70')

DESCRIPTION

Option 3S includes a three-span continuous welded steel plate girder superstructure. This option eliminates five intermediate bents from the existing structure and reduces the bridge length by approximately 175-ft.

CONSTRUCTION COST

The estimated construction cost of this option is $2.2 million.

OPTION 3C: THREE-SPAN PRESTRESSED CONCRETE GIRDER (90'-90'-80')

DESCRIPTION

Option 3C includes a three-span prestressed concrete girder superstructure. This option would eliminate five intermediate bents from the existing structure and reduces the bridge length by approximately 185-ft. Beam depth and vertical clearance over Old Highway 10 were anticipated to be key design parameters. MTS-36 prestressed concrete girders would provide the required vertical clearance.

After optimizing the location of the bent between Old Highway 10 and realigned Elizabeth Lane for horizontal clearance requirements, the resulting span to the existing west abutment exceeds the maximum for the MTS-36 girders. As a result, a retaining wall on the west side of Old Highway 10 would be required to meet allowable span and provide a 2:1 abutment backslope from existing Old Highway 10.

CONSTRUCTION COST

The estimated construction cost of this option is $2.3 million.

SUMMARY DISCUSSION

The estimated construction costs for each option were derived from average MDT Bid Tabs and current market prices through discussions with contractors and suppliers. Cost values include only bridge and wall items using current market prices and do not include contingencies, inflation, IDC, mobilization, roadway, CE, ICAP, traffic control, etc. Non-bridge costs are similar for all options.

Option 2S. $2.3 M
Option 2C. $2.4 M
Option 3S. $2.2 M
Option 3C. $2.3 M

All options are similar in demolition, erection, construction duration, maintenance of traffic, inspection and maintenance, and skew angle. Through our structure selection analyses, all options are viable for the site constraints and materials selection. However, the following discussion highlights the major differences.

TWO-SPAN

The two-span options would require a retaining wall between the realigned Elizabeth Lane and the east abutment. This retaining wall would, at best, complicate accommodating wildlife passage. The two-span options require designing for the maximum span length available for each material (Option 2S: Span 2 and Option 2C: Span 1), which could limit design or span changes in final design.

The two-span concrete Option 2C has an incrementally higher project development risk should Span 1 increase, as any additional length would require girders that are too large for Montana suppliers. These girders would need to be coordinated and shipped from out of state suppliers, likely with none matching MDT (MTS) girder shapes.

THREE-SPAN

The three-span options are slightly lower in cost, and eliminate the need for the retaining wall between the realigned Elizabeth Lane and the east abutment, thereby also simplifying wildlife passage.

Option 3C is designed at its maximum span length due to the horizontal and vertical clearance requirements, again introducing an incrementally higher project development risk as described for Option 2C, above.

The three-span weathering steel option provides more flexibility in final design, reduces the quantity of embankment fill required at the west abutment, allows a larger setback at the west abutment, and does not overly constrain the possibility of future realignment Old Highway 10.

CONCLUSION AND RECOMMENDATION

All options are similar in demolition, erection, construction duration, maintenance of traffic, inspection and maintenance, skew angle, and cost. The final decision and recommendation for the replacement structure is at the discretion of MDT, based on preferences for weathering steel versus prestressed concrete girders, span length, and the inclusion or avoidance of retaining walls.

The three-span weathering steel option shows benefits over the three-span prestressed concrete option, as well as both two-span options. As a result of our analyses, Option 3S three-span continuous weathering steel girder structure is the recommended structure type and layout for the Old Highway 10 replacement structure.

REFERENCES

1. Morrison-Maierle. April 2, 2021. Preliminary Field Review Report.
2. Morrison-Maierle. July 9, 2021. Preliminary Traffic Report
3. HydroSolutions & WESTECH Environmental Services. December 28, 2021. Biological Resources Report.
4. HydroSolutions & WESTECH Environmental Services. February 9, 2022. Wildlife Accommodation Recommendation Memo.
5. SK Geotechnical. April 4, 2022. Preliminary Soil Survey and Materials Report.

APPENDICES

A. Bridge Design Criteria
B. Layout Sheets for Selected Option
C. Meeting Documentation
    a. Step One screening Meeting Minutes

MDT Activity 114

CLARK FORK RIVER TYPE, SIZE, AND LOCATION REPORT

Prepared for :
MONTANA DEPARTMENT OF TRANSPORTATION

I-90 STRUCTURES-W OF ALBERTON
NHPB 90-1(239)65
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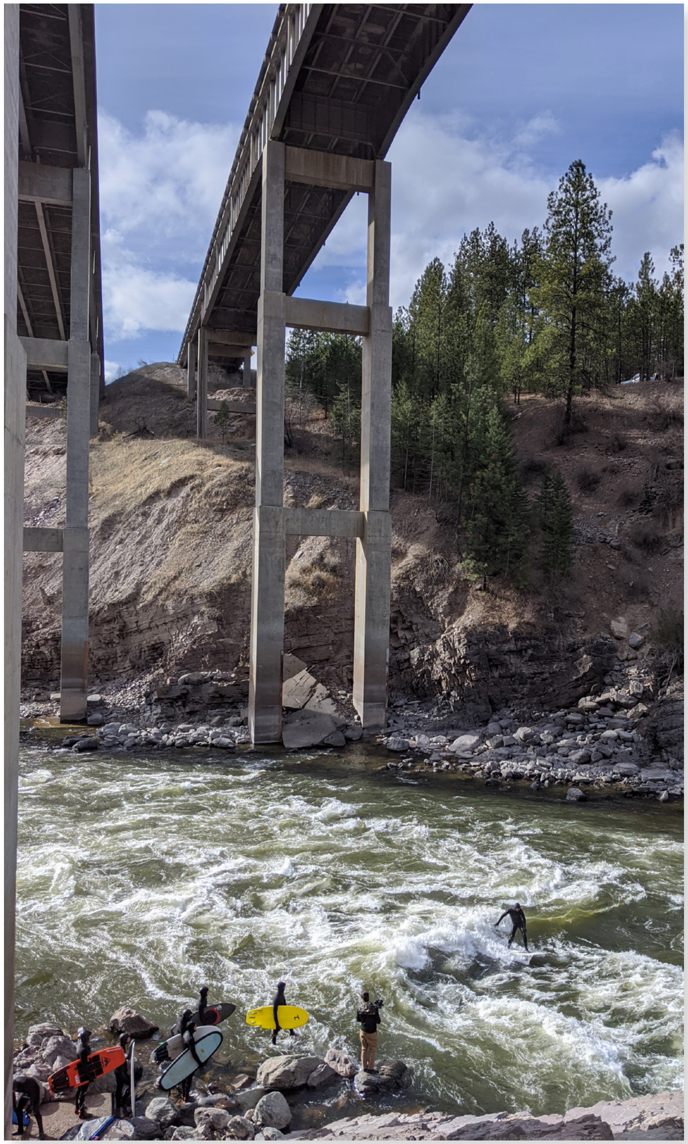

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INTRODUCTION

The proposed I-90 Structures – W of Alberton project has been nominated to remove and replace existing westbound structures on I-90 at Old Highway 10 (RP 65.5), Clark Fork River (RP 66.3), and Cyr Interchange (RP 70.1).

The purpose of the project is to address aging infrastructure and bridges in poor condition. The project structures need to be replaced with new structures that meet current bridge design standards. The objective is to improve functionality, reliability, and safety of the bridges at each of the three sites. To control construction costs, bridges that are typical for Montana with construction familiar to area contractors are preferred.

This structure selection report outlines and discusses the site characteristics, constructability, economics, long term durability, and other determining factors that impact the selection of a structure to replace the westbound I-90 structure crossing the Clark Fork River at RP 66.3.

The outcome of this report is to provide the Montana Department of Transportation with pertinent structure selection criteria and evaluations of three options to select the most appropriate structure type, size, and layout for the replacement of the Clark Fork River Bridge.

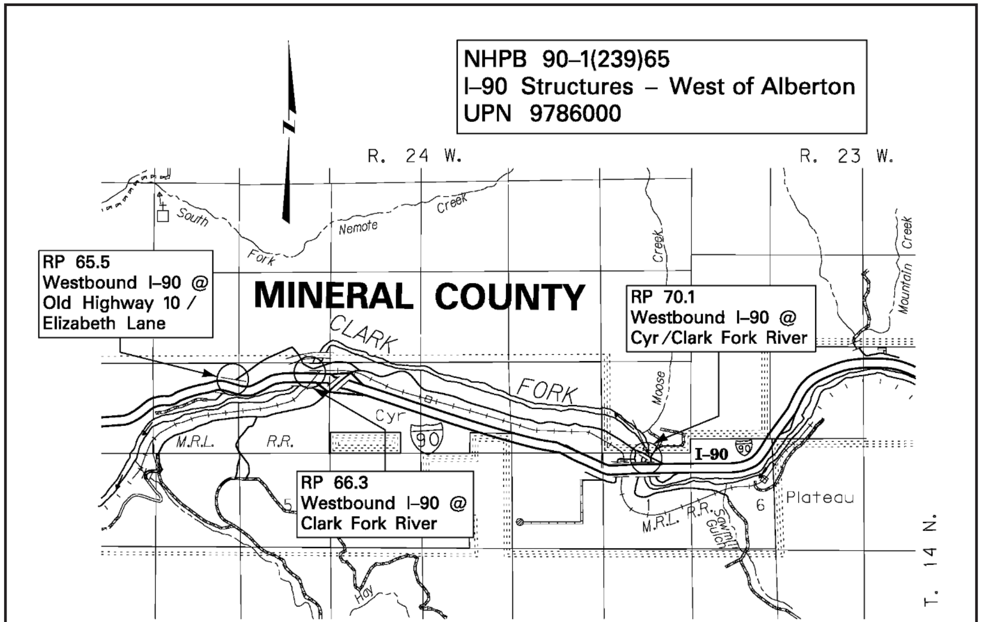


Figure 1: Project Locations Map

BACKGROUND INFORMATION

Structure #01379 (NBI Structure Number I00090066+02792); New NBI ID = 000000202101379

Figure 2: Aerial view looking south with westbound structure in foreground

The I-90 westbound 806.6-ft long, 28-ft wide (31.7' out-to-out) tangent bridge at RP 66.3 spans the Clark Fork River and was initially constructed in 1965 with Federal Aid Project No. I-90-1(21)67. The seven-span structure includes three main spans (3, 4, and 5) of fracture critical continuous welded steel plate twin girders. Spans 1 and 2 include wide-flange girders; spans 6 and 7 include welded steel plate girders.

Rehab projects in 1979, 1981, 1984, 1997, 2004, and 2012 were completed to modify the bridge end guardrail, repair expansion joints, modify the bridge rail, repair / overlay the deck, rehab the steel beams, and address fatigue in the steel beams, respectively.

An inspection report from May 2019 documented growing cracks in transverse steel girders, fracture critical details, and substandard elements. The structure was noted to be a candidate for preservation. However, due to the bridge type, existing capacities, deficiencies, and lack of meeting future needs, a repair investigation conducted by the Department determined that repair would not be feasible.

BRIDGE DESIGN CRITERIA

All design will be completed using AASHTO LRFD Bridge Design Specifications 9th Edition (2020). The current AASHTO LRFD Bridge Design Specifications including all subsequent Interim Specifications will apply throughout final design.

MDT Montana Structures Manual will be used. Dead load, wind load, or other typical loadings will be calculated in accordance with MDT's Montana Structures Manual and AASHTO's LRFD Bridge Design Specifications.

See Appendix A for full bridge design criteria.

LAND USE CONSTRAINTS

Existing I-90 right-of-way is sufficient for all permanent improvements. Construction permits and/or contractor-negotiated agreements are likely necessary to provide temporary access down to the river for demolition and removal of the existing structure, as more fully described below.

ROADWAY

The final westbound roadway width will include two 12-ft travel lanes, a 10-ft outside shoulder and a 4-ft inside shoulder, for a 38-ft face-of-barrier to face-of-barrier roadway width. The existing structure is on a horizontal tangent, with no apparent deficiencies in the mainline alignment.

The horizontal alignment was investigated at a high level to determine the viability of constructing the new bridge adjacent to the existing structure, minimizing traffic control impacts and construction timing requirements. Adjusting the horizontal alignment at the Clark Fork River Bridge would require reconstruction of the interstate ramps west of the structure, acquisition of right-of-way, and most significantly, reconstruction of the railroad bridge east of the Clark River Bridge. There is not adequate horizontal clearance between the existing eastbound and westbound structures to construct a new bridge in the median. Therefore, the replacement bridge will be placed on the existing horizontal alignment.

The longitudinal grade of I-90 on the bridge is +2.385%. The replacement bridge will be placed on the existing vertical alignment.

VERTICAL CLEARANCE

The existing bridge provides approximately 110 feet of freeboard above the base flood elevation. No considerations for future widening are needed.

UTILITIES

No utilities exist within the limits of the project. No considerations for utility accommodations on the structure are needed.

AESTHETICS

No considerations for aesthetics are needed.

PUBLIC CONSIDERATIONS

No substantive public input has been gathered to-date, but anticipated issues of concern to the public include maintaining the standing wave action underneath the existing structure, and possible negative impacts on personal recreation and commercial recreational businesses during construction.

ENVIRONMENTAL

The study area for the Clark Fork River structure includes open water of the Clark Fork River that is associated with recreational and aquatic uses. Other predominant land uses in the study areas include MDT right-of-way, undeveloped floodplain, forest land, and rangeland.

Evaluations of biological resources and probable construction impacts, e.g., temporary construction activities such as access roads, work bridges, sediment runoff, and stream dewatering, and mitigation measures that affect structure selection and layout are summarized as follows:

- The Clark Fork River is United States Department of the Interior Fish and Wildlife Service (USFWS) designated critical habitat for bull trout. Due to the proximity of construction activities to the Clark Fork River, the project "May Affect" bull trout habitat or populations.
- Potential temporary impacts to bull trout include displacement through noise and barometric pressures from bridge foundation replacement and habitat quality degradation from sediment runoff. Sheet pile and pile installation has the potential to cause barotrauma (if impact driving is used) and temporarily displace bull trout.
- Bull trout movement may be temporarily impacted by bridge demolition where the existing bridge occurs within the OHWM of the river, or by the placement of temporary work bridges within the river channel.
- Potential mitigation measures include monitoring at stream dewatering sites, recommendations for drilled shafts rather than driven pilings, and timing and noise restrictions if impact driving is to be used.

Through early coordination, the USFWS provided comments that influence structure selection. Highlights include:

- Impact pile driving may occur between July 15 and August 31. This includes dry land and in-water impact pile driving and is intended to reduce the risk of barotraumas for bull trout.
- Instream removal of bridge piers should occur during low water, i.e., July 15 through October 15.
- Keep in-water work within the river channel to the minimum amount necessary.
- Span channel such that piers are located outside the ordinary high-water mark to the extent practicable.

See Appendix C of the Biological Resources Report (Reference 4) for the July 1, 2021, response from USFWS regarding the proposed project.

HYDRAULICS

This bridge crosses the Clark Fork River within the Alberton Gorge, which was formed by the periodic Glacial Lake Missoula floods. The Alberton Gorge was cut down through glacial sediments into the underlying bedrock. The canyon is approximately 120 feet deep at the crossing location with steep canyon walls.

The interstate bridge crosses the Alberton Gorge at an elevation slightly above the top of the canyon walls. Design of the new bridge girder depth is not constrained by hydraulic design capacity requirements.

The Clark Fork River within the Alberton Gorge has a relatively steep slope (0.4%), and relatively large flood flows (Q100 ≈70,000 cfs). Maximum flow velocity of 14 to 20 feet per second at the scour design event is anticipated. Typically, flow velocities in this range would result in relatively deep scour for bridge piers. However, the reach crossed by the bridge is composed of a bedrock channel that is very resistant to scour. A bridge foundation design anchored directly to the bedrock will be very resistant to scour forces. Scour concerns are not anticipated to be a key foundation design parameter.

This segment of the Clark Fork River is currently mapped as Zone A floodplain (FHBM 300150019B). Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown on the current map. However, a floodplain study update for Mineral County is in progress and the floodplain mapping will be updated to a Zone AE with regulatory flood elevations. The update is anticipated to be effective at the time of construction, requiring a floodplain permit for the project. Initial one-dimensional modeling indicates an insignificant rise in water surface elevations for Option A described herein. The other two options place new bents well outside the floodplain limits. For all options, floodplain permit acquisition is not anticipated to be a key bridge design parameter.

The bridge deck typical section will include a 4-foot inside shoulder and a 10-foot outside shoulder. With the bridge profile slope of +2.385%, the outside shoulder has sufficient width to contain deck drainage spread width for the full bridge length. However, runoff spread width will exceed the 4-foot inside shoulder at a drainage length of 180 feet. The river channel width between ordinary highwater marks (OHWM) is greater at approximately 230 feet.

A full-length, longitudinal deck drainage system for the inside shoulder with piped discharge outside the OHWM is not recommended since these systems are prone to sediment plugging and freezing failures. Alternatively, a drainage system composed of deck drains connected to short lengths of pipe, in combination with scuppers in the bridge deck may be feasible. This system would direct deck runoff outside the OHWM for most events while providing a secondary drainage route less prone to failure to ensure runoff spread width does not encroach into the traveled lane. Project permitting and agency coordination will be needed to address the drainage approach.

GEOTECHNICAL

GENERAL SITE CONDITIONS AND GEOLOGY

As noted above, the Clark Fork River has cut downward through Pleistocene-age glacial sediments into the underlying bedrock consisting of very hard Precambrian-age quartzite and argillite. The overlying sediments are primarily glacial flood deposits consisting of clayey and silty gravel with boulders with high SPT blow counts indicating dense to very dense consistency. A distinct layer of soft clayey silt approximately 15-ft thick, of glacial lake origin, appears in the borings on the east side slope. More in-depth information on site geology, subsurface stratigraphy, and soil and rock properties is presented in the Activity 106 Report by SK Geotechnical (2022) and the Site Reconnaissance Report by Dan Brown and Associates (2021).

SEISMIC

The bridge seismic performance criteria is Zone 2. Liquefaction potential is low to nonexistent, considering the mostly dense and coarse-grained soil deposits and the groundwater level believed to be at or near river elevation.

FEASIBLE FOUNDATIONS

Three foundation types are anticipated for the structure layouts under consideration: driven piles, drilled shafts, and spread footings. The overall feasibility of each in the bridge layouts currently under consideration are discussed as follows. Potential use is discussed more fully in the discussion of each individual layout option later in this report.

DRIVEN PILES

For all three options, driven piles are the most practical and cost-effective foundation type for supporting the bridge abutments. We anticipate that steel H-piles driven to maximum depths of 40 to 50 feet in the dense glacial flood deposits can provide the axial and lateral support required to meet the loading demands. The number of piles and driving criteria will be established once the type selection process is completed and abutment loads have been calculated.

DRILLED SHAFTS

Drilled shaft foundations are under consideration for the 3-span bridge option with two interior piers located just upslope of the existing main piers. Each pier substructure consists of a 2-column bent, with each column supported on a single drilled shaft. Using preliminary estimates of factored loads for Strength I and Strength V limit states, 8-ft diameter drilled shafts extending 20 to 24 feet into rock would provide sufficient geotechnical and structural resistances to support each column.

SPREAD FOOTINGS

Spread footings are the preferred foundation for the main piers of Options A (5-span) and C (3 span). Preliminary analysis under the estimated Strength I and Strength V loads indicate that each two- column pier for both Options A and C would require a footing with a 20-ft plan dimension in the bridge longitudinal direction and 42 feet in the transverse direction.

ANTICIPATED CONSTRUCTION APPROACH

MAINTENANCE OF TRAFFIC/ PROJECT PHASING

INTERSTATE 90

Crossovers will be used to place all I-90 traffic on the eastbound lanes to allow for construction of temporary work bridges, staging, removal and replacement of the project's three bridges. If let as a single project, the sequencing of the work will greatly influence the number, length, and duration of use of the crossovers. For purposes of this report, the Clark Fork and Old Highway 10 bridges are assumed to use a single crossover layout due to their proximity to each other.

Construction and use of the crossovers is expected during the initial phases of construction activity. Wide load staging is likely during use of the crossovers. During operation of the crossovers, closure of Crystal Springs (Exit 65) westbound on- and off-ramps during construction of the Clark Fork bridge would be preferred due to the proximity of the construction work zone to both the off-ramp gore and the eastbound inside guardrail. However, area access needs require providing temporary on- and off-ramps (see additional discussion below).

OLD HIGHWAY 10 / LOCAL ROADS

Access to Old Highway 10 east of the Clark Fork River bridge would still be available at Fish Creek Road (Exit 66) during times of use of the crossover. However, west of the Clark Fork River bridge access to Old Highway 10 / Elizabeth Lane / local roads north of I-90 would be eliminated with the closure of the Crystal Springs (Exit 65) westbound ramps.

Initial evaluation of temporary on- and off-ramps at Exit 65 indicates a solution that while less than ideal, particularly during adverse weather conditions, is functional for this low-volume interchange. Additional measures to maintain work zone safety, such as concrete barrier rail between eastbound and westbound traffic on the west approach and across the eastbound bridge, could be considered during crossover operation.

Individual and commercial recreational uses of the Clark Fork River within the project limits are likely to be unavoidably negatively impacted during project construction.

Figure 3 – Probable Construction Access Routes

CONSTRUCTION / EQUIPMENT ACCESS

Through site investigation and survey, it appears the existing structure was constructed by access roads located on both sides of the river. The remnant southwest access roads are blocked by the eastbound structure piers and would likely not provide viable access. The remnant northwest access road / overhead power utility corridor appears to be partially located on private property and would require a construction permit or coordination between the contactor, the landowner, and Missoula Electric Co-op to be used for this project. If access was provided down the interstate R/W a construction permit would not be required but would increase the earthwork on the project.

The access on the east bank, while steeper than typical, seems to provide reasonable access to the upland bents, and potential access to construct a work bridge or other temporary structures.

Based on initial evaluation, the preferred access would be from the northeast and northwest banks with partial length work bridges constructed from each bank, as shown on Figures 4 & 5. Neither of the two temporary construction access roads are currently suitable for heavy equipment access without modification. Construction of partial length work bridges on each side of the river could provide access to the structure depending on equipment size and capacities.

TEMPORARY WORK BRIDGES

Work bridges would be very tall and challenging. It is expected that the east work bridge spur would require specialized drilled piling. Spurs and/or short work bridges to access the new bents would also be anticipated.

The east bank of the Clark Fork Bridge can be accessed from a northeastern parking lot shown in Figure 4. A footpath currently used by river recreationists to access the standing wave in the river connects the parking lot to the existing structure, crossing underneath between Pier #5 and #6. This footpath can be widened to 30 feet with tree felling and earthwork that would give heavy equipment access to the bridge. Beyond this location, the footpath continues along a significantly steep portion of the hill and is infeasible for use of heavy construction equipment. Usage would likely be closed to recreationists, being restricted to workers on foot and potentially small equipment.

Figure 4 - East Bank Construction Access Layout

A temporary construction trestle is required to be built at this east bank location to provide a level platform for construction equipment. However, the length of the platform is limited based on the terrain to the west of the access path being extremely steep and covered with rock formations. These conditions would be difficult and costly for the construction of temporary foundations beyond what is shown in Figure 4.

To support this limitation during construction and erection, it is recommended that the west bank trestle be extended as far as reasonable to provide additional access (see Figure 5).

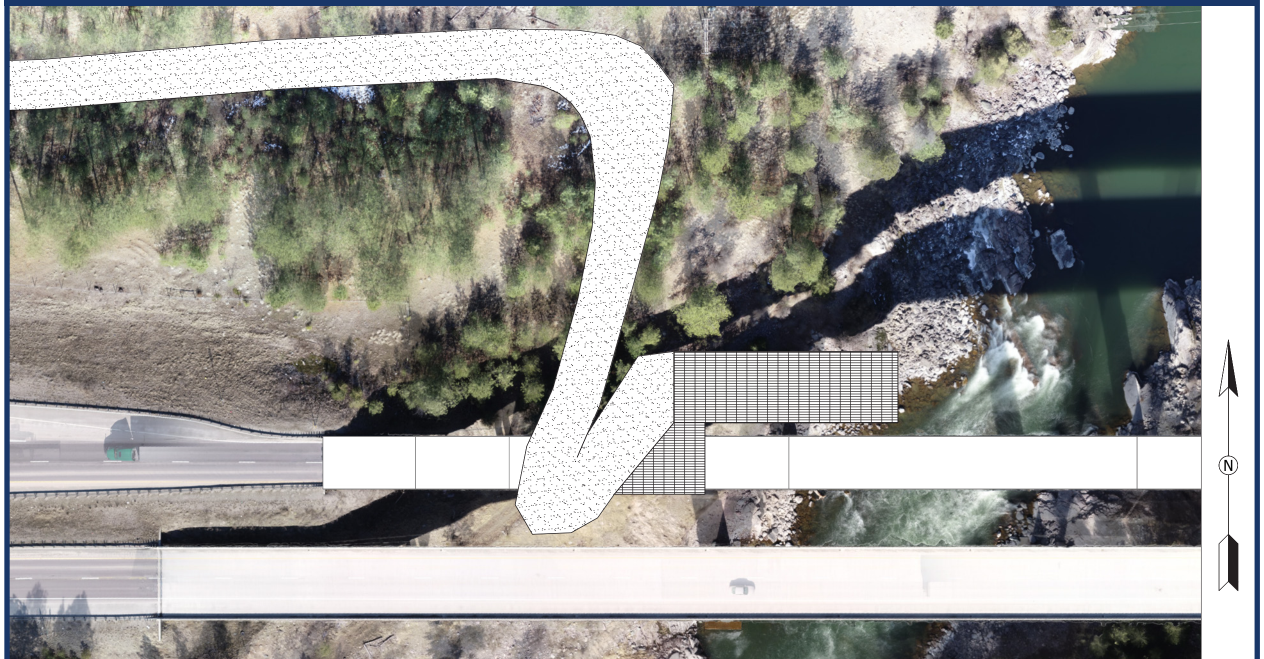


Figure 5 - West Bank Construction Access Layout

DEMOLITION OF EXISTING STRUCTURE

SUPERSTRUCTURE

For the purposes of this report, methods in removing the existing superstructure have been evaluated for the validity of concept. Actual methodology will be the responsibility of the contractor in selection of equipment and its placement. Because the lateral bracing on the existing bridge was removed during a previous rehabilitation project, girder stability may require installing lateral bracing for the purposes of demolition.

Demolition will begin with the center span. Due to the difficulty in reaching the middle span from below, the removal of the main span will likely occur primarily from on top of the bridge. Using relatively small 20-ton to 30-ton equipment, a 40-ft segment of concrete deck, bridge railing and steel diaphragms could be removed and trucked off. Both girders would be severed at mid-span and allowed to cantilever, the exposed girders then cut to the edge of the remaining deck and trucked off. This process is repeated until the full main span has been removed.

The adjacent spans can be removed in a more traditional method. The concrete deck and railing will likely be removed from the top of the bridge and the steel girders lifted using large cranes from the work bridges below.

SUBSTRUCTURE

Elements of the substructure can be accessed from the construction access roads and temporary work bridges described above. The two river piers, being the most difficult to access, are expected to be sawcut into small sections and removed in their entirety by cranes from the temporary work bridges.

The other substructure elements have much more flexibility on techniques used for demolition and will likely come to contractor preference. The sawcut and dismantling method is an option that could be used. Explosive blasting or hydraulic breaking and hammering are other methods that could be utilized, subject to possible environmental restrictions, primarily related to bull trout.

The sequencing of the substructure removal is based on the layout option selected. Options B and C allow for delay of full substructure demolition until after traffic resumes on the new bridge structure.

ERECTION

For the purposes of this report, methods in erecting the new superstructure have been evaluated for the validity of concept. Actual methodology will be the responsibility of the contractor in selection of sequencing, equipment and its placement. The intermediate piers require a temporary work bridge or a work bridge spur to allow heavy construction equipment direct access to the location. This is required for reaching limitations on some of the specialty equipment required, such as shaft drilling rigs, concrete pump trucks, etc.

After the substructure elements are fully constructed, a temporary shoring tower is expected to support the approach spans at bolted splice locations. Both shoring tower locations are within reach of the construction access roads and can be completed with standard construction methods.

The approach span sections would be installed first, sitting on the abutment bearings and shoring towers. This is followed by the pier section that will sit on the shoring tower and cantilever past the pier. This bolted splice would be completed, and all required lateral bracing and diaphragms installed.

While the center main span will be designed to minimize segment weights and lengths for transport and erection, larger cranes (200- ton to 250-ton) will be required for single-pick girder sections and completing a midair bolted splice. Lateral bracing and diaphragms would then be installed.

After the girders, diaphragms and lateral bracing are installed, the concrete decking and bridge railing can be installed with standard construction methods.

ACCELERATED BRIDGE CONSTRUCTION

For purposes of this report, accelerated construction techniques have not been incorporated into the evaluations. However, as the project advances, accelerated construction techniques will be discussed with the Department. Elements that are likely to be studied include partial and full-depth precast concrete deck panels. Partial-depth deck panels would likely reduce the schedule by a couple weeks, eliminating deck forming and form removal requirements. Full-depth deck panels would likely reduce the schedule by approximately one month, eliminating deck forming and concrete curing requirements. While reducing the schedule could be beneficial to the project, drawbacks such as maintenance requirements, performance issues, erection challenges, and increased cost will be discussed with the Department as the project advances.

The inclusion of partial or full-depth concrete deck panels will not influence structure selection, as the schedule savings and cost increase would apply to all structure options.

STRUCTURE LAYOUT OPTIONS

The purpose of this bridge alternatives analysis is to identify structure types and layout options that will meet the needs of this bridge site and comply with the Department's design criteria and preferences. Specifically, constructability, erection, construction costs, construction duration, recreational access, schedule, environmental impacts, traffic impacts, and maintenance costs were identified as important criteria for this project site.

The main challenges at the bridge site are the depth of the canyon, height of the piers, and extremely difficult construction access. Specialty bridges that could locate substructure elements significantly upland of the existing piers would be ideal for this layout. However, removal of the existing structure will still require access to the river to remove the existing superstructure and existing river piers. These specialty structures would be much more costly to design and construct, and without the savings of lesser construction access or temporary works, did not show favorably for overall construction cost. The bridge types that were recognized as potential options but ultimately not advanced in the selection process include: deck arch, steel deck truss, and network tied arch.

Four primary bridge types investigated in detail include welded steel plate girder, prestressed concrete girder, cast-in-place segmentally erected box girder, and spliced post-tensioned concrete girder. Due to construction challenges to remove the existing structure and foundations requiring near access to the existing foundations regardless of new structure type, prestressed concrete girder, cast-in-place segmentally erected concrete structures, and spliced post-tensioned concrete girder structures were preliminarily analyzed but not advanced to further consideration. Erection weight and potential construction approaches were important factors in eliminating concrete bridge type options from further consideration. These conceptual findings were presented to MDT at an initial screening meeting. Meeting materials and documentation of decisions and preferences are located in Appendix C.

With continuous welded steel plate girders as the most promising option to replace the structure over the Clark Fork River, several span arrangements were developed and analyzed for the criteria listed above. The span lengths were selected to optimize constructability, foundation requirements, and overall cost. Both parallel flange and parabolic haunched girders were investigated for cost and constructability. While parallel flange girders could allow for specialized construction techniques such as longitudinal launching, the parabolic haunched girders were preferred to reduce the weight of the mid-span sections which reduces the equipment size required for erection of the girders spanning across the Clark Fork River. Additionally, the parabolic haunched girders showed overall girder cost savings of about 5% to 10%.

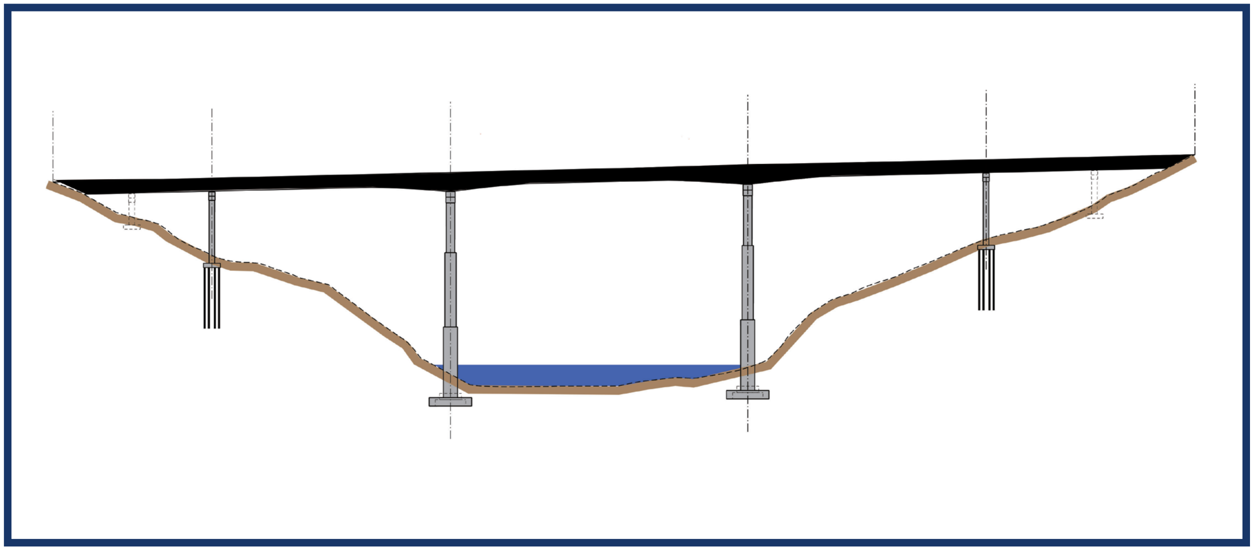
For the superstructure typical section, four girder lines were studied due to the cost-effective and efficient girder spacing and sizing. The girders will carry a cast-in-place concrete deck designed using MDT's deck design spreadsheet. All options will include two 12-ft travel lanes, 4-ft inside shoulder, 10-ft outside shoulder, and the MDT standard single slope concrete barrier on both sides.

A preliminary construction cost estimate was completed for each of the options with the understanding that current market prices for labor and materials are extremely variable and could change significantly by the bid date of this project. Cost values include only bridge items, access, temporary works, and removal using current market prices and do not include contingencies, inflation, IDC, mobilization, roadway, CE, ICAP, traffic control, etc. Non-bridge costs are similar for all options.

OPTION A: FIVE SPANS (120'-160'-210'-180'-130')

DESCRIPTION

Option A includes a five-span continuous welded weathering steel plate girder superstructure with a parabolic haunch in the web at the two river piers. This option locates two river piers in the same locations as the existing structure matching the main span length, with two upland piers.



CONSTRUCTION COST

The estimated construction cost of this option is $13.5 million.

CONSTRUCTABILITY

This option would require very tall 150-ft piers located within the waterway and additional projection of piers into the waterway due to the river skew. Two additional 60-foot-tall piers are required compared to the three span options.

FOUNDATIONS

This option has four intermediate piers and driven pile founded abutments located near the existing abutments. The center piers are located at approximately the location of the existing piers and the footings would bear directly on rock, at or close to the river level. The bedrock can provide high bearing resistance with negligible settlement.

The two upland piers inbound from the abutments would also be founded on pile-supported footings. Depth to top-of-bedrock on the east side would be approximately 30 feet below the base of the footing, allowing piles driven to refusal on rock.

On the west side top-of-rock could be 60+ feet below bottom-of-footing. Driven H-piles or pipe piles both are feasible for providing sufficient resistance with tip elevations in the dense glacial deposits overlying the bedrock, or driven to rock if required by loading demands.

ERECTION

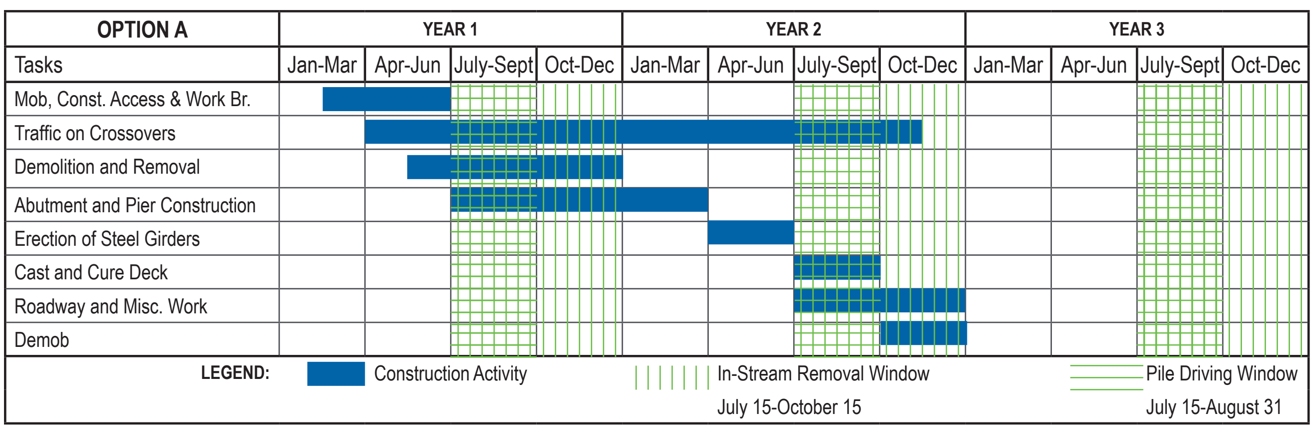
This five-span layout has shorter, lighter girder segments that could allow more flexibility in equipment sizing and access to the work.

CONSTRUCTION DURATION

Locating piers at the existing pier locations would require in-stream demolition and construction, likely requiring two seasons to complete construction due to environmental timing restrictions. Sequencing of this layout option would be largely dependent on the environmental in-stream work / removal requirements.

New abutments would be constructed following existing abutment removal. Removal of the river piers would take place during the in-stream removal window in the fall. Next, the river piers would be constructed using cofferdams to dewater the new footing locations. Construction of the river piers and remaining bents likely could be completed during the winter months with superstructure erection and deck casting taking place the following year.

The overall construction duration would be approximately 21 months.



MAINTENANCE OF TRAFFIC

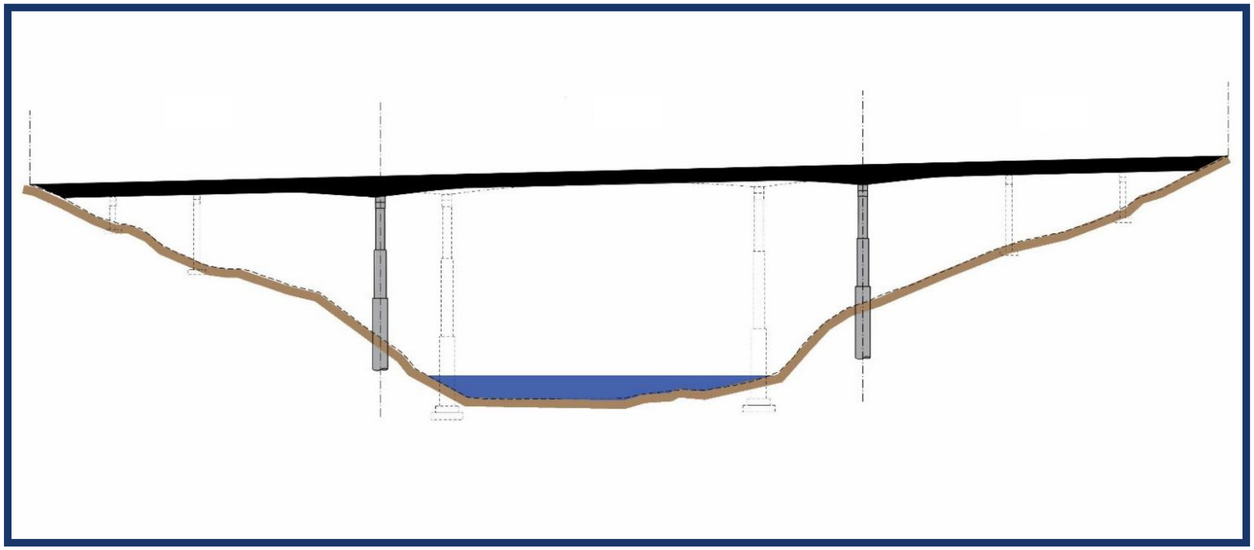
Crossovers for traffic maintenance would be required for at least one winter season. One anticipated approach for sequencing around environmental removal restrictions includes mobilization and construction of the work bridges in the spring. Crossovers would then be implemented on April 15, and demolition of the deck, girders, and existing abutments and intermediate bents would commence during the spring and summer, followed by construction of new piers and bents through the winter while traffic is on crossovers.

Winter use of crossovers is not preferred on the interstate system for a number of reasons, including hazardous operations during snow plowing, possible full shutdown of all traffic as a result of a crash within the limits of crossover with no practical detour options, increased odds of head-on crashes on bridge deck due to snow and ice conditions, etc.

LONG-TERM MAINTENANCE / INSPECTION

Maintenance and inspection will be typical for multiple-span structures over waterways in Montana. This option would require periodic underwater pier / foundation inspection.

OPTION B: THREE SPANS (225'-330'-245')



DESCRIPTION

Option B includes a three-span continuous welded weathering steel plate girder superstructure with a parabolic haunch in the web at the two piers. This option locates the main span bents approximately 60-ft upland from the existing river piers.

CONSTRUCTION COST

The estimated construction cost of this option is $13.3 million.

CONSTRUCTABILITY

This option would reduce the required height of the piers to approximately 90-ft and eliminate two additional piers compared to Option A. These piers would be in a more accessible position for drilled shaft equipment and construction could be scheduled to construct the piers prior to demolition and removal of the existing structure.

FOUNDATIONS

Option B would include driven pile founded abutments located near the existing abutments. The two-column upland intermediate bents would be founded on drilled shafts located as close as practical to the steep rocky slope.

The main construction challenge for drilled shafts is access. It is anticipated that a contractor would install the drilled shafts from a work bridge installed on each side of the river. It is also conceivable that the successful contractor could install the drilled shafts from the ground if an acceptable plan to move equipment to the required locations could be devised. If Option B is advanced, analyses will be performed to assess the stability of the rock mass between the drilled shafts and the face of the slope.

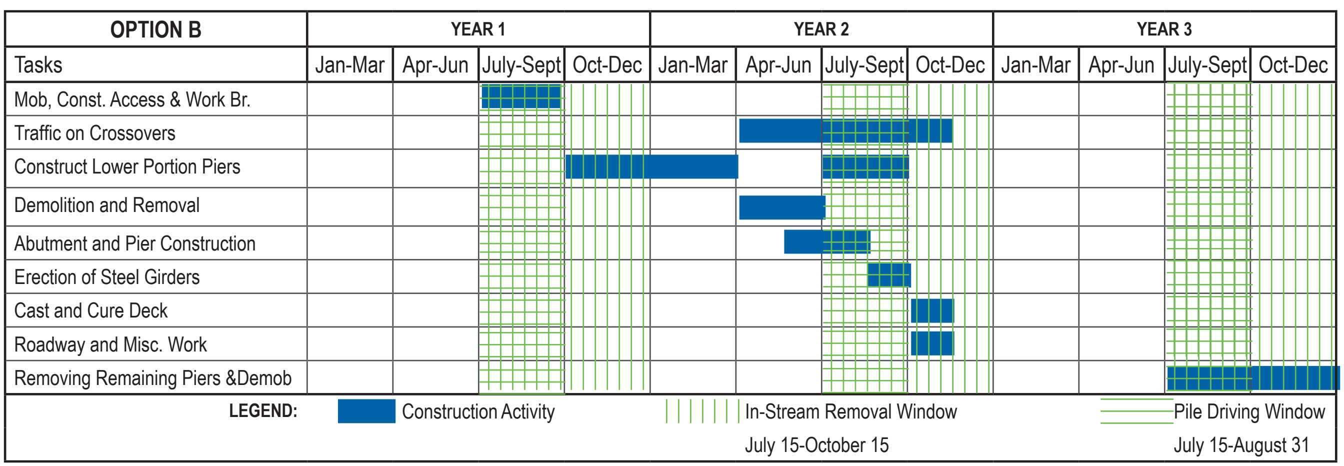
ERECTION

Larger erection equipment may be required to place the longer and heavier steel girders. Preliminary design shows the girders to be approximately 2.1 million pounds, or about 30% heavier than the five-span option A, with lateral bracing likely required along the main span segments. Although Option B contains taller and heavier girders than option A, the spans could be split into 3 girder segments, reducing the pick weight for each segment.

CONSTRUCTION DURATION

One anticipated approach for sequencing around environmental restrictions includes construction of the work bridges, drilled shafts, and partial columns (likely excluding the cap) prior to disrupting traffic. New abutments and bent caps could be constructed as soon as the removal of existing superstructure and abutments is completed. Girder erection, deck forming and casting, and final roadway work would likely take place in the fall. The remaining demolition and removal would likely be completed the following fall, adhering to the in-stream removal requirements for the river piers.

The overall construction duration would be approximately 30 months.



MAINTENANCE OF TRAFFIC

Sequencing of this layout option could provide for reduced disruption to traffic, due to the main piers located upland where there is headroom to construct prior to traffic interruptions. Crossovers would be implemented on April 15, and construction proceeding as described above, allowing for the crossovers to be removed and transition traffic to the new bridge before winter.

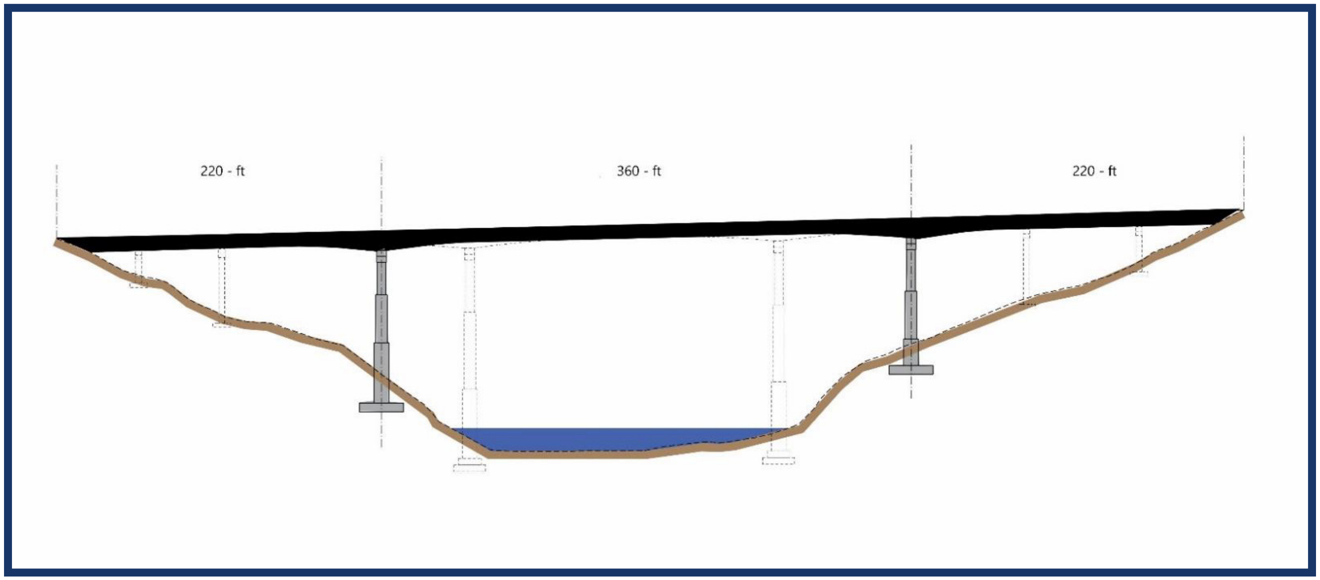
While the overall construction duration is lengthened compared to option A, traffic would not be on the crossovers during winter months.

LONG-TERM MAINTENANCE / INSPECTION

Maintenance and inspection will be typical for multiple-span structures over waterways in Montana. No special maintenance or inspections are required further than the typical MDT biannual inspections. The upland piers would not require scour inspections as they are well above the 100-year water surface elevation.

OPTION C: THREE SPANS (210'-360'-230')

Option C includes a three-span continuous welded weathering steel plate girder superstructure with a parabolic haunch in the web at the two bents. This option locates the main span bents approximately 75-ft upland from the existing river piers.



CONSTRUCTION COST

The estimated construction cost of this option is $14.0 million.

CONSTRUCTABILITY

This option would reduce the required height of the piers to approximately 90-ft and eliminate two additional piers compared to Option A. These piers would be located in a more accessible position for constructing spread footings and construction could be scheduled to construct the piers prior to demolition and removal of the existing structure. Option C would allow for spread footings that could reduce equipment size required along the steep slopes. However, spread footing construction, especially on the west bank, would require a significant 30-40 foot cut, difficult removal of approximately 1,500 cubic yards of material, significant shoring, and replacement of material following footing construction.

Construction of the footings on rock for Option C will require excavations into the steep side slopes. The resulting over-steepened slopes will require temporary support of excavation, to be designed by the contractor subject to review and approval.

FOUNDATIONS

Option C would include driven pile founded abutments located near the existing abutments. The two-column upland intermediate bents would be founded on spread footings located above the steep rocky slope approximately 75 feet upslope of the existing river piers. On both sides of the river, this will require excavation into the steep side slopes down to rock for construction of the footings, along with temporary support of excavation.

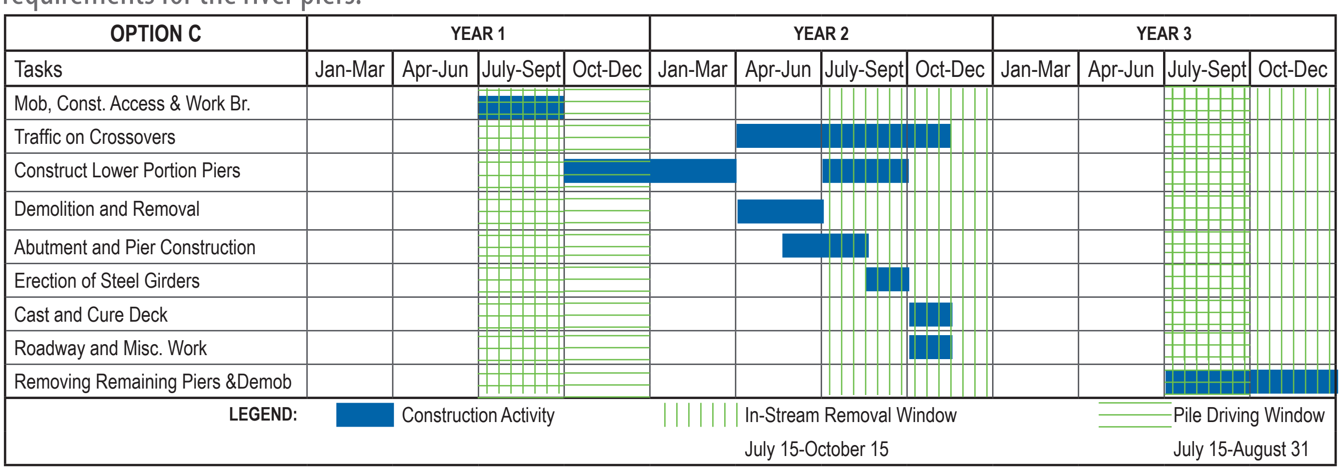
On the west side, one edge of the footing will be close to the near-vertical rock face which extends downward to the river channel. If Option C is advanced, analyses will be performed to assess the stability of the rock mass beneath the footings, including the steep slope immediately underlying the edge of each footing. If it is determined that there is a risk of slope instability, mitigation measures will be considered, e.g., rock bolting or installation of anchors.

ERECTION

This option would require additional design requirements and further challenge steel girder erection. Larger erection equipment may be required to place the longer and heavier steel girders. Preliminary design shows the girders to be approximately 2.4 million pounds with lateral bracing likely required along the main span segments. Although Option C contains taller and heavier girders than option A, the spans could be split into 3 girder segments, reducing the pick weight for each segment.

CONSTRUCTION DURATION

One anticipated approach for sequencing around environmental restrictions includes construction of the work bridges, spread footings, and partial columns (likely excluding the cap) prior to disrupting traffic. Demolition of the deck, girders, abutments, and upper portions of the intermediate bents would commence during the spring and summer. New abutments and bent caps could be constructed as soon as the removal of existing superstructure and abutments is completed. Girder erection, deck forming and casting, and final roadway work would likely take place in the fall. The remaining demolition and removal would likely be completed the following fall, adhering to the in-stream removal requirements for the river piers.



The overall construction duration would be approximately 30 months.

MAINTENANCE OF TRAFFIC

Sequencing of this layout option could provide for reduced disruption to traffic, due to the main piers located upland where there is headroom to construct prior to traffic disruptions. Crossovers would be implemented on April 15, and construction proceeding as described above, allowing for the crossovers to be removed and transition traffic to the new bridge before winter.

While the overall construction is lengthened compared to option A, traffic would not be on the crossovers during winter months.

LONG-TERM MAINTENANCE / INSPECTION

Maintenance and inspection will be typical for multiple-span structures over waterways in Montana. No special maintenance or inspections are required further than the typical MDT biannual inspections. The upland piers would not require scour inspections as they are well above the 100-year water surface elevation.

SUMMARY DISCUSSION

The following discussion compares the three options within each selection criteria:

CONSTRUCTION COST

The estimated construction costs for each option were derived from average MDT Bid Tabs and current market prices through discussions with contractors and suppliers. Cost values include only bridge quantities using current market prices and do not include contingencies or inflation.

Option A. $13.5 M
Option B. $13.3 M
Option C. $14.0 M

CONSTRUCTABILITY

All options require construction access down to / within the river for demolition and removal of the existing structure.

Option A would require new construction within the Clark Fork River OHWM. Construction of new spread footings would likely require the use of cofferdams and dewatering. Contractors' lack of familiarity with constructing and working with cofferdams may represent an additional project risk. Additionally, blasting may be required to reach new footing elevation and footprint.

Options B and C eliminate in-stream construction and provide easier access for new construction along the upland slopes.

FOUNDATIONS

Table 2 below summarizes the foundations considered most feasible for each of the bridge layout options under consideration.

TABLE 2. Summary of Foundations for Bridge Options

Bridge Layout Option	Abutments	Center Piers (River Span)	Intermediate Piers
A. 5-Span, Welded Steel Plate Girders	Driven pile group	Spread footings on rock; bearing at river level	Pile-supported footings
B. 3-Span, Welded Steel Plate Girders	Driven pile group	Drilled shafts in rock, ≈ 60 feet upslope of existing main piers	N/A
C. 3-Span, Welded Steel Plate Girders	Driven pile group	Spread footings on rock, ≈ 75 feet upslope of existing main piers	N/A

Each of the foundation types under consideration poses some challenges and risk related to construction. Table 3 below summarizes the challenges and level of risk as perceived at the present time.

TABLE 3. Summary of Challenges and Risk, Foundations.

Foundation Type	Known or Potential Challenges	Level of Risk
Driven Piles	Driving obstructions in the form of cobbles and boulders	Low to moderate
Spread footings on rock	Ability to excavate a uniform bearing surface	Low to moderate
	Ability to effectively dewater	Moderate
Rock-Socketed Drilled Shafts	Drilling from work bridge	Moderate to high
	Excavation of large diameter holes in hard rock	Moderate
	Equipment access if no work bridge	Moderate

Lack of sufficient subsurface information in the form of too few borings poses a risk for all bridge projects. At least one boring at each foundation location is recommended once the layout has been selected. This recommendation admittedly poses a challenge at the Clark Fork Bridge site, considering the steep terrain and difficult access for drill rigs. However, any challenges or costs associated with additional borings are far outweighed by the risk management benefits of having adequate knowledge of the ground conditions prior to final design and construction of the foundations. Seismic refraction survey work is also recommended to better evaluate the depth and slope of bedrock, particularly for alternatives utilizing spread footing foundations.

TEMPORARY WORKS CONSIDERATIONS

Significant temporary structures will be required for all options. Option B incorporates large diameter drilled shafts for support of the main river span. The contractor may elect to erect a temporary work bridge from which the drilled shafts (as well as other bridge demolition and bridge erection elements) would be installed. Review of the contractor's design and installation plan for all proposed temporary work bridges and foundations would be required.

Option C will require significant temporary support of excavation (shoring) to facilitate construction of footings on the steep side slopes. We anticipate the temporary shoring will be contractor-designed with review of the design and work plan.

ERECTION

Option A includes five spans that could be erected with cranes located near the abutments, on the existing backspans, or on temporary work bridges.

Options B and C would be constructed similar to Option A, although Options B and C contain taller and heavier girders. The spans could be split into 3 girder segments, reducing the pick weight for each segment.

CONSTRUCTION DURATION

Option A would follow a typical construction sequence of temporary works, removal, and construction, which would likely take place over two years.

To avoid use of crossovers during winter months, Options B and C may have longer construction durations. This could add another construction season, with disruption to recreational uses, in order to remain in compliance with environmental restriction windows for completing removal of the existing structure.

TRAFFIC IMPACTS

Removal and construction of Option A would take place over two years, with crossovers required full time during construction, i.e., crossovers would be in use during winter.

Removal and construction of Options B and C would take place over three years, with crossovers required for one construction season, without use during winter.

MAINTENANCE / INSPECTION

Maintenance and inspection will be typical for multiple-span structures over waterways in Montana.

Option A would require regular inspection and maintenance of two additional intermediate bents, as well as underwater / scour inspection of the two main river piers.

Options B and C would eliminate underwater inspection and reduce the number of substructure elements to inspect and maintain.

PERFORMANCE MATRIX

Because the three layout options have nearly equal preliminary construction cost estimates, an evaluation of the expected performance of the three bridge options based on the following criteria is proposed to guide the option selection:

- Constructability / Temporary Works (Ease of Access; Safety of Construction)
- Maintenance of Traffic (Duration of Impacts to I-90 Traffic; Local Roads)
- Construction Duration; Recreational Access (Temporary Disruption)
- Environmental Impacts (Construction Impacts; Wildlife Accommodations)
- Future Inspections and Maintenance (Expected Durability; Extraordinary On-Going Efforts)
- Project Development / Risk (Level of Uncertainties; Cost Escalation Risk)

These six criteria were initially assigned weights based on perceived value to the Department and the affected public. Each performance criterium was assigned a numerical value to quantify an overall performance score. The performance score was then divided by the estimated construction cost for each option in order to provide a best-value ranking of the three options.

FINAL

Performance Criteria		Constructability / Temporary Works	Maintenance of Traffic	Construction Duration / Recreational Access	Environmental Impacts	Future Inspections and Maintenance	Project Development / Risk	Total Performance Score	Construction Cost ($M)	Best Value (Performance/Cost)
		Assigned Weights								
Weight		30	15	10	20	10	15	100		
Option A	5									
	4									
	3									
	2									
	1									
Subtotal:		60	30	40	60	30	45	265	13.5	19.6
Option B	5									
	4									
	3									
	2									
	1									
Subtotal:		90	60	30	80	40	45	345	13.3	25.9
Option C	5									
	4									
	3									
	2									
	1									
Subtotal:		60	60	30	80	40	30	300	14.0	21.4

This type of evaluation is completed early in the project development stage to provide broad support for selection of a single option to advance to Alignment and Grade Review. In this case, the measure of value was calculated as the ratio of performance over the estimated cost. The best-value is provided by greater performance, while still accounting for cost.

The preliminary findings of the design team indicate Option B is the best-value option considering the draft weighted performance criteria and the assigned numerical importance.

CONCLUSION AND RECOMMENDATION

As a result of our analyses, Option B is the recommended structure type and layout for the Clark Fork Bridge. Option B shows significant benefits to traffic maintenance, as well as fewer substructure elements, shorter piers, and elimination of underwater inspection and maintenance, compared to Option A. Compared to Option C, Option B reduces the center span length and weight, provides benefits to constructability and erection, as well as best overall performance.

REFERENCES

1. Dan Brown and Associates. January 27, 2021. Technical Memo No. 1; Geotechnical Site Reconnaissance.
2. Morrison-Maierle. April 2, 2021. Preliminary Field Review Report.
3. Morrison-Maierle. July 9, 2021. Preliminary Traffic Report
4. HydroSolutions & WESTECH Environmental Services. December 28, 2021. Biological Resources Report.
5. HydroSolutions & WESTECH Environmental Services. February 9, 2022. Wildlife Accommodation Recommendation Memo.
6. SK Geotechnical. March 31, 2022. Preliminary Soil Survey and Materials Report.
7. Dan Brown and Associates. March 29, 2022. Preliminary Foundation Design Report.

APPENDICES

A. Bridge Design Criteria
B. Layout Sheets for Selected Option
C. Meeting Documentation
    a. Foundation Reuse Meeting Minutes
    b. Step One screening Meeting Minutes

MDT Activity 114

CYR TYPE, SIZE, AND LOCATION REPORT

Prepared for :
MONTANA DEPARTMENT OF TRANSPORTATION

I-90 STRUCTURES-W OF ALBERTON

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TABLE OF CONTENTS

INTRODUCTION

The proposed I-90 Structures – W of Alberton project has been nominated to remove and replace existing westbound structures on I-90 at Old Highway 10 (RP 65.5), Clark Fork River (RP 66.3), and Cyr Interchange (RP 70.1).

The purpose of the project is to address aging infrastructure and bridges in poor condition. The project structures need to be replaced with new structures that meet current bridge design standards. The objective is to improve functionality, reliability, and safety of the bridges at each of the three sites. To control construction costs, bridges that are typical for Montana with construction familiar to area contractors are preferred.

This structure selection report outlines and discusses the site characteristics, constructability, economics, long term durability, and other determining factors that impact the selection of a structure to replace the westbound I-90 structure crossing the Clark Fork River near the Cyr Interchange at RP 70.1.

The outcome of this report is to provide the Montana Department of Transportation with pertinent structure selection criteria and evaluations of three options to select the most appropriate structure type, size, and layout for the replacement of the Cyr Bridge.

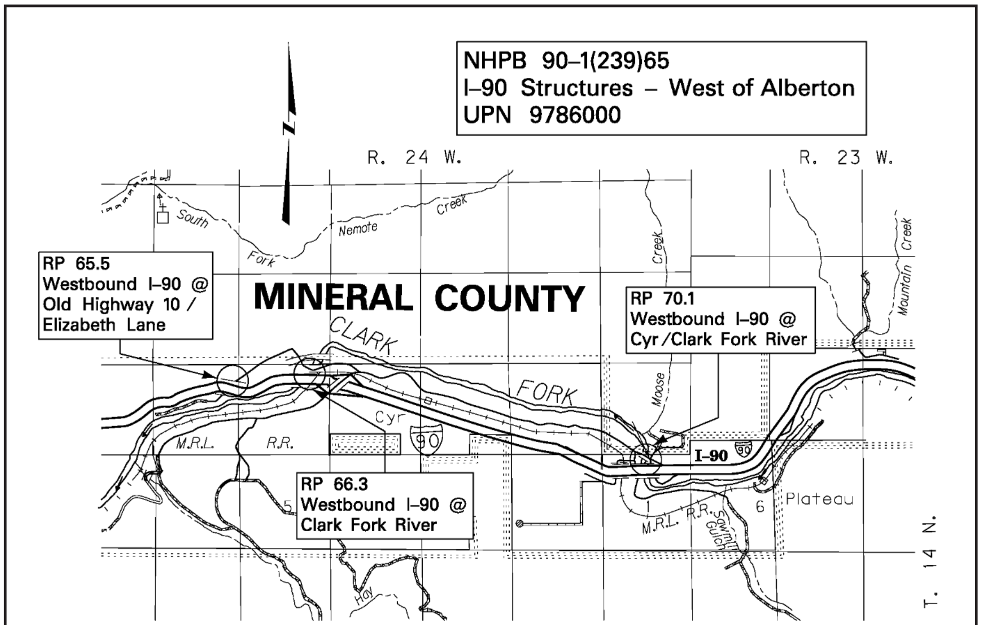


Figure 1: Project Locations Map

BACKGROUND INFORMATION

Structure #01379 (NBI Structure Number I00090066+02792); New NBI ID = 000000202101379

Figure 2: Aerial view looking southeast with westbound structure in foreground

The I-90 westbound 762.2-ft long, 28-ft wide (31.7′ out-to-out) tangent bridge at RP 70.1 spans Sawmill Gulch Road, the Clark Fork River, and the Cyr Interchange eastbound I-90 on-ramp and was initially constructed in 1965 with Federal Aid Project No. I 90 1(22)71. The nine-span structure includes three main spans (4, 5, and 6) of fracture critical continuous welded steel plate twin girders. Spans 1, 2, 8 and 9 include prestressed concrete girders; spans 3 and 7 include welded steel plate girders.

Rehab projects in 1979, 1981, 1984, 1997, 2004, and 2012 were completed to modify the bridge end guardrail, replace expansion joints, modify the bridge rail, repair / overlay the deck, rehab the steel beams, and address fatigue in the steel beams, respectively.

An inspection report from May 2019 documented growing cracks in transverse steel girders, fracture critical details, and substandard elements. The structure was noted to be a candidate for deck replacement and structure replacement with a 47.0 sufficiency rating and poor (1) FHWA Bridge Condition.

BRIDGE DESIGN CRITERIA

All design will be completed using AASHTO LRFD Bridge Design Specifications 9th Edition (2020). The current AASHTO LRFD Bridge Design Specifications including all subsequent Interim Specifications will apply throughout final design.

MDT Montana Structures Manual will be used. Dead load, wind load, or other typical loadings will be calculated in accordance with MDT's Montana Structures Manual and AASHTO's LRFD Bridge Design Specifications.

See Appendix A for full bridge design criteria.

LAND USE CONSTRAINTS

Existing I-90 right-of-way is sufficient for all permanent improvements. Construction permits and/or contractor-negotiated agreements are likely necessary to provide temporary access down to the river for demolition and removal of the existing structure, as more fully described below.

ROADWAY

The final westbound roadway width will include two 12-ft travel lanes, a 10-ft outside shoulder and a 4-ft inside shoulder, for a 38-ft face-of-barrier to face-of-barrier roadway width. The existing structure is on a horizontal tangent, with no apparent deficiencies in the mainline alignment.

The horizontal alignment was investigated at a high level to determine the viability of constructing the new bridge adjacent to the existing structure, minimizing traffic control impacts and construction timing requirements. Adjusting the horizontal alignment at the Cyr Interchange would require reconstruction of the interstate ramps, acquisition of right of way, and reconstruction of the railroad bridge west of the Cyr Structure. There is not adequate horizontal clearance between the existing eastbound and westbound structures to construct a new bridge in the median. Therefore, the replacement bridge will be placed on the existing horizontal alignment.

The longitudinal grade of I-90 on the bridge varies, as the bridge is almost entirely within a 3,400 ft vertical curve transitioning from 0.96% to -2.92% well beyond the bridge end. The instantaneous grade is approximately -1.38% at the east abutment. The replacement bridge will be placed on the existing vertical alignment.

VERTICAL CLEARANCE

The Cyr Structure crosses three under-bridge facilities including Sawmill Gulch Road, the Clark Fork River, and the Cyr Interchange eastbound I-90 on-ramp. Sawmill Gulch Road has over 50-ft of vertical clearance for both Westbound and Eastbound structures. The existing bridge provides approximately 70 feet of freeboard above the base flood elevation of Clark Fork River. Sawmill Gulch Road and Clark Fork River vertical clearance requirements are sufficient and do not affect structure selection.

The current vertical clearances for the Cyr Interchange eastbound on-ramp include 16.53-ft and 17.38-ft for Westbound and Eastbound structures, respectively. As stated in the Preliminary Traffic Report, a minimum vertical clearance under the replacement structure of 17.0-ft should be provided.

The eastbound on-ramp vertical clearance affects structure selection, requiring a shallower structure depth or lowering the eastbound on-ramp profile from existing to achieve 17.0-ft vertical clearance. Lowering the I-90 eastbound on-ramp was investigated and would likely be required to some extent on all options considered.

Options 1 would require the ramp to be lowered approximately two feet to increase vertical clearance to 17.0-ft. The longer spans of Options 2 will require an expansion joint at the intermediate bent directly west of the ramp due to the impracticality of lowering the ramp more than two feet to achieve the preferred vertical clearance. This expansion joint allows a shallower steel or concrete beam to be placed over the ramp, nominally reducing the roadwork required for lowering the ramp.

No consideration for future widening will be taken.

UTILITIES

A single telephone cable is buried on the west side of Sawmill Gulch Road and may conflict with a proposed bent in Options 1S and 1C. Relocation may be required but is not expected to be extraordinarily difficult. No considerations for utility accommodations on the structure itself are needed.

AESTHETICS

No considerations for aesthetics are needed.

PUBLIC CONSIDERATIONS

No substantive public input has been gathered to-date, but anticipated issues of concern to the public include possible negative impacts on personal recreation and commercial recreational businesses during construction, potential restrictions to use of the Cyr Bridge Fishing Access Site, as well as potential traffic impacts and intermittent closures for the I-90 eastbound on-ramp and Sawmill Gulch Road.

ENVIRONMENTAL

The study area for the Cyr structure includes open water of the Clark Fork River that is associated with recreational and aquatic uses. Other predominant land uses in the study areas include MDT right-of-way, undeveloped floodplain, forest land, and rangeland.

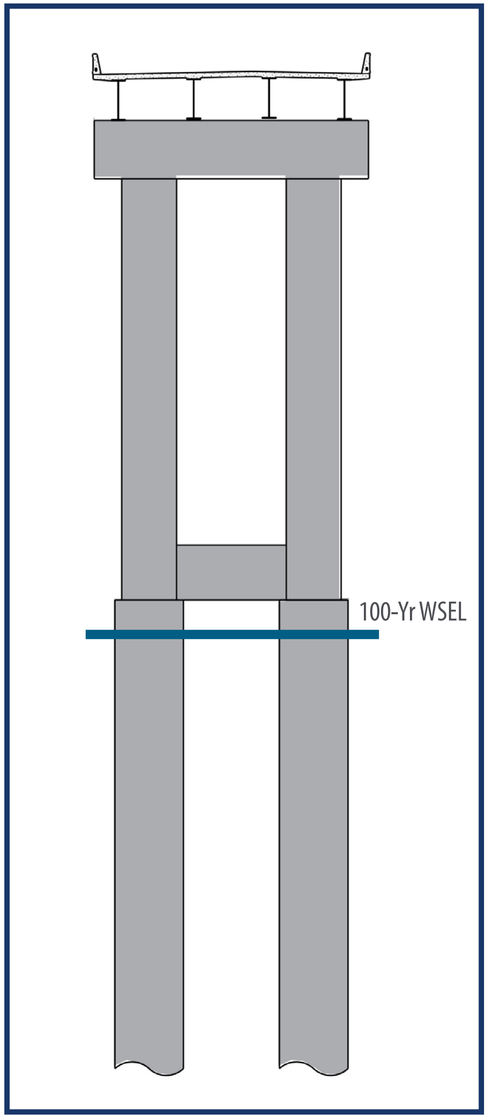
Evaluations of biological resources and probable construction impacts, e.g., temporary construction activities such as access roads, work bridges, sediment runoff, and stream dewatering, and mitigation measures that affect structure selection and layout are summarized as follows:

- The Clark Fork River is United States Department of the Interior Fish and Wildlife Service (USFWS) designated critical habitat for bull trout. Due to the proximity of construction activities to the Clark Fork River, the project "May Affect" bull trout habitat or populations.
- Potential temporary impacts to bull trout include displacement through noise and barometric pressures from bridge foundation replacement and habitat quality degradation from sediment runoff. Sheet pile and pile installation has the potential to cause barotrauma (if impact driving is used) and temporarily displace bull trout.
- Bull trout movement may be temporarily impacted by bridge demolition where the existing bridge occurs within the OHWM of the river, or by the placement of temporary work bridges within the river channel.
- Potential mitigation measures include monitoring at stream dewatering sites, recommendations for drilled shafts rather than driven pilings, and timing and noise restrictions if impact driving is to be used.

Through early coordination, the USFWS provided comments that influence structure selection. Highlights include:

- Impact pile driving may occur between July 15 and August 31. This includes dry land and in-water impact pile driving and is intended to reduce the risk of barotraumas for bull trout.
- Instream removal of bridge piers should occur during low water, i.e., July 15 through October 15.
- Keep in-water work within the river channel to the minimum amount necessary.
- Span channel such that piers are located outside the ordinary high-water mark to the extent practicable.

See Appendix C of the Biological Resources Report (Reference 4) for the July 1, 2021, response from USFWS regarding the proposed project.



HYDRAULICS

This bridge crosses the Clark Fork River near the upstream extent of the Alberton Gorge, which was formed by the periodic Glacial Lake Missoula floods. The Alberton Gorge was cut down through glacial sediments into the underlying bedrock. The canyon is approximately 100 feet deep at the crossing location with steep canyon walls. The canyon is much wider immediately upstream of the bridge where a wide bench was scoured into the overlying materials about 25 feet above the channel elevation on the western floodplain. Downstream of the bridge the canyon is much narrower with canyon walls elevated well above the flood elevations.

The interstate bridge crosses the Clark Fork River at the canyon top elevation to the east. To the west there is an abutment fill slope approximately 20 feet above the natural ground elevation and approximately 60 feet above the bench immediately adjacent to the river channel. Design of the new bridge girder depth is not constrained by hydraulic design capacity requirements.

The Clark Fork River through the bridge reach has a moderately steep slope (~0.2%), and relatively large flood flows (Q100 ≈70,000 cfs). Maximum flow velocity at the scour design event of 10 to 14 feet per second is anticipated. Preliminary hydraulic modeling indicates a relatively severe 22° attack angle. The channel bed crossed by the interstate is composed of clay, silt, and sand with intermixed gravel and boulder deposits.

The relatively high velocities, attack angle, and fine-grained soil channel composition yields relatively deep pier scour risk at the crossing location. Due to the attack angle and the close proximity of the existing westbound and eastbound piers, the existing diaphragm wall piers effectively combine to yield a very wide projected width. The proposed drilled shaft and column pier configurations reduce the total projected pier width and tend to reduce scour risk for both the existing eastbound I-90 and proposed bridge piers.

Initial modeling indicates not aligning the proposed piers with the existing eastbound piers would further reduce the total scour depth for both bridges by reducing the effective projected width of the side-by-side structures. Scour is preliminarily estimated to be 27 to 32 feet for the proposed two-column pier configurations. Scour potential is anticipated to be a key foundation design parameter for this crossing.

This segment of the Clark Fork River is currently mapped as Zone A floodplain (FHBM 300159014A). Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown on the current map. However, a floodplain study update for Mineral County is in progress and the floodplain mapping will be updated to a Zone AE with regulatory flood elevations. The update is anticipated to be effective at the time of construction, requiring a floodplain permit for the project. Initial one-dimensional modeling indicates an insignificant rise in water surface elevations for the bridge configurations described herein. For all options, floodplain permit acquisition is not anticipated to be a key bridge design parameter at this site.

The bridge deck typical section will include a 4-foot inside shoulder and a 10-foot outside shoulder. With the new bridge profile average slope over the river channel of +1.15%, the outside shoulder has sufficient width to contain deck drainage spread width for the full bridge length. However, runoff spread width will exceed the 4-foot inside shoulder at a drainage length of 125 feet. The river channel width between ordinary highwater marks (OHWM) is approximately 320 feet at the bridge.

A full-length, longitudinal deck drainage system for the inside shoulder with piped discharge outside the OHWM is not recommended since these systems are prone to sediment plugging and freezing failures. Alternatively, a drainage system composed of deck drains connected to short lengths of pipe, in combination with scuppers in the bridge deck may be feasible. This system would direct deck runoff outside the OHWM for most events while providing a secondary drainage route less prone to failure to ensure runoff spread width does not encroach into the traveled lane. Project permitting and agency coordination will be needed to address the drainage approach.

GEOTECHNICAL

GENERAL SITE CONDITIONS AND GEOLOGY

The stratigraphy at the Cyr Bridge includes Pleistocene glacial flood and glacial lake deposits unconformably overlying hard bedrock of the Wallace Formation. Several features of the subsurface profile will affect the foundation types most feasible for the bridge layout options under consideration:

1. A relatively thick stratum of glacial lake origin consisting of soft to stiff clay and silt. On the west side of the river, this layer averages around 40 feet thick while on the east side the thickness ranges from 75 to 90 feet. Abutments and upland piers founded on pile-supported footings will be designed to avoid reliance on this layer.

2. The glacial lake stratum is sandwiched between glacial flood deposits consisting of medium dense to very dense sand and gravel with cobbles and boulders. These layers will be targeted for pile tip bearing for pile-supported abutments and upland pier footings.

3. Top of rock at the main river piers is at depths ranging from 63 feet below existing ground at existing Pier 5 on the west side, to approximately 30 feet below existing ground at existing Pier 6 on the east side of the channel. We envision these center piers to be founded on 2-column bents with each column supported on a single drilled shaft socketed into the bedrock.

Detailed information on site geology, subsurface stratigraphy, and soil and rock properties is provided in the Cyr Bridge Activity 106 Report by SK Geotechnical (2022) and the Cyr Site Reconnaissance Report by DBA (2021).

SEISMIC

The bridge seismic performance criteria is Zone 2. Liquefaction potential is low to nonexistent, considering the mostly dense and coarse-grained soil deposits and the groundwater level believed to be at or near river elevation.

FEASIBLE FOUNDATIONS

Two foundation types are anticipated for the structure layouts under consideration: driven piles and drilled shafts. The overall feasibility of each in the bridge layouts currently under consideration are discussed as follows. Potential use is discussed more fully in the discussion of the individual layout options later in this report.

DRIVEN PILES

For all four options, driven piles are the most practical and cost-effective foundation type for supporting the bridge abutments and upland intermediate bents. We anticipate that steel H-piles driven to maximum depths of 40 to 50 feet in the dense glacial flood deposits can provide the axial and lateral support required to meet the abutment loading demands. Upland intermediate bents will be supported with steel H-piles or pipe piles driven to approximately 50 feet on the west side and 100+ feet on the east. The number of piles and driving criteria will be established once the type selection process is completed and abutment and bent loads have been calculated.

DRILLED SHAFTS

For all four options, drilled shaft foundations are the most practical and robust foundation type for supporting the two main-span river piers, located near or upslope of the existing main piers. Each pier substructure consists of a 2-column bent, with each column supported on a single drilled shaft. Using preliminary estimates of factored loads for Strength I and Strength V limit states, 9-ft or 10-ft diameter drilled shafts extending 15 to 18 feet into rock would provide sufficient geotechnical and structural resistances to support each column.

ANTICIPATED CONSTRUCTION APPROACH

MAINTENANCE OF TRAFFIC/ PROJECT PHASING

INTERSTATE 90

Crossovers will be used to place all I-90 traffic on the eastbound lanes to allow for construction of temporary work bridges, staging, removal, and replacement of the project's three bridges. If let as a single project, the sequencing of the work will greatly influence the number, length, and duration of use of the crossovers. For purposes of this report, the Cyr bridge is assumed to use a single, separate crossover layout due to the magnitude of the overall project, and approximate 7-mile length of a single crossover for all three bridges.

Construction and use of the crossovers is expected during the initial phases of construction activity. Wide load staging is likely during use of the crossovers. Sequencing the project to reduce disruption to traffic will include construction of the piers and bents located upland where there is headroom to construct, albeit with some challenges, prior to traffic disruptions. Crossovers would be implemented on April 15, and construction proceeding as described above, allowing for the crossovers to be removed and transition traffic to the new bridge before winter.

I-90 ON-RAMP

Access to eastbound I-90 via the Cyr on-ramp will be maintained throughout construction, with intermittent closures anticipated for some overhead work.

SAWMILL GULCH RD.

Access to Sawmill Gulch Rd. will be maintained throughout construction, with intermittent closures anticipated for some overhead work and equipment access.

CONSTRUCTION / EQUIPMENT ACCESS

Through site investigation and survey, it appears that the structure was constructed by access roads located on both sides of the river. The existing west access and likely staging area appears to be located partially on private property, which may require a construction permit or coordination between the contractor and the landowner to utilize for this project. The original access on the east bank is too narrow for modern equipment, and would require modification (cut and fill, shoring, etc.) prior to use. Both access roads are heavily grown in and not currently suitable for heavy equipment access without modification.

As is typical with bridge construction in Montana, separate work bridges on each bank of the river would allow access to the length of the structure from the east and west banks as appropriate.

Figure 3 – Construction Access Routes

TEMPORARY WORK BRIDGES

Based on initial evaluation, the preferred access from existing roadways is anticipated from the southwest and northeast banks, as shown in Figure 3, with work bridges constructed from each bank as shown in Figure 4. Work bridge spurs are anticipated to be constructed to access the new and existing foundations. The east bank experiences a much higher elevation change from finished grade to the river. As a result, the work bridge extending from the east bank will be higher in elevation and much shorter than the work bridge constructed from the west bank.

Work bridge construction from the east and west banks will be typical for pile-supported temporary work bridge construction in / over Montana waterways. Spurs and / or short work bridges to access the existing and new piers would also be anticipated as shown in Figure 4.

The west bank at the Cyr Bridge can be accessed from a short access road south of the I-90 structures along the bank shown in Figures 3 and 4. The narrow dirt road was likely used for construction access to the existing eastbound and westbound structures. This access road appears to begin on private property to the south and transition to MDT right-of-way. This access road could likely be widened and used with a construction easement. If a construction easement is not preferred or available, it could be possible to construct a new access road entirely in the MDT right-of-way with additional earthwork and vegetation removal. The new or existing access road can be widened to 30 feet with tree felling and earthwork that would give heavy equipment access to the bridge.

Figure 4 - Construction Work Bridges Layout

The east bank at the Cyr Bridge can be accessed from the eastbound I-90 on-ramp, as shown in Figures 3 and 4. The length of the platform is limited based on the steep and rocky terrain to the west of the access road. River access from the east access road and work bridge will not be feasible, due to the steep slopes, large boulders, and elevation difference between the access road/work bridge and the river.

DEMOLITION OF EXISTING STRUCTURE

For the purposes of this report, methods in removing the existing superstructure have been evaluated for the validity of concept. Actual methodology will be the responsibility of the contractor in selection of equipment and its placement. In 2004, the lateral bracing provided at the time of original construction was removed from the structure and may complicate removal. During final design, removal and constructability options will be studied in more detail.

With full length access to the existing structure through the temporary work bridges, removal of the existing structure will be performed with typical demolition methods. The barriers and decking will be removed by equipment on top of the bridge. With cranes below on the temporary work bridges, the steel girders can be lowered onto the work bridge and removed through the west construction access.

The existing substructure has access for a contractor by the construction accesses and temporary bridge structures. From this, the existing piers can be removed by sawcut and dismantling, explosive blasting, or hydraulic breaking and hammering, subject to possible environmental restrictions primarily related to bull trout. The selected method will be based on permitting, contractor preference and equipment.

ERECTION

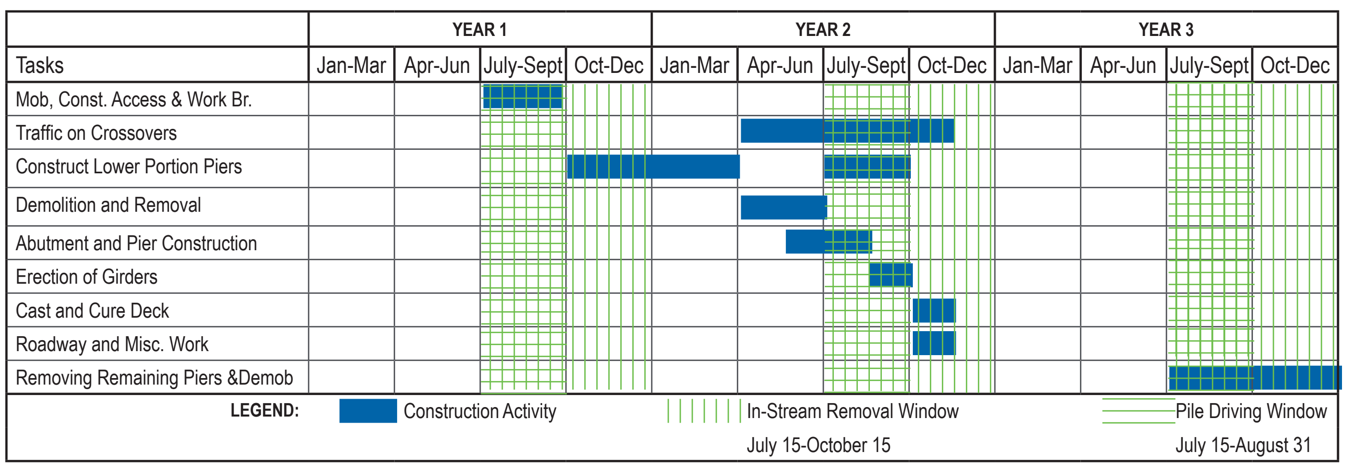
For the purposes of this report, methods in erecting the new superstructure have been evaluated for the validity of concept. Actual methodology will be the responsibility of the contractor in selection of sequencing, equipment and its placement. The erection of the superstructure and its foundation requires a full-span temporary work bridge to provide direct access to pier locations and to girder lines. This is due to the reaching limitations of the expected specialty equipment required, such as shaft drilling rigs, concrete pumps, large-capacity cranes, etc.

Sharp turns, steep slopes, and limited staging areas at the project site will provide challenges for transport and erection of prestressed concrete, weathering steel, or post-tensioned spliced concrete girders. Specifically, on the west bank, long and heavy girders will need to be transported from Sawmill Gulch Road to the temporary work bridge for erection. While staging and erection methodology may vary based on the selected contractor, longer and heavier girders will exacerbate construction challenges. In addition, temporary work bridges will need to be strengthened with more driven piles, larger girders, and heavier decking for the use of larger cranes placing heavier girders. Based on discussions with multiple contractors that have recently or are currently working on tall, long-span river crossing bridge construction projects with work bridges over waterways, we have attempted to adjust preliminary cost estimates to include the additional costs associated with construction access and work bridges for each option.

CONSTRUCTION DURATION

One anticipated approach for sequencing to meet environmental restrictions includes construction of the work bridges, drilled shafts, and partial columns (likely excluding the cap) prior to disrupting traffic. New abutments and bent caps could be constructed as soon as the removal of existing superstructure and abutments is completed. Girder erection, deck forming and casting, and final roadway work would likely take place in the fall. The remaining demolition and removal would likely be completed the following fall, adhering to the in-stream removal requirements for the river piers.

The overall construction duration would be approximately 30 months. There is likely an opportunity for construction completion at the end of year two if removal of the remaining piers takes place during the deck placement, cure and roadway work.



ACCELERATED BRIDGE CONSTRUCTION

For purposes of this report, accelerated construction techniques have not been incorporated into the evaluations. However, as the project advances, accelerated construction techniques will be discussed with the Department. Elements that are likely to be studied include partial and full-depth precast concrete deck panels. Partial-depth deck panels would likely reduce the schedule by a couple weeks, eliminating deck forming and form removal requirements. Full-depth deck panels would likely reduce the schedule by approximately one month, eliminating deck forming and concrete curing requirements. While reducing the schedule could be beneficial to the project, drawbacks such as maintenance requirements, performance issues, erection challenges, and increased cost will be discussed with the Department as the project advances.

The inclusion of partial or full-depth concrete deck panels will not influence structure selection, as the schedule savings and cost increase would apply to all structure options.

STRUCTURE LAYOUT OPTIONS

The purpose of this bridge alternatives analysis is to identify structure types and layout options that will meet the needs of this bridge site and comply with the Department's design criteria and preferences. Specifically, constructability, erection, construction costs, construction duration, schedule, and maintenance costs were identified as important criteria for this project site.

The main challenges are the hydraulics (scour), height of the piers, maintaining vertical clearance at Cyr Interchange eastbound on-ramp, and difficult construction access. To minimize construction challenges, span configuration and pier/bent locations were investigated to provide required vertical clearance while reducing conflicts with existing timber piling that could introduce unnecessary risk for drilled shaft construction.

During the preliminary site and structure examination, multiple specialty structures were investigated, including deck arch, steel deck truss, and network tied arch. After a high-level screening, these specialty structures were eliminated as viable for this bridge site, due to the required access for pier removal, high cost of design and construction, and relatively short span layout feasibility.

In addition to specialty structures, a cast-in-place segmentally erected structure was investigated to alleviate the challenges to site access and longer spans. Segmental concrete construction was eliminated as a viable option for this bridge site, due to the higher cost for design and construction, feasibility of temporary work bridges spanning the entire river adjacent to the existing structure, limited experience for local contractors, and limited if any advantage to construction schedule.

Conceptual findings and preliminary structure layouts were presented to the Department at an initial screening meeting. Meeting materials and documentation of decisions and preferences are located in Appendix C.

Three primary bridge types are investigated in detail including welded steel plate girder, prestressed concrete girder, and spliced post-tensioned concrete girder. With all girders offering viable options to replace the structure over the Clark Fork River at Cyr, several span arrangements were developed and analyzed for the criteria listed above. The span lengths were selected to optimize constructability, equipment requirements, hydraulic/scour impacts, foundation requirements, and overall cost.

Four bridge layouts were studied in detail including welded steel plate girder and prestressed concrete girders matching the existing center span layout/length and welded steel plate girder and spliced post-tensioned concrete girders with a longer main span of 240-ft.

For the superstructure typical section, four girder lines were studied due to the cost-effective and efficient girder spacing and sizing for all three girder options. The girders will carry a cast-in-place concrete deck designed using MDT's deck design spreadsheet. All options will include two 12-ft travel lanes, 4-ft inside shoulder, 10-ft outside shoulder, and the MDT standard single slope concrete barrier on both sides.

A preliminary construction cost estimate was completed for each of the options with the understanding that current market prices for labor and materials are extremely variable and could change significantly by the bid date of this project. Cost values include only bridge items, access, temporary works, and removal using current market prices and do not include contingencies, inflation, IDC, mobilization, roadway, CE, ICAP, traffic control, etc. Non-bridge costs are similar for all options.

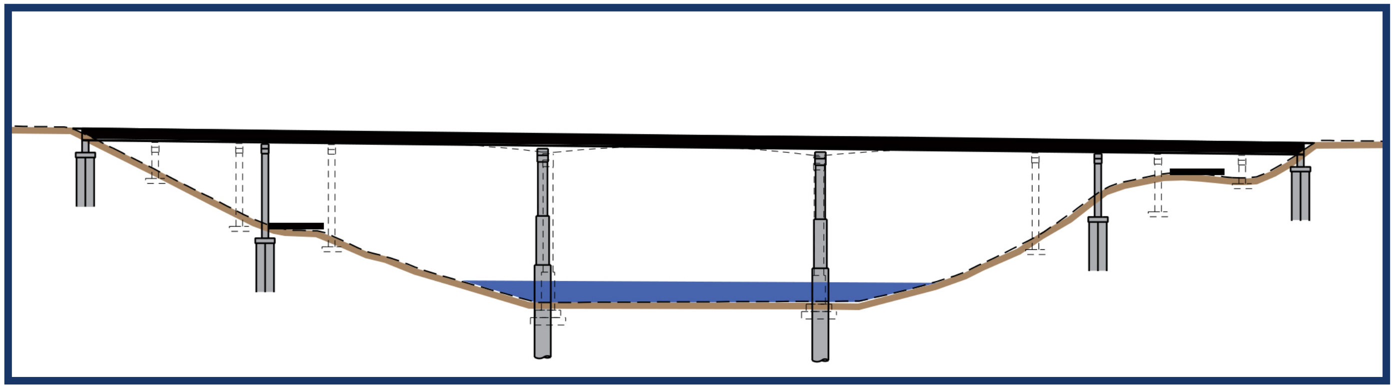
The layout options developed for further analysis are:

- 1S. Five-span steel girder (110'-170'-170'-170'-120')
- 1C. Five-span prestressed concrete girder (110'-170'-170'-170'-120')
- 2S. Four-span steel girder (210'-240'-175'-100')
- 2C. Four-span spliced post-tensioned concrete girder (210'-240'-175'-100')

OPTION 1S: FIVE-SPAN STEEL GIRDER (110'-170'-170'-170'-120')

DESCRIPTION

Option 1S includes a five-span continuous welded weathering steel plate girder superstructure. This option locates two river piers in the same locations as the existing structure matching the main span length, with two upland piers. This option would allow for a continuous steel girder superstructure and locate the expansion joints at each abutment. However, additional roadwork would be required to lower the eastbound I-90 on-ramp approximately two feet to provide adequate vertical clearance.



CONSTRUCTION COST

The estimated construction cost of this option is $12.9 million.

CONSTRUCTABILITY

This option would require tall piers (90-ft) located within the waterway and one additional 60-foot-tall pier is required compared to the four-span options.

Option 1S would include driven pile founded abutments located near the existing abutments. The two-column upland intermediate bents would be founded on driven pile supported footings, and the river piers would be founded on drilled shaft foundations.

Due to the location of the river piers, a wide stance spandrel pier would be required to provide efficient span lengths and alleviate existing foundation conflicts during construction. As shown in Figure 5, the spandrel pier would locate the drilled shafts outside of the existing foundation footprint. While a spandrel pier will allow construction prior to removal of the existing structure, construction and removal could be more challenging due to the close proximity of the existing footing and new drilled shafts.

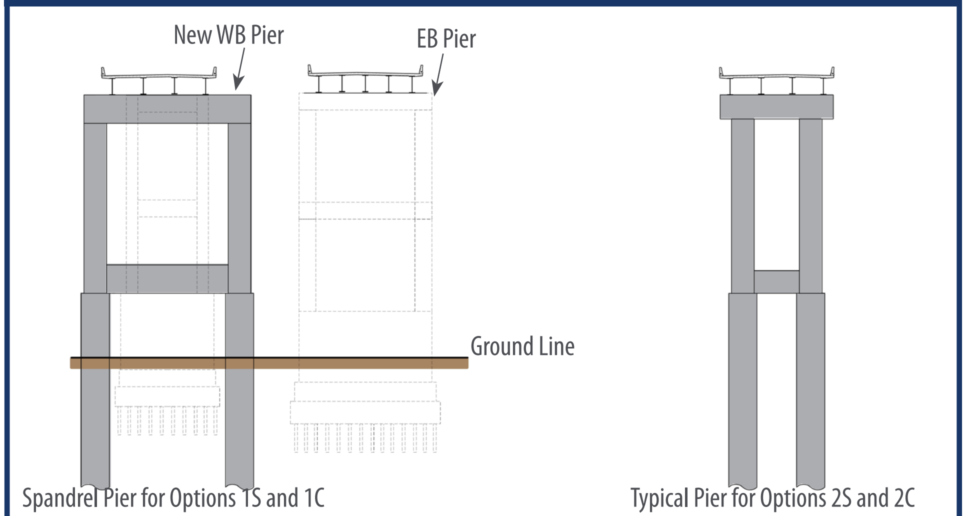


Figure 5 - Spandrel Pier for Options 1 / Typical Pier for Options 2

ERECTION

This five-span steel girder layout allows shorter, lighter girder segments that could aid in erection. Girders could be spliced to allow crane sizes that are typically seen in Montana. Girder erection would be typical for many of the recent steel girder bridge replacement projects over the Clark Fork River and other large rivers in Montana. This may include temporary bents and pier bracing to aid in steel girder erection.

CONSTRUCTION DURATION

The construction duration required for Option 1S would follow the schedule outlined above for a two to three-year completion time.

LONG-TERM MAINTENANCE / INSPECTION

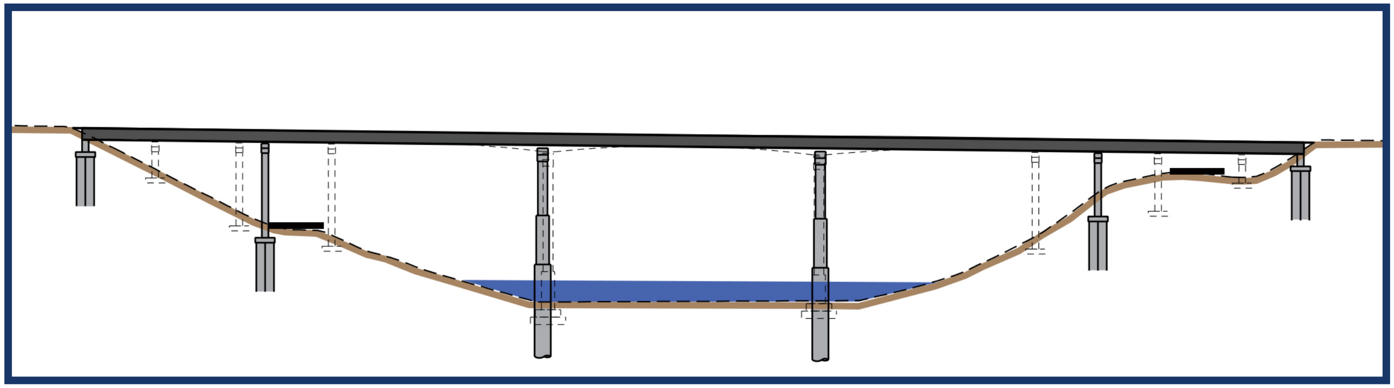
Maintenance and inspection will be typical for multiple-span structures over waterways in Montana. No special maintenance or inspections are required beyond the typical MDT biannual inspections. The upland piers would not require scour inspections as they are well above the 100-year water surface elevation.

This option would require periodic underwater pier/shaft maintenance and inspection.

OPTION 1C: FIVE-SPAN PRESTRESSED CONCRETE GIRDER (110'-170'-170'-170'-120')

DESCRIPTION

Option 1C includes a five-span precast prestressed concrete girder superstructure. This option locates two river piers in the same locations as the existing structure matching the main span length, with two upland piers. This option would allow for a prestressed concrete superstructure and locate the expansion joints at each abutment. However, additional roadwork would be required to lower the eastbound I-90 on-ramp approximately two feet to provide adequate vertical clearance.



CONSTRUCTION COST

The estimated construction cost of this option is $13.4 million.

CONSTRUCTABILITY

This option would require very tall piers (90') located within the waterway and one additional 60-foot-tall pier is required compared to the four-span options.

Option 1C would include driven pile founded abutments located near the existing abutments. The two-column upland intermediate bents would be founded on driven pile supported footings, and the river piers would be founded on drilled shaft foundations.

Due to the location of the river piers, a wide stance spandrel pier would be required to provide efficient span lengths and alleviate existing foundation conflicts during construction. As shown in Figure 5, the spandrel pier would locate the drilled shafts outside of the existing foundation footprint. While a spandrel pier will allow construction prior to removal of the existing structure, construction and removal could be more challenging due to the close proximity of the existing footing and new drilled shafts.

ERECTION

This five-span prestressed concrete girder layout allows shorter girder segments compared to the four-span options. However, girder erection would require larger cranes located on the work bridge to place the substantially heavier concrete beams. The large and heavy concrete beams would increase the difficulty for erection, due to the limited staging area, challenging maneuverability, and tight turning movements required for erection. Additionally, the girders have an estimated weight of 175 kips which will require much larger cranes, additional work bridge cost (additional spurs for access, more temporary piles, larger girders, etc.), and a larger staging/turning area, compared to the shorter, lighter steel girder segments in Options 1S and 2S.

CONSTRUCTION DURATION

The construction duration required for Option 1C would follow the schedule outlined above for a two to three-year completion time.

LONG-TERM MAINTENANCE / INSPECTION

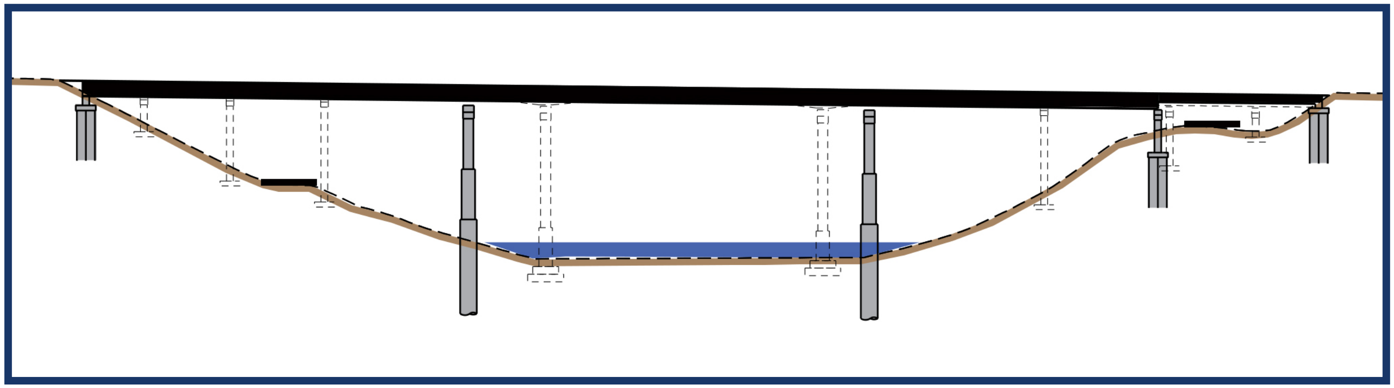
Maintenance and inspection will be typical for multiple-span structures over waterways in Montana. No special maintenance or inspections are required beyond the typical MDT biannual inspections. The upland piers would not require scour inspections as they are well above the 100-year water surface elevation.

This option would require periodic underwater pier/shaft maintenance and inspection.

OPTION 2S: FOUR-SPAN STEEL GIRDER (225’-240’-175’-100’)

DESCRIPTION

Option 2S includes a three-span continuous welded weathering steel plate girder superstructure. The east span above the eastbound I-90 on-ramp will be a one-span simply supported welded weathering steel plate girder superstructure with an expansion joint located at the intermediate bent and an integral abutment. This option locates the main span bents approximately 35-ft upland from the existing river piers.



CONSTRUCTION COST

The estimated construction cost of this option is $12.4 million.

CONSTRUCTABILITY

This option would slightly reduce the required height of the piers and eliminate an additional pier compared to Option 1. These piers would be in a more accessible position for drilled shaft equipment and construction.

Option 2S would include a driven pile founded abutment located near the existing east abutment, and a driven pile supported abutment at the west bridge end. The two-column upland main-span intermediate bents would be founded on drilled shafts, while the east intermediate bent would be driven pile founded near the existing bent. Shafts constructed under the shadow of the bridge will present manageable construction challenges such as placement of the reinforcing and overhead height restrictions.

ERECTION

Larger erection equipment may be required to place longer and heavier steel girders. However, erection would be typical for Montana contractors lifting and placing girders from the work bridge along the existing structure. Preliminary design shows the girders to be approximately 30% heavier than the five-span option 1S, which is similar to most longer-span steel girder bridges in Montana. Girder erection would be typical for many of the recent steel girder bridge replacement projects over the Clark Fork River and other large rivers in Montana. This may include temporary bents and pier bracing to aid in steel girder erection.

CONSTRUCTION DURATION

The construction duration required for Option 1C would follow the schedule outlined above for a two to three-year completion time.

LONG-TERM MAINTENANCE / INSPECTION

Maintenance and inspection will be typical for multiple-span structures over waterways in Montana. No special maintenance or inspections are required beyond the typical MDT biannual inspections. The upland piers would not require scour inspections as they are well above the 100-year water surface elevation.

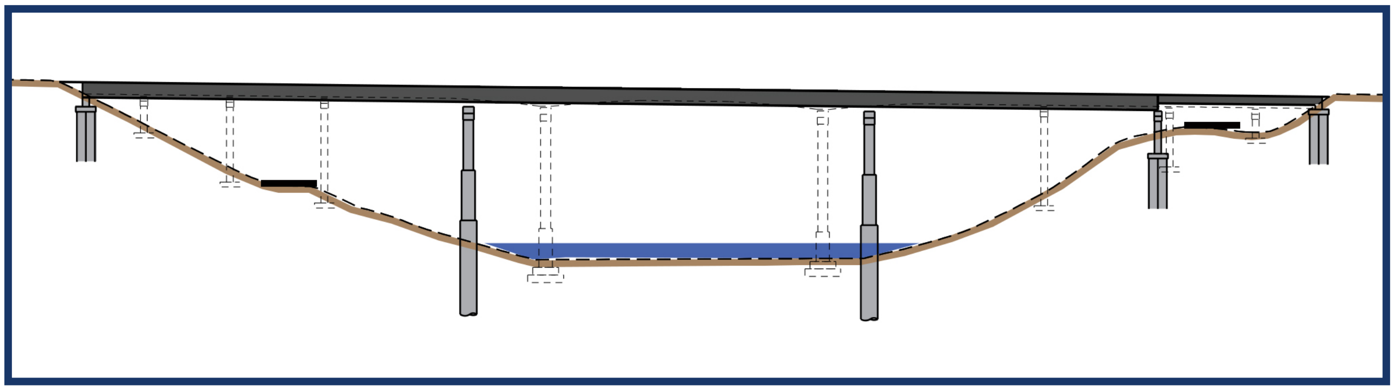
This option would require periodic underwater pier/shaft maintenance and inspection.

OPTION 2C: FOUR-SPAN SPLICED POST-TENSIONED CONCRETE GIRDER (225'-240'-175'-100')

DESCRIPTION

Option 2C includes a three-span continuous spliced post-tensioned concrete girder and a single span prestressed girder over the eastbound on-ramp. This option locates the main span bents approximately 35-ft upland from the existing river piers. Option 2C would include a driven pile founded abutment located near the existing east abutment and a driven pile supported abutment at the west bridge end. The two-column upland main-span intermediate bents would be founded on drilled shafts, while the east intermediate bent would be driven piles founded near the existing bent.

The superstructure will utilize a Utah BT shape, UBT96, with four post-tensioned splice locations utilizing concrete strengths up to 10ksi. Splice locations will be located roughly 40-50 feet from the intermediate bents. It is expected that girder segment ends will have flared ends to encase tendon anchors, but these can be detailed to be cast-in-place as well. This decision should be discussed as the project advances.



CONSTRUCTION COST

The estimated construction cost of this option is $13.1 million.

CONSTRUCTABILITY

This option would slightly reduce the required height of the piers and eliminate an additional pier compared to Option 1. These piers would be in a more accessible position for drilled shaft equipment and construction.

Temporary support towers are required to complete the splices in the spans adjacent to the main span. These towers will be located approximately 50 feet away from the new bent locations. Construction for the support towers can be completed by access from construction roads and the work bridges. Shafts constructed under the shadow of the bridge will present manageable construction challenges such as placement of the reinforcing and overhead height restrictions.

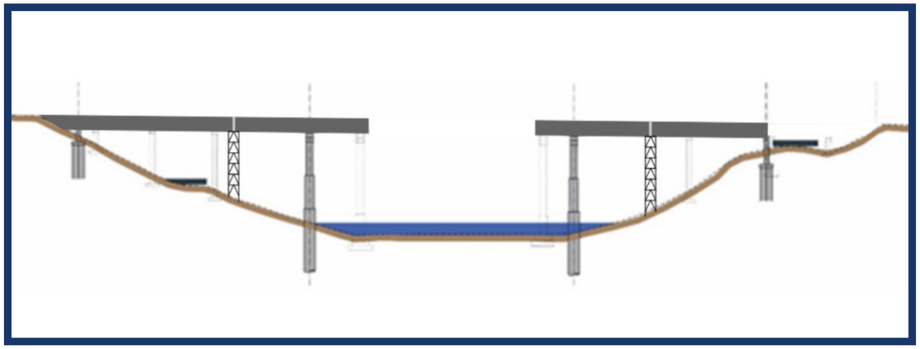
Post-tensioning of pre-cast girders is a common construction technique that has not been used in Montana. It is expected that local contractors will be unfamiliar with its use and implementation. This bridge type will require a subcontract with a specialist that will perform the tensioning of the tendons and assist the contractor with all other aspects of post-tensioning, e.g., fishing the tendons, grouting the ducts, etc.

ERECTION

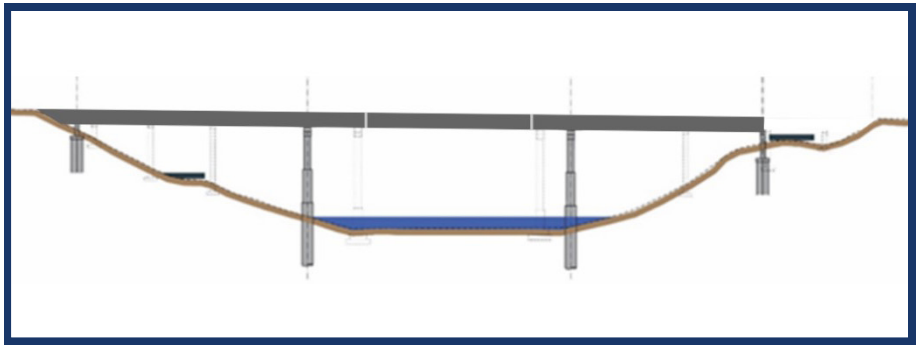
Option 2C includes very heavy crane picks, similar to Option 1C (128 kips for the pier segment and 162 kips for the main span segments). To use equipment commonly used by local contractors, the work bridge must extend to all bridge girder lines at the middle of the main span and close to the east river bent. Otherwise, large crane equipment will be required for an extended reach.

The superstructure will be erected in the following sequence:

1. Temporary supports will be erected. End girder segments and pier girder segments will be installed onto temporary supports and bearings. Post-tensioning ducts will be spliced, splice reinforcement will be placed, cast abutment and pier diaphragms and splice concrete. Once splice concrete reaches desired strength, stage 1 post-tensioning will be installed.

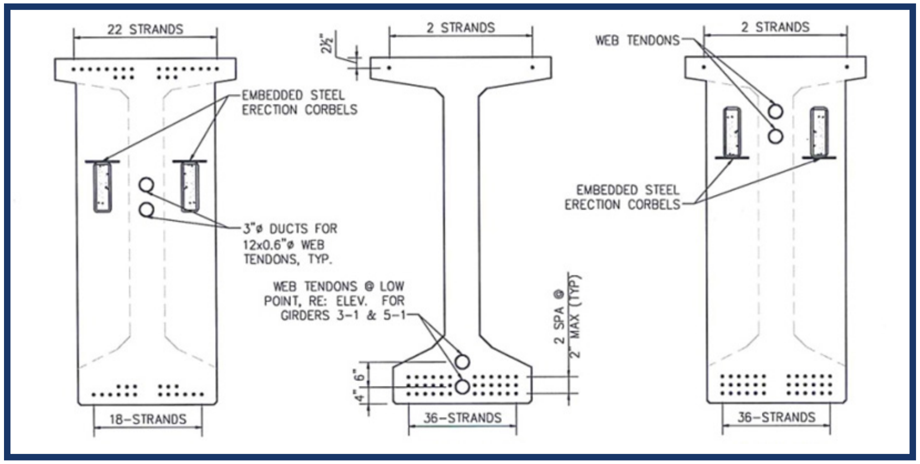


2. Place drop-in girder segment on corbel supports located on cantilever ends. Install erection bolts into corbel and install temporary lateral bracing on drop-in segment for global stability. Post-tensioning ducts will be spliced, splice reinforcement will be placed, cast splice concrete. Once splice concrete reaches desired strength, stage 2 continuity post-tensioning will be installed.

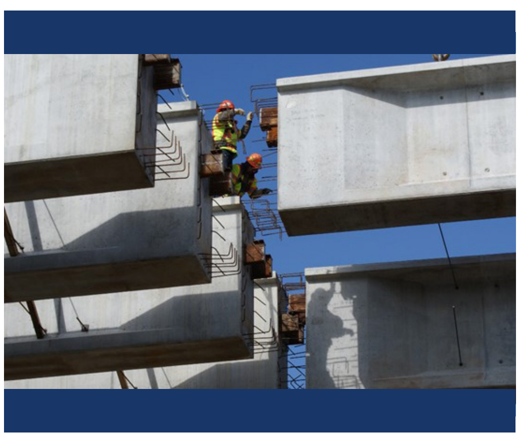


3. Span over the eastbound on-ramp installed with standard construction methods. Deck and railing cast.

The drop-in girder will be supported on corbels imbedded into the precast segment ends as shown below. Girder segments will be joined with high strength bolts through the connection plates welded to steel corbels. The corbel connection is designed to resist construction loads and is not used for final connection strength of the splice.



Corbel connections are preferred over a more traditional strongback connection due to the speed of construction, and corbel connections allow clearances for splice falsework. However, if corbels are used, greater care is required during erection to confirm the distance between corbels matches those with the drop-in girder.



CONSTRUCTION DURATION

Post-tensioning concrete girders has an advantage of construction speed with minimal requirements of lateral bracing needs during construction. However, construction speed is also influenced by the need to have cast-in-place splices cure to required strength prior to tensioning strands. It is expected that the post-tensioning girder erection will take up to 2-3 weeks longer than that of steel and would increase the traffic crossover requirement by that length of time.

This will not affect the overall construction duration of 30 months due to the environmental requirements for substructure removal.

LONG-TERM MAINTENANCE / INSPECTION

Maintenance and inspection will be typical for multiple-span structures over waterways in Montana. No special maintenance or inspections are required beyond the typical MDT biannual inspections. The upland piers would not require scour inspections as they are well above the 100-year water surface elevation.

Post-tensioned girders, traditionally, have shown themselves to result in a low-maintenance structure. They are designed to keep the entire girder fully compressed during its life-span and as a result minimized concrete cracking. The tendons are protected by corrugated metal ducts filled with void-less cementitious grout. Duct grout caps are then fully encased by a concrete closure pour at the end of the girders.

SUMMARY DISCUSSION

The following discussion compares the four options within only those selection criteria that vary depending on the option selected:

CONSTRUCTION COST

The estimated construction costs for each option were derived from average MDT Bid Tabs and current market prices through discussions with contractors and suppliers. Cost values include only bridge quantities using current market prices and do not include contingencies or inflation.

Option 1S: $12.9 M
Option 1C: $13.4 M
Option 2S: $12.4 M
Option 2C: $13.1 M

CONSTRUCTABILITY

The main span (river) piers will include two-column pier construction with drilled shaft deep foundations for all options. The spandrel pier required for Options 1S and 1C will introduce challenges for construction of the new pier, as well as demolition and removal of the existing piers. Main span piers on Options 2S and 2C will be located under the shadow of the existing bridge upland of the existing piers, which could present manageable challenges during construction such as overhead height constraints for the drilling equipment and placement of the reinforcing cage.

FOUNDATIONS

Table 2 below summarizes the foundations considered most feasible for each of the bridge layout options under consideration.

TABLE 2. Summary of Foundation Types for Cyr Bridge.

Bridge Layout Option	Abutments	Center Piers (River Span)	Intermediate (Upland) Piers
A. 5-Span Bridge	Driven pile group	Large-diameter drilled shafts, 1 per column	Pile-supported footings
B. 4-Span Bridge	Driven pile group	Large-diameter drilled shafts, 1 per column	Pile-supported footing, east side only

Each of the foundation types under consideration poses challenges and risk related to construction. Table 3 below summarizes the challenges and level of risk as perceived at the present time.

TABLE 3. Summary of Foundation Construction Challenges and Risk.

Foundation Type	Known or Potential Challenges	Level of Risk
Driven Piles	Driving obstructions in the form of cobbles and boulders	Low to Moderate
Rock-Socketed Drilled Shafts	Drilling from work bridge	Moderate to High
	Drilling in cobbles and boulders	Moderate
	Existing timber piles (obstructions)	High
	Excavation of large diameter holes in very hard rock	Moderate
	Working directly adjacent to the existing bridge	Moderate
	Working beneath existing bridge	Moderate

Lack of sufficient subsurface information in the form of too few borings poses a risk for all bridge projects. The design team recommends at least one boring at each foundation location. In particular:

- Depth to bedrock at the proposed main pier locations requires further investigation, either by borings or geophysical survey.
- Thickness of the glacial lake stratum at the intermediate upland pier final locations requires additional investigation to establish required pile lengths.

A potential risk associated with new foundations in-line with the existing foundations of the eastbound bridge, as proposed for both Options 1 (5-span), is the potential effect on the river flow characteristics. This has long-term implications for scour potential, as well as for recreational floating / boating. These issues require further investigation and study if one of the 5-span options moves forward.

TEMPORARY WORKS CONSIDERATIONS

All options require construction access down to / within the river for demolition and removal of the existing structure. A temporary work bridge constructed from each bank is feasible and common for similar bridge replacement projects throughout Montana. Therefore, work bridges will be incorporated in all four options. Options 1S and 2S would allow for typical work bridge construction in Montana, due to the crane size required for transporting and placing the steel girder segments. Options 1C and 2C would require stronger and more robust work bridges with additional piling and additional spurs, due to the large crane sizes and heavier prestressed concrete and spliced post-tensioned concrete beams included in each option.

ERECTION

For all options, steel or concrete girders can be staged and placed from the temporary work bridges on each bank. Options 1S and 2S include steel girder segments that could be erected with crane sizes common to Montana contractors. Options 1C and 2C will require larger crane sizes to stage and place the prestressed concrete and spliced post-tensioned concrete girders.

CONSTRUCTION DURATION

Option 2C: Four-span spliced post-tensioned concrete girder is expected to take up to 2-3 weeks longer than that of steel and prestressed concrete options and will increase the traffic crossover requirement by that length of time. However, this will not affect the overall construction duration of 30 months due to the environmental requirements for substructure removal.

PERFORMANCE MATRIX

Because the four layout options have similar preliminary construction cost estimates, an evaluation of the expected performance of the four bridge options based on the following criteria is proposed to guide the option selection:

- Constructability / Temporary Works (Ease of Access; Safety of Construction)
- Maintenance of Traffic (Duration of Impacts to I-90 Traffic; Local Roads)
- Construction Duration; Recreational Access (Temporary Disruption)
- Environmental Impacts (Construction Impacts; Wildlife Accommodations)
- Future Inspections and Maintenance (Expected Durability; Extraordinary On-Going Efforts)
- Project Development / Risk (Level of Uncertainties; Cost Escalation Risk)

These six criteria were initially assigned weights based on perceived value to the Department and the affected public. Each performance criterium was assigned a numerical value to quantify an overall performance score. The performance score was then divided by the estimated construction cost for each option in order to provide a best-value ranking of the four options.

This type of evaluation is completed early in the project development stage to provide broad support for selection of a single option to advance to Alignment and Grade Review. In this case, the measure of value was calculated as the ratio of performance over the estimated cost. The best-value is provided by greater performance, while still accounting for cost.

The preliminary findings of the design team indicate Option 2S is the best-value option considering the draft weighted performance criteria and the assigned numerical importance.

Performance Criteria		Constructability / Temporary Works	Maintenance of Traffic	Construction Duration / Recreational Access	Environmental Impacts	Future Inspections and Maintenance	Project Development / Risk	FINAL		
		Assigned Weights						Total Performance Score	Construction Cost ($M)	Best Value (Performance/Cost)
Weight		30	15	10	20	10	15	100		
Option 1S	5									
	4									
	3									
	2									
	1									
Subtotal:		90	60	40	80	40	45	355	12.9	27.5
Option 1C	5									
	4									
	3									
	2									
	1									
Subtotal:		60	60	30	80	40	45	315	13.4	23.5
Option 2S	5									
	4									
	3									
	2									
	1									
Subtotal:		90	60	40	80	40	60	370	12.4	29.8
Option 2C	5									
	4									
	3									
	2									
	1									
Subtotal:		60	60	30	80	40	45	315	13.1	24.0

CONCLUSION AND RECOMMENDATIONS

As a result of our analyses, Option 2S is the recommended structure type and layout for the Cyr Bridge. Option 2S shows significant benefits to erection, combined with a preferred location for construction of the drilled shafts. Option 2S reduces the quantity of substructure elements, requires shorter piers, provides greater flexibility in final design to reduce potential pier scour effects, and eliminates spandrel pier construction. Compared to Option 2C, Option 2S reduces the girder weight, provides benefits to constructability and erection, and provides the best overall performance.

REFERENCES

1. Dan Brown and Associates. January 27, 2021. Technical Memo No. 1; Geotechnical Site Reconnaissance.
2. Morrison-Maierle. April 2, 2021. Preliminary Field Review Report.
3. Morrison-Maierle. July 9, 2021. Preliminary Traffic Report
4. HydroSolutions & WESTECH Environmental Services. December 28, 2021. Biological Resources Report.
5. HydroSolutions & WESTECH Environmental Services. February 9, 2022. Wildlife Accommodation Recommendation Memo.
6. SK Geotechnical. March 31, 2022. Preliminary Soil Survey and Materials Report.
7. Dan Brown and Associates. March 29, 2022. Preliminary Foundation Design Report.

APPENDICES

A. Bridge Design Criteria
B. Layout Sheets for Selected Option
C. Meeting Documentation
    a. Foundation Reuse Meeting Minutes
    b. Step One screening Meeting Minutes

Appendix A

BRIDGE DESIGN CRITERIA

memo

TO: Alberton Structures Design Team

FROM: Morrison Maierle

RE: Bridge Design Criteria
I-90 Structures West of Alberton
NHPB 90-1(239)65; UPN 9786000

Design Codes and References

- MDT Structures Manual
- AASHTO LRFD Bridge Design Specifications (LRFD Specs), 9th Ed., 2020.
- AASHTO Manual for Bridge Evaluation (MBE), 3rd Edition, 2018.
- AASHTO/AWS D1.5 Bridge Welding Code, 2015.

Design Loads

- Load Modifier: All structures are expected to be conventional construction and typical bridge importance so Load modification factor of 1.0 will be used.

- Load Factors and Combinations
  - Load combinations and factors in accordance with AASHTO table 3.4.1-1
- Permanent Loads (AASHTO 3.5) All typical loadings are per LRFD and MDT Structure Manual with clarifications noted below
  - Components (DC)
    - MDT Standard Bridge Rail Type Single Slope 36” = 411 plf
    - Utilities = No utilities expected.
  - Wearing Surface (DW)
    - Sacrificial Wearing Surface = ½” per MDT design memo dated December 2, 2009
    - Future Wearing Surface = 10 psf in accordance with MDT structures manual
  - Superimposed permanent loads (i.e. barrier, FWS, etc.) will be distributed equally to the girders per MDT structures manual 14.2.4 and AASHTO unless it is determined that more accurate distribution is warranted
- Live Loads (AASHTO 3.6.1 & 3.6.2)
  - 3 – 12 ft lanes of HL-93 loading with appropriate multiple presence factors
  - Dynamic load allowance will be 15% for Fatigue limit states and 33% for all other limit states. Will be applied to elements above ground. Impact will not be applied to bearings in accordance with AASHTO 14.4.1
  - Fatigue Loading = 2400 $ADTT_{SL}$
  - L/800 without pedestrian facilities (3.6.1.3.2)
- Wind Loads (WL, WS)
  - Wind loads are computed for a base design wind velocity of 115 mph
  - In accordance with AASHTO LRFD Bridge Design Specifications
  - No advanced wind study or analysis scoped
- Temperature (TU)
  - Design Temperature range will be based on AASHTO 3.12.2.2 Procedure B
  - Range is 105°F to -30°F (70 years of historical weather data according to NOAA)

- Setting temperature = 60°F (Assume 65% of range to account for setting temperature based on LRFD)

- Ice Loads
  - The Clark Fork River will be designed for 12-in of ice (MDT Structures 14.3.5)
  - Ice pressures will be assumed to be 16 ksf (MDT Structures 14.3.5)
  - NOAA reports 37 ice jams on the Clark Fork River but not more than 9 occurring in Missoula and zero reported in Alberton (https://www.wrh.noaa.gov/tfx/hydro/IJAD/WOD.php?wfo=tfx)
- Earthquake Effects
  - Seismic design shall be in accordance LRFD Bridge Design Code
  - 7% Probability of exceedance in 75-year design event

Parameter	Clark Fork Bridge	Cyr Bridge	Old Hwy 10 Bridge
PGA =	0.108	0.111	0.11
S_S =	0.257	0.264	0.262
S_1 =	0.086	0.08	0.087
A_S =	0.129	0.175	0.132
S_{DS} =	0.308	0.419	0.315
S_{D1} =	0.146	0.211	0.149
Soil Site Class =	SDC - C	SDC - D	SDC - C
Seismic Design Class:	*Zone 2	Zone 2	*Zone 2

* The Clark Fork Bridge and Old Hwy 10 Bridge have an S_{D1} of 0.146 and 0.149 respectively, which would place this location in Seismic Zone 1 ($S_{D1} < 0.15$); however, due to the significant length of the bridges, height of the piers, long spans, and complexity in design and construction, the Clark Fork Bridge and Old Hwy 10 Bridge will be designed for Seismic Zone 2.

Materials

- Concrete
  - Use Montana “Class Structure” Concrete for cast-in-place concrete substructures
  - Use Montana “Class Structure Low Slump” for all cast-in-place superstructure concrete
  - Use Montana “Drilled Shaft Concrete” for all drilled shaft concrete
  - Minimum Required Compressive Strength at 28-days (f’c)= 4000 psi for Class Structure, Class Structure Low Slump, and Drilled Shaft Concrete
  - Shrinkage coefficients 0.0002 after 28 days and 0.0005 after one year of drying
  - Shrinkage and creep coefficients will be calculated per AASHTO LRFD Bridge Design Specifications 9th Edition
- Reinforcing Steel
  - All mild steel reinforcement shall be ASTM A615 unless specified otherwise
    - Minimum yield strength, Fy= 60 ksi
    - Modulus of elasticity, Es = 29,000 ksi
  - All deck and curb reinforcing, as well as any reinforcing projected into the deck will be epoxy coated. All reinforcing at supports with expansion joints will be epoxy-coated.
  - All other reinforcing will be “black”
  - All transverse and longitudinal reinforcing in the columns and shafts will be ASTM A706 Weldable steel.

        - Minimum yield strength, Fy= 60 ksi
        - Modulus of elasticity, Es = 29,000 ksi
- Structural Steel
    - AASHTO M270 Grade 50W and Grade HPS 70W.
    - Weathering steel will be used throughout bridge where appropriate
    - Paint beam ends at open joints
    - Assume ASTM A325 Type 3 High Strength Bolts and Class B surfaces for all connections.
- Prestressed Concrete
    - f'ci = 7500 psi and f'c = 8000 psi
    - 0.6" dia. 270 ksi low relaxation strands
    - Time-dependent prestressed losses – Approximate losses
    - Shear design – Sectional Design Model
- Post-Tensioned Spliced Concrete Girders
    - f'ci = 7500 psi and f'c = 9000 psi for Girders
    - f'ci = 5000 psi and f'c = 7250 psi for CIP Splices
    - 0.6" dia. 270 ksi low relaxation strands
    - 4" diameter corrugated steel ducts
    - Time-dependent prestressed losses – Time-Step Method losses

Load Ratings

- Perform Load Rating for each structure in accordance with LRFD Manual for Bridge Evaluation Manual in AASHTOWare Bridge Rating Software

Deviations From Standards

- No deviation from standards are expected

Appendix B

LAYOUT SHEETS FOR SELECTED OPTION

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Appendix C

MEETING DOCUMENTATION

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Meeting Minutes
I-90 Structures – West of Alberton
NHPB 90-1(239)65; UPN 9786000

Date: **March 7, 2022 – 12:30pm**

Attendees:

- ☒ Stephanie Brandenberger, MDT
- ☒ Bob Vossen, MDT
- ☒ Nathan Haddick, MDT
- ☒ Andy Cullison, MDT
- ☒ John Schmidt, MDT
- ☒ Bret Boundy, MDT
- ☒ Jon Rainwater, MDT
- ☒ Paul Hilchen, MDT
- ☒ Joe Weigand, MDT
- ☒ Laura McDonald, MDT
- ☒ Will Tangen, MDT
- ☒ Jim Scoles, MMI
- ☒ John Turner, DBA
- ☒ Cory Rice, SKG
- ☒ Andy Mish, M&M
- ☒ John Lynch, M&M
- ☒ Jason Millar, MMI
- ☒ Luke Carlson, MMI
- ☒ Nik Ortman, MMI
- ☒ Phill Forbes, MMI

Purpose:

A meeting was held on this date to provide an overview of the Step 2 detailed screening of structure types for the I-90 Structures – West of Alberton project and facilitate discussion on the three draft Type, Size, and Location (TS&L) Reports prepared by the Consultant. Refer to the attached presentations for an outline of the topics discussed during the meeting.

Outcome:

The Department concurred with the recommended structures at each of the three sites, with direction to advance each to Alignment Review level.

The meeting began with introductions and a brief overview of the project scope. The meeting discussion was guided with PowerPoint presentations of the common project elements, followed by details for each of the three structures. The following is intended to summarize the discussion.

Common Project Elements:

No horizontal or vertical alignment modifications to I-90 are proposed, thereby requiring crossovers to maintain traffic on the Interstate. The location and possibly number of crossovers may be affected by how the project is either phased or split for construction.

Environmental constraints affect the schedule at the two crossings of the Clark Fork River and are singularly related to avoiding and / or minimizing impacts to bull trout. The bridge over Old Highway 10 is not subject to any out of the ordinary environmental restrictions.

Access to the Clark Fork and Cyr structures for demolition of existing and construction of new structures will prove to be very difficult and was evaluated in detail for TS&L reporting. The preliminary estimated costs presented are representative of bridge construction items only. No contingency, inflation, IDC, or roadway costs were included, but it was noted that these "non-bridge" costs are similar at each respective site for all options.

Because the estimated costs of the structures at each site are so similar, the Consultant recommended using a performance matrix with weighted criteria to identify the best-value structure type for each site. During the meeting, adjustments to the scoring of the Cyr and Clark Fork structures were made but did not alter the outcomes. The adjusted performance matrices sites are attached. The matrix for the relatively straightforward Old Highway 10 crossing was not included in the TS&L report but was used by the Consultant to make its recommendation.

After the presentation of common elements, the Consultant presented highlights from the TS&L Reports. The PowerPoint slides are attached and the TS&L Reports themselves provide the detailed information. The following is intended only to capture the discussion during the meeting.

Cyr:

Spread footings were not studied in detail because of the apparent risk of scour, with computed depths sufficient to indicate the eastbound substructure may be at risk of failure. Moving the proposed main span piers outward towards the respective banks mitigates the risk. Paul Hilchen noted that the streambed appears to be pretty well armored at this location. Luke Carlson pointed out that the scour calculations do not consider the materials and / or armor layer, noting that the underlying soils are very susceptible to scour should the armoring layer fail.

Drilled shafts with permanent casing would be challenging here but are the most practical and robust foundation type for the main span piers. A qualified contractor with the proper equipment and project planning should be able to readily complete the shafts, currently estimated to be 9-ft or 10-ft in diameter. Locating new shafts apart from the existing foundations will minimize possible conflicts with existing piling.

Drilled-in pipe piles were discussed, with the Consultant noting that even 30" pipe piles would not likely be sufficient for the lateral loads.

Long-term viability and maintenance costs of weathering steel are considered by the Department to be on-par with prestressed concrete beams. John Lynch also noted that once the spliced concrete girders are post-tensioned there is no need for future tensioning, and the strands can be well-protected against corrosion.

It was agreed that the costs to advance designs for both steel and concrete would likely not prove to be cost effective. To that end, the Consultant's recommendation to advance Option 2S – Four-Span Steel Girder bridge as the best value was accepted. As part of the recommendation, the design should include lowering the profile of the I-90 eastbound on-ramp to provide 17'-0" of clearance if feasible.

Clark Fork:

In response to Jon Rainwater's question about possible channel migration, John Turner noted that the river channel is incised in argillite rock, with no discernable change since the initial construction in 1965. While migration over time is possible, the time it would take for any significant shift in the channel is expected to be much longer than the life of the new bridge.

If removal of the existing footings at this site to 3 feet below the thalweg is required, the Contractor will need to get access to the river level and the work may present difficult conditions. Potential for blasting, possibly unpredictable river hydraulics results, and in-stream work restrictions add to the difficulty. Communication about the issues associated with this part of the work with MT Fish, Wildlife & Parks well before permit application(s) should help to gain their concurrence with the most feasible solution.

While drilling at the intermediate bent locations may prove challenging, it was agreed they should be better represented in the performance matrix score for Constructability. As can be seen in the adjusted matrix, the outcome would remain the same as presented in the TS&L Report. The Consultant's recommendation to advance Option B – Three-Span Steel Girder bridge as the best value was accepted.

Old Highway 10 / Elizabeth Lane:

The retaining walls needed to support the I-90 embankments for three of the options would be approximately 9 feet tall. It was agreed that any wall installed with the new bridge should be inspected regularly to maintain the integrity of the Interstate. Avoiding a structure layout that requires a retaining wall is preferred.

The Consultant's recommendation to advance Option 3S – Three-Span Steel Girder bridge as the best value was accepted.

Conclusion:

Design documents will be prepared for Alignment Review at all three sites with the recommended structure option at each.

TYPE SIZE AND LOCATION SELECTION



I-90 Structures – West of Alberton
NHPB 90-1(239)65
UPN 9786000

1

Meeting Purpose

- Outline bridge type, size, and layout options for each structure
- Present preliminary bridge cost estimates and recommendations

Meeting Outcome

- Establish Department preferences for any option or report considerations
- Confirm preferred structures to advance

2

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Project Overview

- Replace three westbound I-90 Structures
- Documented growing cracks in transverse steel girders, fracture critical details, and substandard elements.
- Clark Fork River crossing structures are ~760-ft and ~800-ft, with tall (120-ft to 160-ft) main span piers.
- Elizabeth Lane structure is fracture critical, in poor condition, and provides substandard vertical clearance over Old Highway 10

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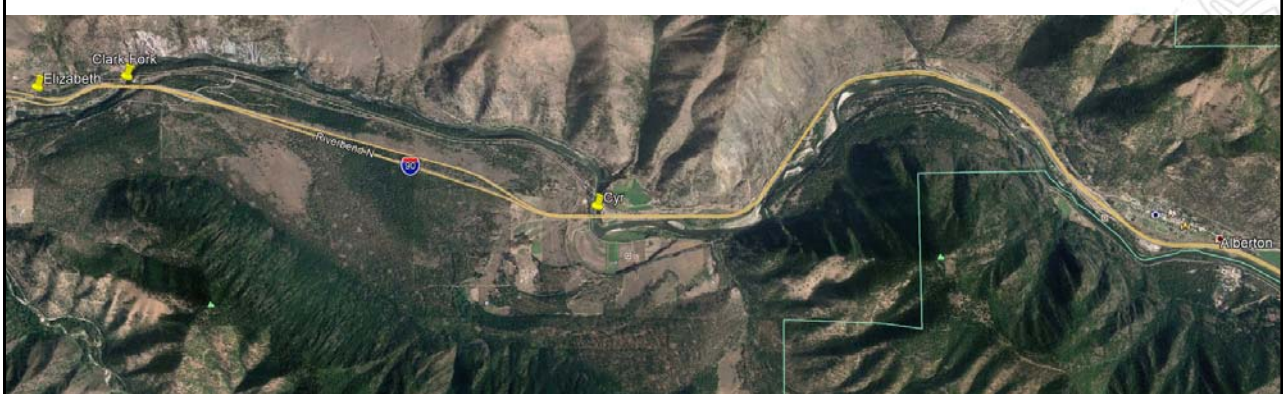
Locations

Clark Fork Structure – https://youtu.be/Fk0a_IlyS4I

Cyr Structure – https://youtu.be/wZQdn4KVMBE

Elizabeth Lane Structure - https://youtu.be/JitzO39IwlY



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Assumptions

- Replacement of structures
- No piers in the middle of the Clark Fork River
- Recreation (boater/floater) and environmental considerations will play a part in structure decisions
- Maintenance of traffic on crossovers in winter not preferred
- Embankment fill is acceptable to reduce bridge length on Old Hwy 10

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Roadway

- Roadway width: 38-ft face-of-barrier to face-of-barrier
  - Two 12-ft travel lanes
  - 10-ft outside shoulder
  - 4-ft inside shoulder
- Horizontal alignment maintained
  - Realignment would require reconstruction of ramps, acquisition of right-of-way, reconstruction of railroad bridge, etc.
- Vertical alignment maintained

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Maintenance of Traffic

- I-90
  - o Crossovers placed on eastbound lanes during construction
  - o Time and schedule dependent on project sequencing
  - o 1 crossover, or 2 crossovers
- Old Highway 10 / and Local Roads
  - o Access to Old Hwy. 10 (east of Clark Fork Bridge) available at Fish Creek Road (Exit 66)
  - o Potential temporary on- and off-ramps at Exit 65
  - o Negative individual and commercial recreational impacts are likely unavoidable

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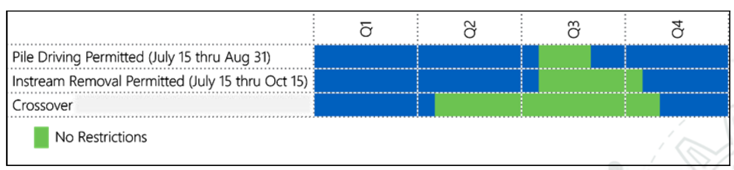
Environmental



- Piles should only be driven (dry land and in-water) between July 15 and August 31 without driving restrictions
- Instream removal of bridge piers should occur during low water (July 15 through October 15)
- Department preference to not have traffic crossovers during the winter season, which will be challenging due to project size and substructure challenges

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Environmental

- No permanent impacts to terrestrial resources are anticipated.
- No permanent impacts to Species Of Concern or special status species are anticipated.
- The project is expected to have “No Effect” on grizzly bear, Canada lynx, and whitebark pine.
- Wildlife Accommodation provided at all bridge sites
  - Additional 3-foot-wide mid-slope bench provided on the east embankment of the replacement structure

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Performance Matrix Criteria

- Constructability / Temporary Works (Ease of Access; Safety of Construction)
- Maintenance of Traffic (Duration of Impacts to I-90 Traffic; Local Roads)
- Construction Duration; Recreational Access (Temporary Disruption)
- Environmental Impacts (Construction Impacts; Wildlife Accommodations)
- Future Inspections and Maintenance (Expected Durability; Extraordinary On-Going Efforts)
- Project Development / Risk (Level of Uncertainties; Cost Escalation Risk)

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Performance Matrix Review

- Logical Criteria
- Proper Weighting
- Scoring of Options
  - Clark Fork Bridge
  - Cyr Interchange Bridge
- Finalize Type, Size, and Location Recommendation

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Demolition of Existing Structure

- Demolition of Old Highway 10 will follow typical removal for multiple span bridges over roadways in Montana
- Superstructure removal for Clark Fork and Cyr Bridges
  - Girders may require addition of temporary lateral bracing for removal
  - Deck/barrier removal followed by girder removal is expected to begin at the center span and move outward toward each bank.
  - Access expected on the existing structure, as well as work bridges below
- Substructure removal for Clark Fork and Cyr Bridges
  - Access from trails/roads and work bridges
  - River piers expected to be sawcut into small sections and lifted by cranes from work bridges
  - Remaining bents and abutments removed with typical methods on access roads or work bridge

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Accelerated Bridge Construction

- ABC elements are currently not incorporated in any bridge options
- Potential ABC elements that could be included in all options throughout design include:
  - Partial-depth precast concrete deck panels
    - Could reduce the schedule by two to three weeks
  - Full-depth precast concrete deck panels
    - Could reduce the schedule by approximately one month eliminating deck forming and concrete curing

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Construction Cost Estimates

- Preliminary construction cost estimates were completed for each option with the understanding that current market prices for labor and materials are extremely variable and could change significantly by the bid date of this project.
- Cost values include:
  - Bridge items, access, temporary works, and removal using current market prices
- Cost values do not include:
  - Contingencies, inflation, IDC, mobilization, roadway, CE, ICAP, traffic control, etc.
- Non-bridge costs are similar for all options.

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CYR BRIDGE

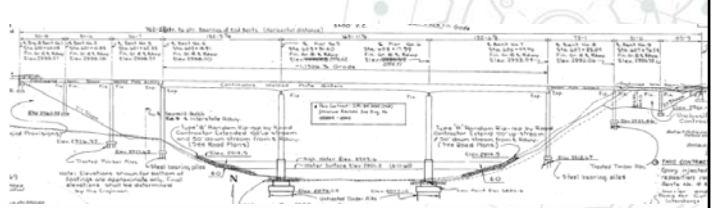
TYPE SIZE AND LOCATION

I-90 Structures – West of Alberton
NHPB 90-1(239)65
UPN 9786000

1

Existing Conditions

- Length: 762-ft
- Width: 31′-8″
- Spans: 9
- Span Lengths: 45′-9″ to 166′-0″
- Pier Height: 124-ft
- Foundations: Spread footings with no piles and spreads with steel or timber piles



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Vertical clearances

- Sawmill Gulch (sufficient clearance)
- I-90 EB on-ramp
  - EB Bridge: 17.38-ft
  - WB Bridge: 16.53-ft
- Lowering EB on-ramp required to achieve 17-ft vertical clearance
  - Options 1S and 1C: ~1-2 feet lower
  - Options 2S and 2C: a few inches lower
    - If a few inches less than 17-ft is acceptable, no roadwork would be required for 2S or 2C.

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Anticipated Construction Approach

- Construction / Equipment Access
  - East access from EB on-ramp
  - West access from Sawmill Gulch Rd.
    - Construction easement for access
  - Earthwork and vegetation removal required to widen for equipment access

4

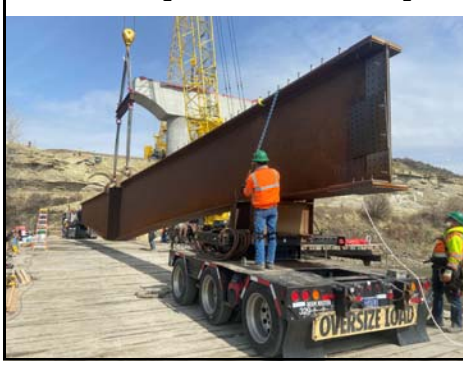
Anticipated Construction Approach

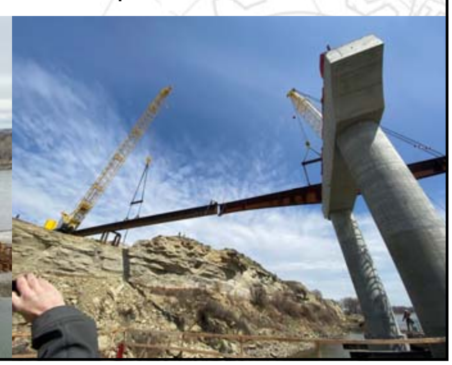
- Temporary Work Bridges
  - Work bridge and work bridge spurs required for removal of existing piers and construction of new piers
  - Work bridges constructed from each bank
    - West bank provides a more gradual slope
    - East bank is steeper and more challenging

5

Anticipated Construction Approach

- Erection
  - Launching, erection from EB bridge, highline, derrick cranes, etc. investigated
  - Large cranes erecting steel girders from work bridges anticipated





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Overview of Options

Substructure options:
- Driven piles foundations
- Drilled shafts

Superstructure:
- Welded steel plate girder
- Prestressed concrete girder
- Spliced post-tensioned concrete girder

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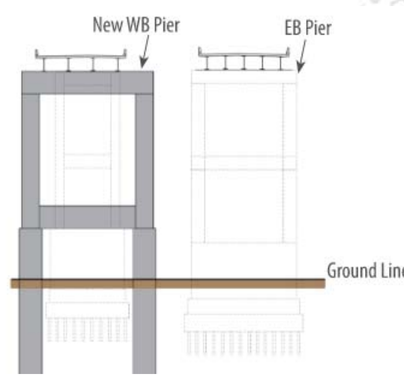
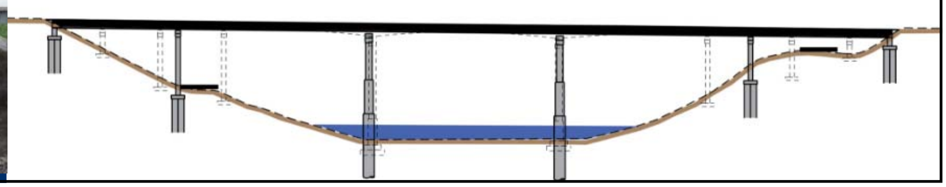
OPTION 1S: FIVE-SPAN STEEL GIRDER (110′-170′-170′-170′-120′)

- Continuous weathering steel girder
- ~90-ft tall spandrel river piers in waterway with drilled shafts
- Upland bents with driven pile foundations
- Driven pile founded abutments





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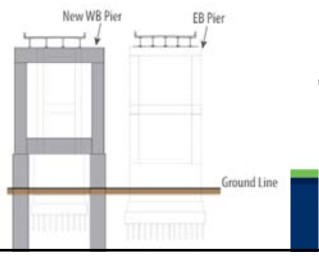
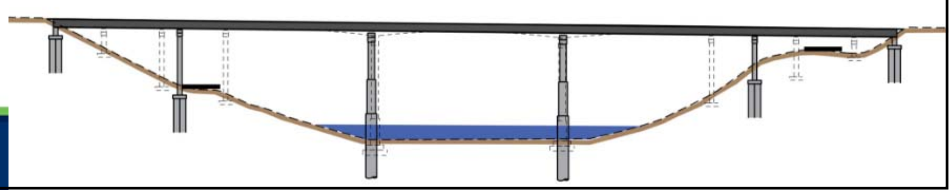
OPTION 1C: FIVE-SPAN PRESTRESSED CONCRETE GIRDER (110′-170′-170′-170′-120′)

- Prestressed concrete girder superstructure
- ~90-ft tall spandrel river piers in waterway with drilled shafts
- Upland bents with driven pile foundations
- Driven pile founded abutments





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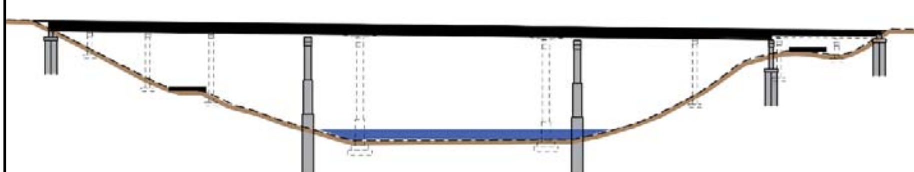
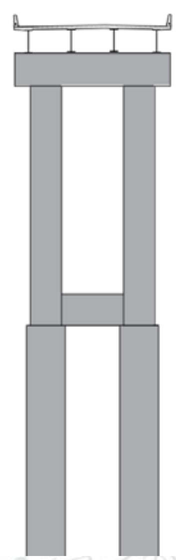
OPTION 2S: FOUR-SPAN STEEL GIRDER (225′-240′-175′-100′)

- Steel girder superstructure
- Main span piers located ~35-ft upland (from existing) with drilled shafts
- Upland bent and abutments with driven pile foundations
- Expansion joint at Bent No. 3





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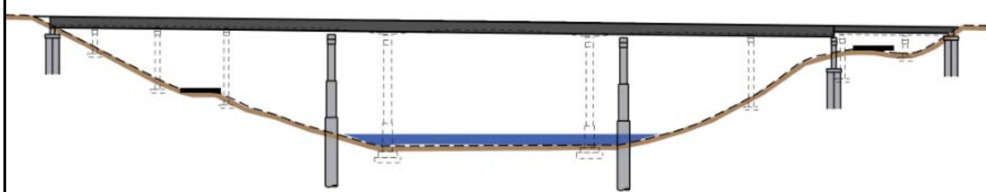
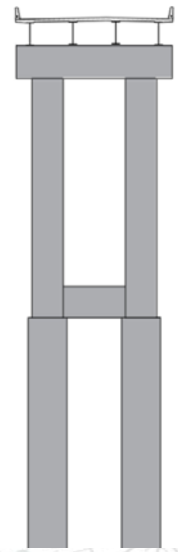
OPTION 2C: FOUR-SPAN SPLICED POST-TENSIONED CONCRETE GIRDER (225′-240′-175′-100′)

- Spliced post-tensioned concrete girder superstructure
- Main span piers located ~35-ft upland (from existing) with drilled shafts
- Upland bent and abutments with driven pile foundations
- Expansion joint at Bent No. 3





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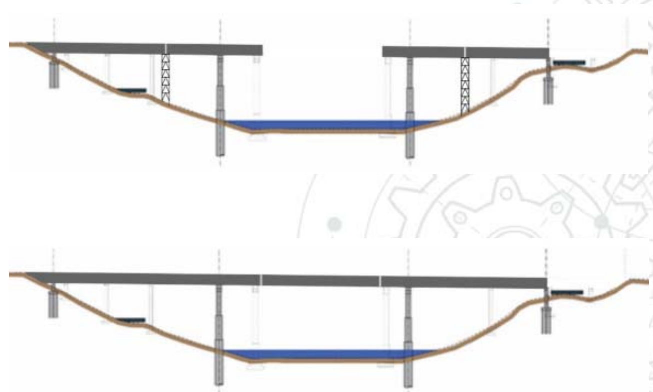
OPTION 2C: FOUR-SPAN SPLICED POST-TENSIONED CONCRETE GIRDER (225′-240′-175′-100′)

- Erection sequence
  - Construction of temporary supports
  - Place girder segments on supports
  - Post-tensioning ducts spliced, reinforcement placed, abutments/diaphragms cast, splice concrete
  - Stage 1 post tensioning installed
  - Place center span on corbel supports of existing piers
  - Install erection bolts and temp. lateral bracing.
  - Post-tensioning ducts spliced, reinforcement placed, abutments/diaphragms cast, splice concrete
  - Stage 2 continuity post-tensioning installed
  - Span 4 over I-90 EB on-ramp installed with standard construction methods.
  - Cast and cure deck and railing



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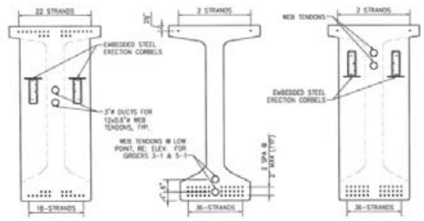
OPTION 2C: FOUR-SPAN SPLICED POST-TENSIONED CONCRETE GIRDER (225′-240′-175′-100′)

- Temporary Supports
  - Corbels
  - Strongback
- Long-term Maintenance and Inspection
  - Low-maintenance
  - Designed to keep the girder fully compressed during its life-span resulting in minimized concrete cracking
  - Tendons are protected by corrugated metal ducts filled with void-less cementitious grout
  - Duct grout caps are fully encased by the concrete closure pour



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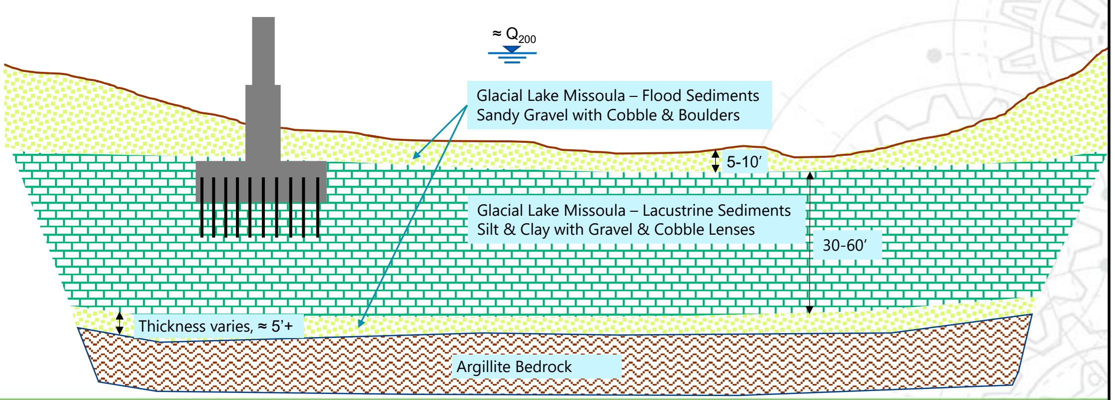
Hydraulics

- Riverbed Materials



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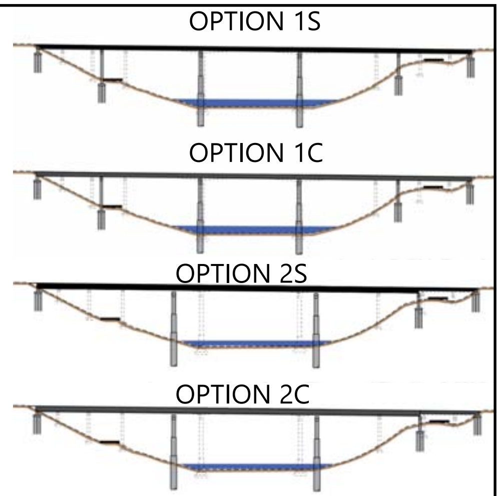
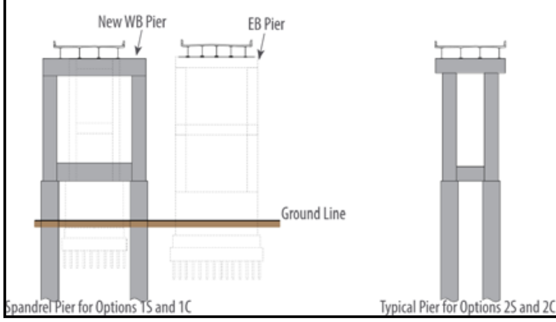
Hydraulics

- Proposed Waterway Pier Options
  - o Option 1: Piers in the channel (aligned w/ Ex.)
  - o Option 2: Piers located further landward





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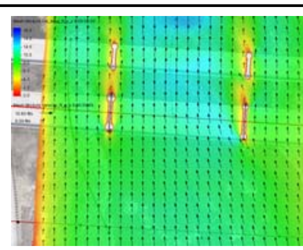
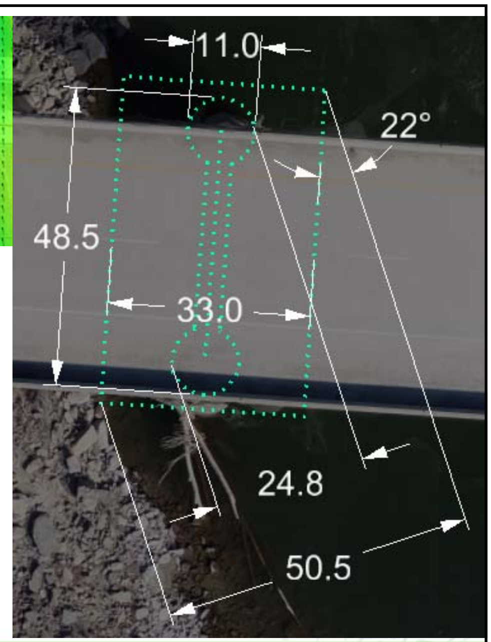
Hydraulics

- Existing Scour
  - o Scour Depth Risk = 19.4' (1996)
  - o Wall Pier, Footing, & Piling
  - o 22° Skew to Flow
  - o Computed Scour Depth Risk ≈ 58'
  - o Existing Maximum Scour ≈ 19.5' (Pile Buckling)
- Proposed Scour
  - o All Options Reduce Existing Risk
  - o 240' Option Increases Risk Reduction
  - o Computed Scour For 10' Column Group ≈ 31'





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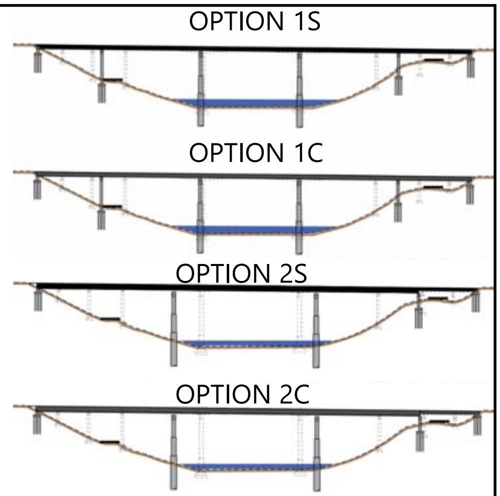
Geotechnical

- General site conditions
  - o Geology
  - o Seismic Zone 2
- Driven Piles
  - o Abutments and upland intermediate bents
  - o H-piles driven to depths of 40 to 50-ft at abutments
  - o H-piles driven to depth of ~50-ft for west upland bents and ~100+ ft on east upland bents
- Drilled Shafts
  - o 9-ft or 10-ft diameter drilled shafts
  - o Extend to depths of 15-18-ft into rock
  - o Casing



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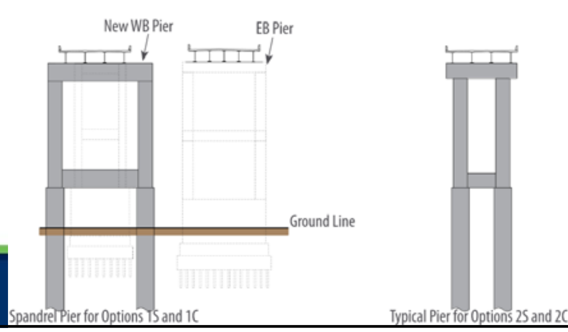
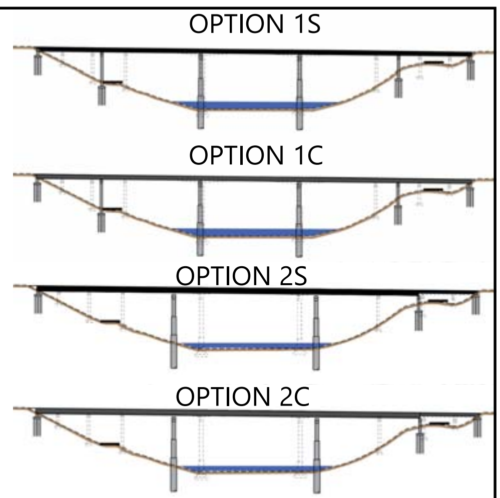
Geotechnical

- Challenges
  - o Existing timber piles
  - o Drilling around existing piers
  - o Drilling under structure vs. adjacent to existing piers





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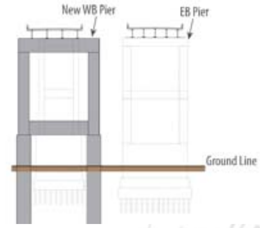
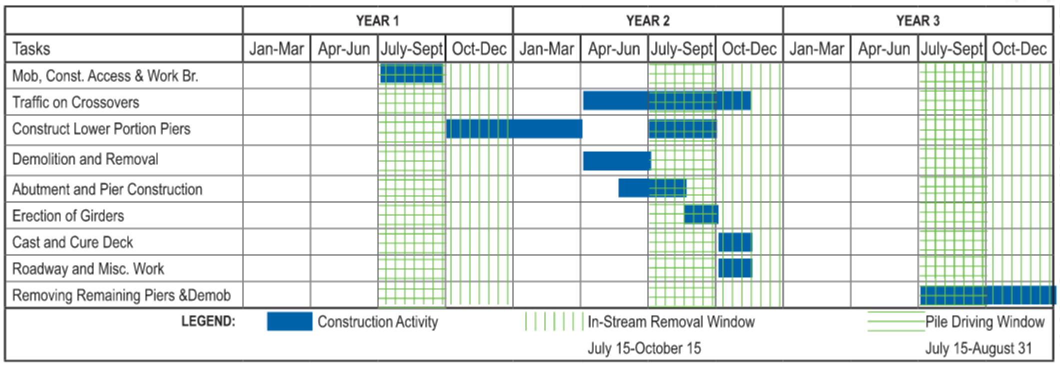
Construction Schedule





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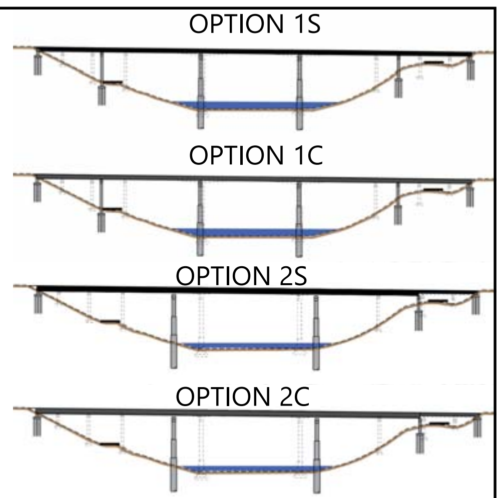
Summary Discussion



- Construction Cost
  - Option 1S: $12.9 M
  - Option 1C: $13.4 M
  - Option 2S: $12.4 M
  - Option 2C: $13.1 M
- Constructability
  - Options 1S and 1C require a wide-stance spandrel pier, compared to a more typical pier geometry for Options 2S and 2C
  - Options 2S and 2C will locate piers in the shadow under the existing bridge.

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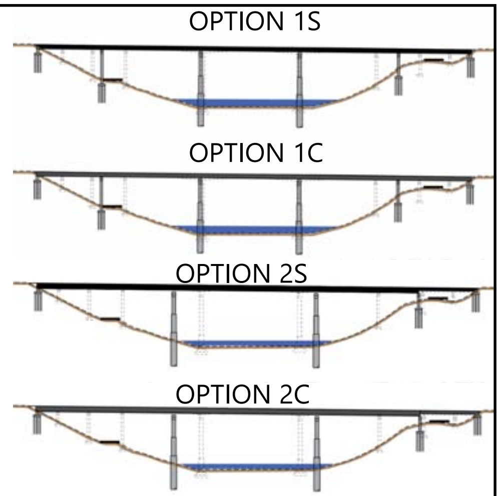
Summary Discussion



- Temporary Works
  - o Options 1S and 2S would allow for typical work bridge construction in Montana.
  - o Options 1C and 2C would require stronger and more robust work bridges likely requiring:
    - Additional piling
    - Additional spurs
    - Stronger girders

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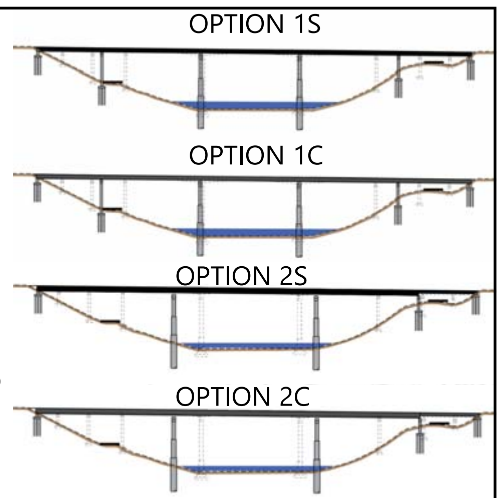
Summary Discussion



- Erection
  - o Options 1S and 2S include steel girder segments that would be erected with crane sizes common to Montana contractors
  - o Options 1C and 2C will require larger crane sizes to stage and place the prestressed concrete and spliced post-tensioned concrete girders
- Construction Duration / Traffic Impacts
  - o Option 2C is expected to take up to 2-3 weeks longer than the steel and prestressed concrete options but will not affect the overall construction duration

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Performance Matrix Criteria

- Constructability / Temporary Works (Ease of Access; Safety of Construction)
- Maintenance of Traffic (Duration of Impacts to I-90 Traffic; Local Roads)
- Construction Duration; Recreational Access (Temporary Disruption)
- Environmental Impacts (Construction Impacts; Wildlife Accommodations)
- Future Inspections and Maintenance (Expected Durability; Extraordinary On-Going Efforts)
- Project Development / Risk (Level of Uncertainties; Cost Escalation Risk)

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Performance Matrix

The preliminary findings of the design team indicate Option 2S is the best-value option considering the draft weighted performance criteria and the assigned numerical importance.

DRAFT

Performance Criteria		Constructability / Temporary Works	Maintenance of Traffic	Construction Duration / Recreational Access	Environmental Impacts	Future Inspections and Maintenance	Project Development / Risk	Total Performance Score	Construction Cost ($M)	Best Value (Performance/Cost)
		Assigned Weights								
Weight		30	15	10	20	10	15	100		
Option 1S	5									
	4									
	3									
	2									
	1									
	Subtotal:	90	60	30	80	30	45	345	12.9	26.7
Option 1C	5									
	4									
	3									
	2									
	1									
	Subtotal:	60	60	30	80	40	45	315	13.4	23.5
Option 2S	5									
	4									
	3									
	2									
	1									
	Subtotal:	90	60	40	80	30	60	360	12.4	29.0
Option 2C	5									
	4									
	3									
	2									
	1									
	Subtotal:	60	60	30	80	40	45	315	13.1	24.0

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Performance Criteria		Constructability / Temporary Works	Maintenance of Traffic	Construction Duration / Recreational Access	Environmental Impacts	Future Inspections and Maintenance	Project Development / Risk	FINAL		
	Assigned Weights							Total Performance Score	Construction Cost ($M)	Best Value (Performance/Cost)
Weight		30	15	10	20	10	15	100		
Option 1S	5									
	4									
	3									
	2									
	1									
Subtotal:		90	60	40	80	40	45	355	12.9	27.5
Option 1C	5									
	4									
	3									
	2									
	1									
Subtotal:		60	60	30	80	40	45	315	13.4	23.5
Option 2S	5									
	4									
	3									
	2									
	1									
Subtotal:		90	60	40	80	40	60	370	12.4	29.8
Option 2C	5									
	4									
	3									
	2									
	1									
Subtotal:		60	60	30	80	40	45	315	13.1	24.0

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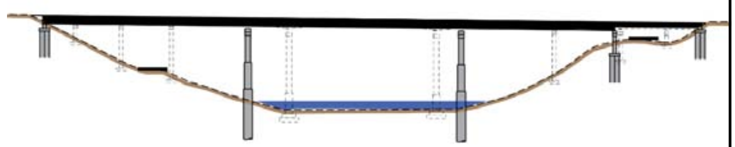
Conclusion and Recommendation

OPTION 2S: FOUR-SPAN STEEL GIRDER (225'-240'-175'-100')

- Steel girder superstructure
- Main span piers located ~35-ft upland (from existing) with drilled shafts
- Upland bent and abutments with driven pile foundations
- Expansion joint at Bent No. 3



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SK GEOTECHNICAL
MONTANA MDT DEPARTMENT OF TRANSPORTATION
DAN BROWN AND ASSOCIATES
MODJESKI and MASTERS — Experience great bridges.

CLARK FORK BRIDGE

TYPE SIZE AND LOCATION

I-90 Structures – West of Alberton
NHPB 90-1(239)65
UPN 9786000

1

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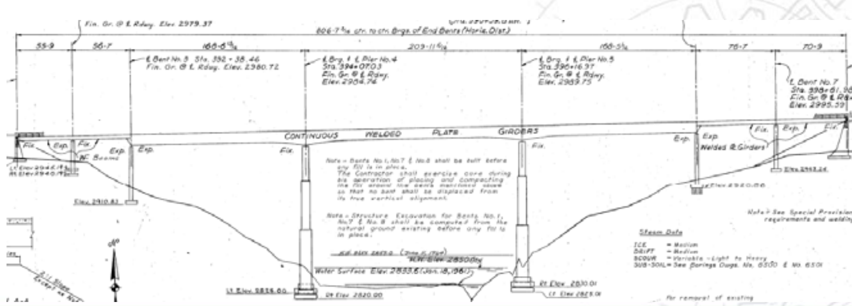
Existing Conditions

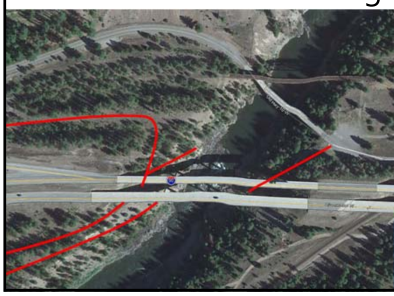
- Length: 807-ft
- Width: 31’-8”
- Spans: 7
- Span Lengths: 55’-9” to 210’-0”
- Pier Height: 165-ft
- Foundations: Spread footings (one with piles)



2

Anticipated Construction Approach

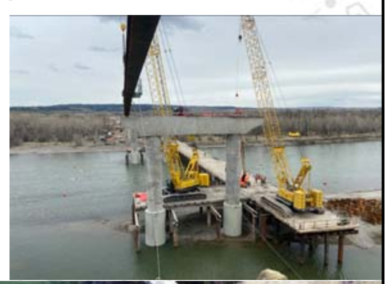
- Construction / Equipment Access
  - East access from parking area and trail
  - West access from Exit 65
    - Construction easement along powerline corridor
    - Interstate R/W (no easement, additional earthwork required)
  - Earthwork and vegetation removal required to widen for equipment access

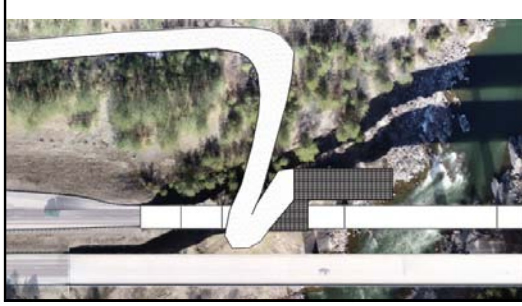


3

Anticipated Construction Approach

- Temporary Work Bridges
  - Work bridges constructed from each bank on steep, rocky, challenging terrain
  - Spurs required for removal of existing piers and construction of new piers
  - Specialized drilled piling likely required





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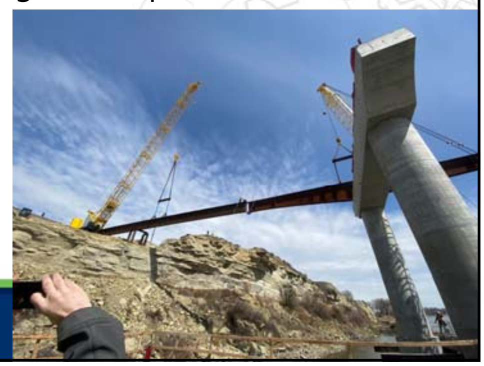
Anticipated Construction Approach

- Erection
  - Launching, erection from EB bridge, highline, derrick cranes, etc. investigated
  - Large cranes erecting steel girders from work bridges anticipated



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Overview of Options

Substructure options:
- Spread footings
- Driven piles foundations
- Drilled shafts

Superstructure:
- Welded steel plate girder

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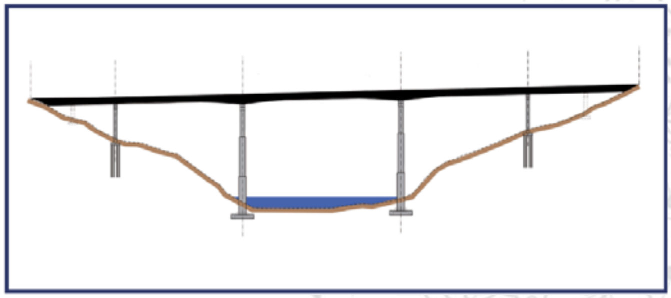
OPTION A: FIVE SPANS (120′-160′-210′-180′-130′)

- Continuous weathering steel girder
- ~150-ft tall river piers in waterway with spread footings
- ~60-ft tall upland bents with driven pile foundation
- Driven pile founded abutments



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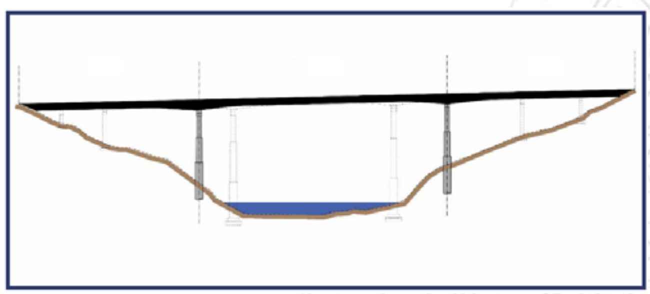
OPTION B: THREE SPANS (225′-330′-245′)

- Continuous weathering steel girder
- ~100-ft tall upland bents with drilled shaft foundation
- Driven pile founded abutments



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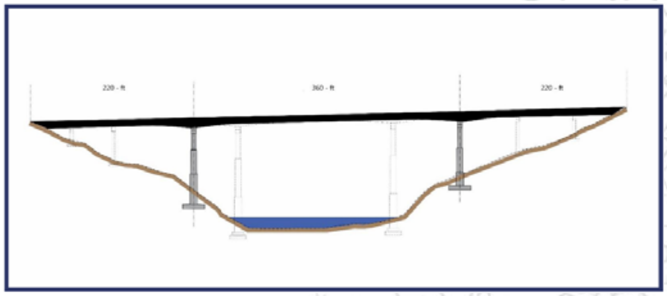
OPTION C: THREE SPANS (210'-360'-230')

- Continuous weathering steel girder
- ~100-ft tall upland bents with spread footing foundation
- Driven pile founded abutments



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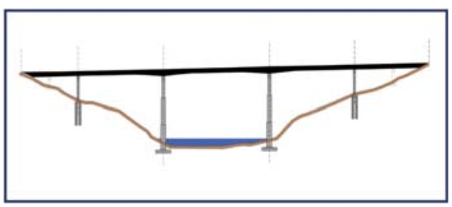
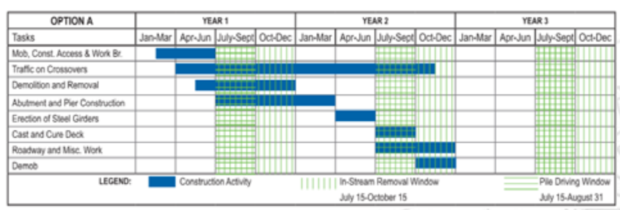
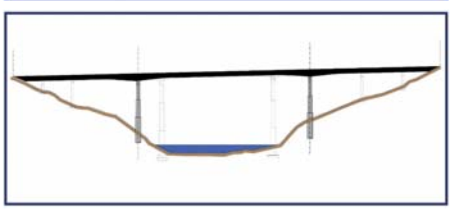
Construction Schedule

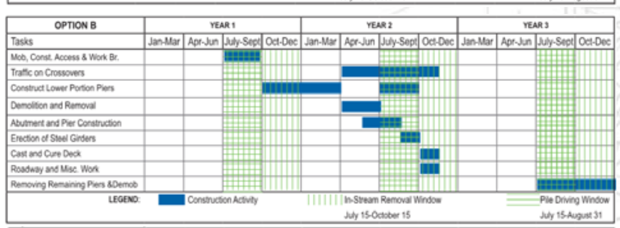
OPTION A



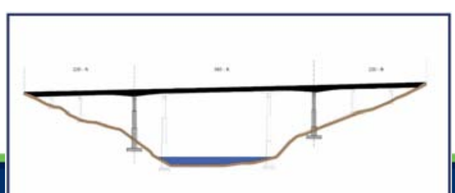


OPTION B





OPTION C



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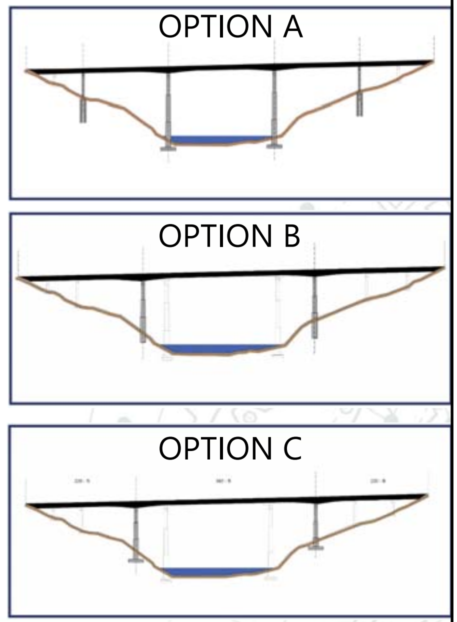
Hydraulics

- Scour concerns not anticipated due to bedrock channel resistant to scour
- Option A: Piers located in the water
- Options B & C: Bents located upland out of waterway



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Geotechnical

- General site conditions
  - o Geology
  - o Steep Slopes
- Seismic Zone 2
  - o On the line between Zone 1 and 2, but designed to Zone 2, due to bridge and site complexity

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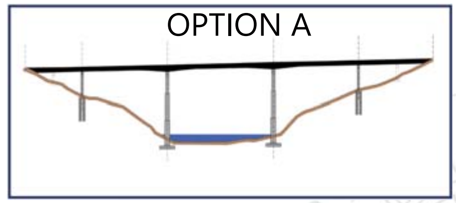
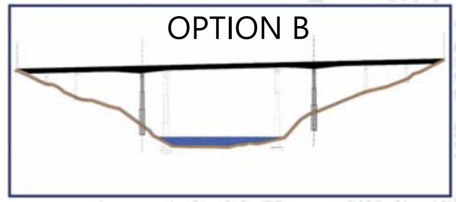
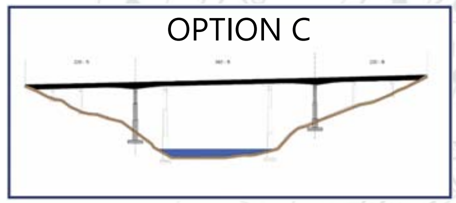
Foundations – Option A

- Driven Piles
  - o Abutments and upland intermediate bents
  - o H-piles driven to depths of 40 to 50-ft
- Spread Footings
  - o Approximate dimensions of 20-ft longitudinal by 42-ft transverse







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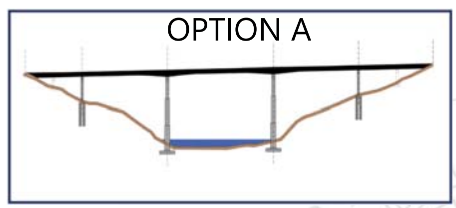
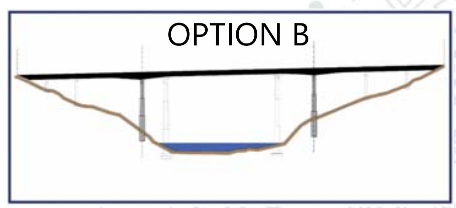
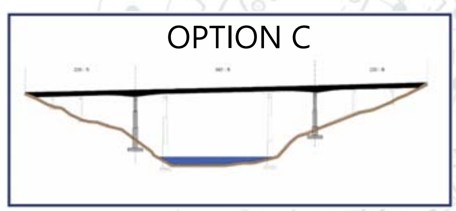
Foundations – Option B

- Driven Piles
  - o Abutments and upland intermediate bents
  - o H-piles driven to depths of 40 to 50-ft
- Drilled Shafts
  - o 8-ft dia. shafts extending 20 to 24-ft into rock







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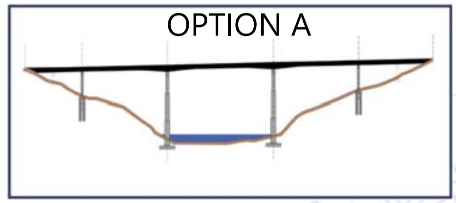
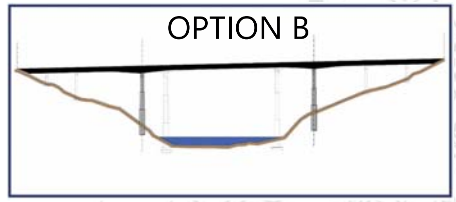
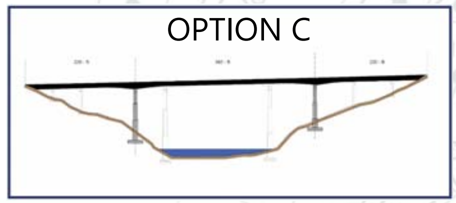
Foundations – Option C

- Driven Piles
  - o Abutments and upland intermediate bents
  - o H-piles driven to depths of 40 to 50-ft
- Spread Footings
  - o Approximate dimensions of 20-ft longitudinal by 42-ft transverse
  - o Large quantity of excavation/fill required for Option C







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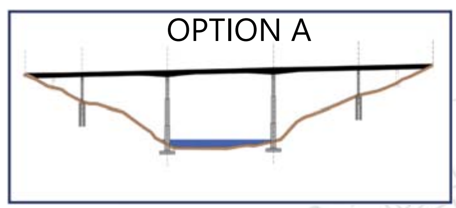
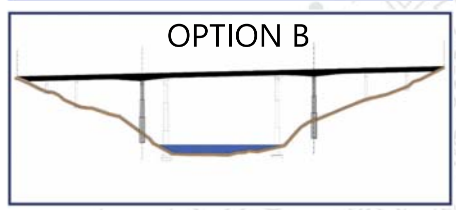
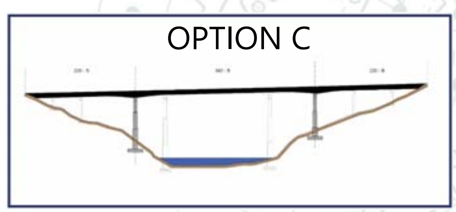
Summary Discussion

- Construction Cost
  - o Option A: $13.5M
  - o Option B: $13.3M
  - o Option C: $14.0M
- Constructability
  - o Option A requires construction of spread footings within Clark Fork River OHWM, requiring use of cofferdams and dewatering
  - o Options B and C eliminate in-stream construction







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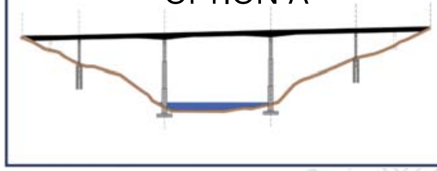
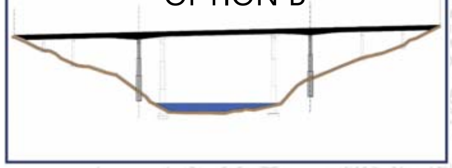
Summary Discussion

- Temporary Works
  - o Significant temporary structures required for all options
  - o Option C will require significant temporary support of excavation (shoring) for construction of footings on steep side slopes
- Erection
  - o Option A, B & C end spans could be erected with cranes on ground and main span from temporary work bridges
  - o Longer spans Options B and C may require additional girder splices for erection

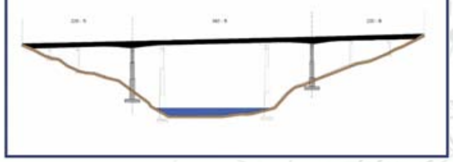
OPTION A



OPTION B



OPTION C



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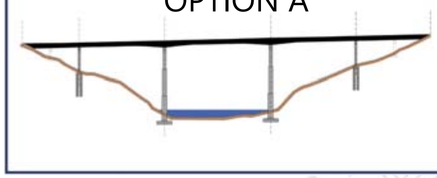
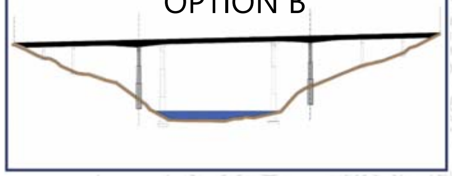
Summary Discussion

- Traffic Impacts
  - o Option A: Crossovers required during the entire construction schedule (winter crossovers required)
  - o Options B and C: Construction sequencing could eliminate winter crossovers
- Maintenance / Inspection
  - o Option A would require regular underwater inspections on river piers
  - o Options B and C would require regular inspection and maintenance for intermediate bents outside the waterway

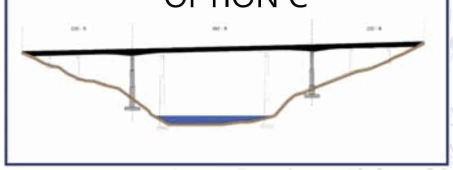
OPTION A



OPTION B



OPTION C



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Performance Matrix Criteria

- Constructability / Temporary Works (Ease of Access; Safety of Construction)
- Maintenance of Traffic (Duration of Impacts to I-90 Traffic; Local Roads)
- Construction Duration; Recreational Access (Temporary Disruption)
- Environmental Impacts (Construction Impacts; Wildlife Accommodations)
- Future Inspections and Maintenance (Expected Durability; Extraordinary On-Going Efforts)
- Project Development / Risk (Level of Uncertainties; Cost Escalation Risk)

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Performance Matrix

The preliminary findings of the design team indicate Option B is the best-value option considering the draft weighted performance criteria and the assigned numerical importance.

Note: For the final structure selection report, this matrix will be reviewed with the Department after consideration of the draft report to review:

- Performance Criteria;
- Assigned Weights to each Criterium;
- Scoring of Options A through C; and
- Finalize the Best-Value Option.

DRAFT

Performance Criteria		Constructability / Temporary Works	Maintenance of Traffic	Construction Duration / Recreational Access	Environmental Impacts	Future Inspections and Maintenance	Project Development / Risk	Total Performance Score	Construction Cost ($M)	Best Value (Performance/Cost)
		Assigned Weights								
Weight		30	15	10	20	10	15	100		
Option A	5									
	4									
	3									
	2									
	1									
	Subtotal:	60	30	40	60	30	45	265	13.5	19.6
Option B	5									
	4									
	3									
	2									
	1									
	Subtotal:	90	60	30	80	40	45	345	13.3	25.9
Option C	5									
	4									
	3									
	2									
	1									
	Subtotal:	90	60	30	80	40	30	330	14.0	23.6

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FINAL

Performance Criteria		Constructability / Temporary Works	Maintenance of Traffic	Construction Duration / Recreational Access	Environmental Impacts	Future Inspections and Maintenance	Project Development / Risk	Total Performance Score	Construction Cost ($M)	Best Value (Performance/Cost)
		Assigned Weights								
Weight		30	15	10	20	10	15	100		
Option A	5									
	4									
	3									
	2									
	1									
	Subtotal:	60	30	40	60	30	45	265	13.5	19.6
Option B	5									
	4									
	3									
	2									
	1									
	Subtotal:	90	60	30	80	40	45	345	13.3	25.9
Option C	5									
	4									
	3									
	2									
	1									
	Subtotal:	60	60	30	80	40	30	300	14.0	21.4

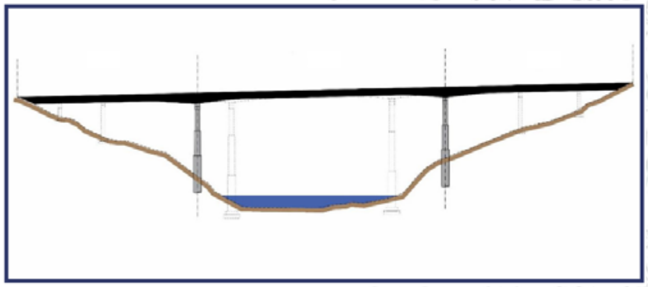
This type of evaluation is completed early in the project development stage to provide broad support for selection of a single option to advance to Alignment and Grade Review. In this case, the measure of value was calculated as the ratio of performance over the estimated cost. The best-value is provided by greater performance, while still accounting for cost.

The preliminary findings of the design team indicate Option B is the best-value option considering the draft weighted performance criteria and the assigned numerical importance.

Conclusion and Recommendation

OPTION B: THREE SPANS (225′-330′-245′)

- Continuous weathering steel girder
- ~100-ft tall upland bents with drilled shaft foundation
- Driven pile founded abutments



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OLD HIGHWAY 10

TYPE SIZE AND LOCATION

I-90 Structures – West of Alberton
NHPB 90-1(239)65
UPN 9786000

1

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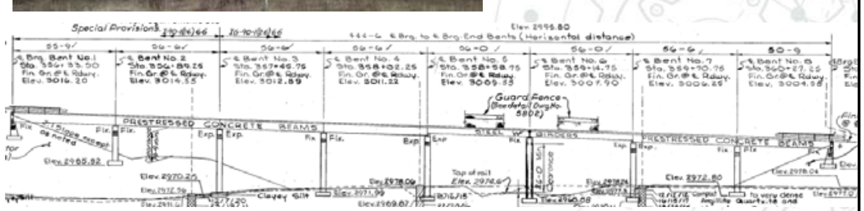
Existing Conditions

- Bridge Length: 445-ft
- Bridge Width: 31′-8″
- No. Spans: 8
- Span Lengths: 50′-9″ to 56′-6″
- Pier Height: 40-ft
- Foundations: Spread footings



2

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Roadway

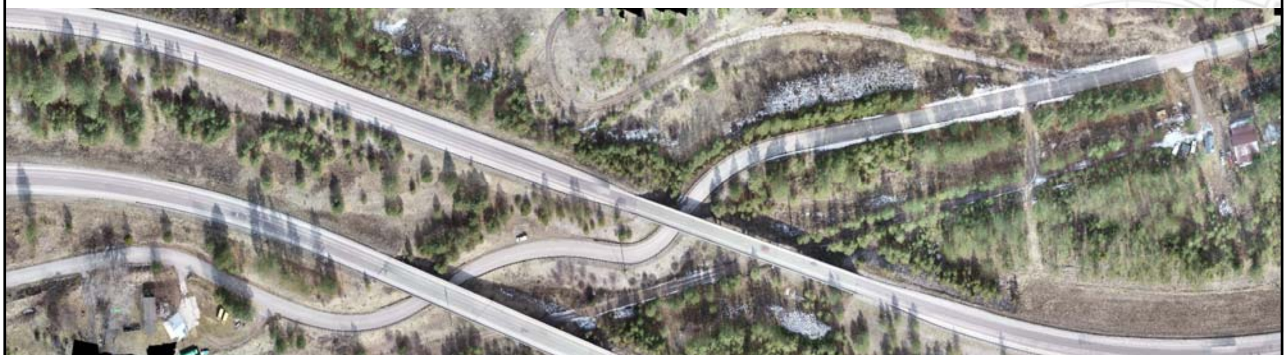
- Vertical clearance requirements for Highway 10 EB and WB
  - EB Vertical Clearance: 14.04-ft
  - WB Vertical Clearance: 15.42-ft
- Utilities
  - Overhead
  - Underground
- Wildlife Crossing
- Right-of-Way

3

4

Old Highway 10

Existing Alignment



5

Roadway and Bridge Options

- Straightening Old Hwy 10 to eliminate S-Curves
- Full-length bridge replacement (replace in-kind)
- Moving Elizabeth Lane Approach Access along Old Hwy 10

Replace structure at same length

Maintain Highway 10 alignment

Realign Highway 10

6

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Geotechnical

- General Site Conditions
- Seismic Zone 2
- Foundations
  - Driven Piles
    - Abutments and intermediate bents
  - Spread footings
    - Intermediate bents if final design loading allows
- Slope stability

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Anticipated Construction Approach

- Typical access, erection, removal for multiple-span structures over land in MT
- Some temporary shoring may be required
- Crossovers for traffic
- One construction season expected

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Structure Layout Options Considered

Substructure options
- Spread footings
- Driven Piles

Superstructure
- Welded steel plate girder
- Prestressed concrete girder

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OPTION 1: FULL LENGTH STRUCTURE (REPLACE IN-KIND)

- Span lengths: 110’, 112’, 112’, 110’ (444’)
- No changes to HWY 10, Elizabeth Lane, or structure location
- Larger deck area for future maintenance
- Higher construction and future maintenance cost

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OPTION 2S: TWO-SPAN STEEL GIRDER (100'-150')

- Continuous weathering steel girder
- Eliminates six bents and reduces bridge length by ~195-ft from existing
- Retaining wall required between I-90 embankment fill and Elizabeth Lane
- Bridge construction cost: $2.3 M

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OPTION 2C: TWO-SPAN PRESTRESSED CONCRETE GIRDER (90'-150')

- Prestressed concrete girder
- Eliminates six bents and reduces bridge length by ~205-ft from existing
- Retaining wall required between Northeast I-90 embankment fill and Elizabeth Lane
- Retaining wall required between Southwest I-90 embankment fill and Old Hwy 10
- Bridge construction cost: $2.4 M

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OPTION 3S: THREE-SPAN STEEL GIRDER (100'-100'-70')

- Continuous welded steel girder
- Eliminates five bents and reduces bridge length by ~175-ft from existing
- Bridge construction cost: $2.2 M

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OPTION 3C: THREE-SPAN PRESTRESSED CONCRETE GIRDER (90'-90'-80')

- Prestressed concrete girder
- Eliminates five bents and reduces bridge length by ~185-ft from existing
- Retaining wall required between Southwest I-90 embankment fill and Old Hwy 10
- Bridge construction cost: $2.3 M

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Summary Discussion

- Construction Cost
  - 2S. Two-span steel girder (100’-150’): $2.3M
  - 2C. Two-span prestressed concrete girder (90’-150’): $2.4M
  - 3S. Three-span steel girder (100’-100’-70’): $2.2M
  - 3C. Three-span prestressed concrete girder (90’-90’-80’): $2.3M

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Summary Discussion

- Comparison
  - Two-span
    - Retaining walls required between realigned Elizabeth Lane and east abutment
    - Steel and prestressed concrete beams are at max span lengths due to vertical and horizontal clearance requirements
  - Three-span
    - Slightly lower in cost and eliminate the need for retaining walls at the east abutment (improving wildlife accommodations)
    - Option 3C is designed at its max span length and requires a retaining wall at the west abutment
    - Option 3S provides more flexibility for span length adjustments and does not require retaining walls

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Conclusion and Recommendation

OPTION 3S: THREE-SPAN STEEL GIRDER (100'-100'-70')

- Flexibility in final design
- No retaining walls required
- Most cost-effective option

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Meeting Minutes
I-90 Structures – West of Alberton
NHPB 90-1(239)65; UPN 9786000

Date: **August 19, 2021 – 12:30pm**

Attendees:

- ☒ Bob Vosen, MDT
- ☒ Jason Senn, MDT
- ☒ Andy Cullison, MDT
- ☒ Jacquelyn Smith, MDT
- ☒ John Schmidt, MDT
- ☒ Jim Scoles, MMI
- ☒ Andy Mish, M-M
- ☒ Larry Egan, M-M
- ☒ Paul Axtell, DBA
- ☒ John Turner, DBA
- ☒ Jason Millar, MMI
- ☒ Charlie Brisko, MMI
- ☒ Phill Forbes, MMI

Purpose: A meeting was held on this date to discuss the initial, high-level screening of structure types for I-90 Structures – West of Alberton project. Refer to the attached matrices for a list of structure types, along with the pros and cons of each discussed during the meeting.

Outcome: Direction was provided to the Consultant team regarding Department preferences to narrow the list of structure types to advance to a more detailed study.

The meeting began with introductions followed by Jim Scoles noting that full replacement of the structures is presented for all three structures. The remaining portion of the meeting was dedicated to a PowerPoint presentation of the three sites and structure types and sizes considered, with discussions on the following topics.

Base Assumptions: The following assumptions to be used by the Consultant team were affirmed:

- Full replacement of structures and substructures, based on earlier Foundation Reuse Report recommendations;
- No significant changes to I-90 alignments;
- No proposed piers in mid-river; and
- Environmental constraints regarding pile driving and bridge removal activities will bear on the construction schedule.

Crossovers: Maintaining traffic on crossovers during the winter is a maintenance and safety concern. While not preferred, crossovers are acceptable if a positive barrier between lanes on the eastbound structures is provided. Consideration should also be given to alternative routing in the event of a crash / incident occurring within the limits of two-way traffic on the eastbound lanes.

Jim Scoles noted that there are structure layouts that could avoid winter crossovers.

Beams: Andy Mish noted that spliced post-tensioned precast concrete beams have been used in Montana and can extend span lengths. Constant-depth sections can be used up to approximately 240'; variable-depth sections up to approximately 325'. Andy also noted that much depends on precaster capabilities and options for delivery to the site.

Steel and precast concrete beam options are available options for all sites. Andy Cullison stated that the Department has experienced fewer long-term maintenance problems with concrete beams across the state, but acknowledged that with weathering steel plate, maintenance should not preclude further study of steel plate girders. Andy recommended conferring with Dave Crumley as the Department's best source for bridge maintenance issues / history. The Consultant team was directed to continue to consider steel and concrete options as appropriate.

Clark Fork Bridge: Jim Scoles introduced this site as having considerable physical constraints that limit the number of feasible options. Of primary concern is difficult physical access for construction equipment to reach the river at this site. Two separate shorter work bridges constructed from opposite banks is currently believed to be the likeliest possibility to remove the existing structure and construct the new bridge. Additional access and erection approaches will be studied in further detail as the study advances.

The eight options described in the attached matrix for the Clark Fork River – Structure 01379 were reviewed. Jim Scoles noted the three options recommended for further study are all steel beams; option 1 with concrete beams is considered a viable option except that the weight of the individual girders is a concern for erection. Charlie Brisko stated that costs will be developed during the detailed study of all options carried forward.

In response to a question, Andy Cullison indicated that underwater inspections are a regular component of the Department's inspection program and should not drive the selection of bridge layout.

Cyr Interchange Bridge: Jim Scoles stated that this site has similar constraints to the Clark Fork Bridge, although access should be easier. A single work bridge constructed from the readily accessed west bank of the river is considered the likeliest possibility to remove the existing structure and construct the new bridge. However, large boulders will be a challenge for pile driving to construct the work bridge.

An additional design consideration is the vertical clearance of the new structure over the eastbound I-90 on-ramp. As-built plans indicate a "14'-6" Min." clearance; inspection reports indicate 16'-6" vertical clearance is provided; 17'-0" is the desirable clearance for the replacement structure.

The six options described in the attached matrix for the Cyr Interchange – Structure 01385 were reviewed. Jim Scoles noted the two basic options recommended for further study include steel, prestressed concrete, and spliced post-tensioned concrete girders. A third option identified as "4S" in the matrix is questionable given the perched foundation. The foundations of the piers located adjacent to the river channel are possibly susceptible to scour with any migration of the main channel of the river.

Andy Cullison expressed concern about the Department's existing snooper trucks possible limitations to reach below the deck. The Consultant team will seek Dave Crumley's input in this regard. Mr. Cullison also inquired if rigid "K-frame" piers were considered to decrease the length of the center span. Andy Mish stated that in his experience, K-frame piers are generally not used at this tall of pier heights, but the

Consultant team would evaluate this type of substructure. The design team further discussed K/V piers in more detail after the meeting and followed up with Andy on September 2nd. The design team and Andy agreed that the use of K/V piers are tied more to aesthetics and would not provide benefit for access, constructability, or cost for either the Clark Fork or Cyr Bridges. No further action will be required.

Elizabeth Lane Bridge: Jim Scoles noted that preliminary analysis indicates good options at this site using 100' spans. The primary structure layout drivers include whether the Department wants to realign Old Highway 10 under the structure to remove one of the existing curves currently posted with a 25 mph advisory plate, and whether to accommodate feasible wildlife passage recommendations.

Bob Vosen indicated his interest in shortening the bridge to decrease initial and long-term maintenance costs, but said he would only make that decision after an on-site review. Jason Senn was tasked with setting up a field review, and will include Maintenance personnel in the meeting.

Given evidence that larger animals are currently using Elizabeth Lane as a crossing corridor, maintaining reasonable wildlife passage is warranted.

Schedule: Jim Scoles advised the attendees that the bathymetric survey at the two river crossings has proved to be extremely difficult and has not been completed as of this date. This lack of data has already delayed the hydraulic and scour analyses.

Jason Senn indicated that overall the project is about one month behind schedule for the Alignment Review milestone submittals and review.

Summary / Action Items: The following near-term actions will be taken:

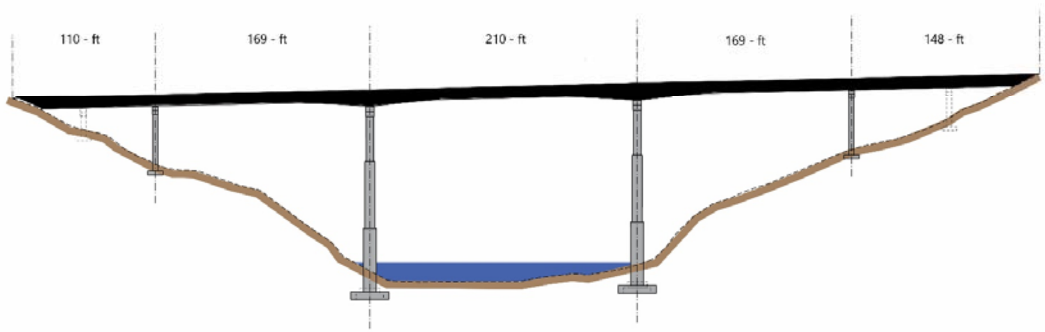
1. Andy Cullison stated that he would take the information provided today under advisement, discuss issues with others in the Bridge Bureau, and provide comments, if any, to the Consultant team.
2. Jason Senn will schedule an on-site field review of Old Highway 10 and Elizabeth Lane to facilitate a decision regarding improvement of these roadways to improve safety and shorten the replacement structure.
3. The Consultant team will carry the following matrix options forward to detailed structure selection analysis reports:
    a. Clark Fork: Option 1S, Option 2S, Option 3S
    b. Cyr Interchange: Options 1S and 1C, Options 2S and 2C
4. I-90 bridge options at Elizabeth Lane / Old Highway 10 will be presented directly with a detailed structure selection analysis report, i.e. no initial, high-level screening of structure types will be conducted.

The meeting ended at 2:00pm

Attachments:
Clark Fork Matrix and PowerPoint Slides
Cyr Matrix and PowerPoint Slides
Elizabeth Lane / Old Highway 10 PowerPoint Slides

Further Study	Option	Description	Advantages	Disadvantages	Comments
X	1S	**Span lengths: 110, 169, 210, 169, 148** • Match existing bent and pier locations, remove two upland bents • Welded steel plate girders	• Shorter span with low superstructure cost • Easier erection with lighter steel members	• Challenging access to river for pier construction • Crossovers required during the winter • Very tall piers (160') located within waterway and additional projection of piers into waterway due to skew • Potential environmental impact for bull trout, due to piers located further in the river • Underwater pier/foundation inspection required	• Potential scour • Piers could be skewed to minimize projection into river
	1C	**Span lengths: 110, 169, 210, 169, 148** • Match existing bent and pier locations, remove two upland bents • Spliced post-tensioned concrete girders	• Cost effective superstructure • Precast production can be optimized for construction schedule	• Challenging access to river for pier construction • Crossovers required during the winter • Very tall piers (160') located within waterway and additional projection of piers into waterway due to skew • Heavy girders increase erection challenges • Potential environmental impact for bull trout, due to piers located further in the river • Underwater pier/foundation inspection required	• Potential scour • Piers could be skewed to minimize projection into river
X	2S	**Span lengths: 235, 325, 245** • New main piers upland of existing • Welded steel plate girders	• Four intermediate bents are eliminated • Easier new pier access • Crossovers likely not required during winter	• Challenging long span steel structure • Large steel girders with costly superstructure • Larger equipment required to erect	
	2C	**Span lengths: 235, 325, 245** • New main piers upland of existing • Spliced post-tensioned concrete girders	• Four intermediate bents are eliminated • Easier new pier access • Crossovers likely not required during winter • Precast production can be optimized for construction schedule	• Challenging long span concrete structure • Large prestressed concrete girders with costly superstructure • Larger equipment required to erect	• Splice post-tensioned girders will require variable depth girders over piers • Need to coordinate with MDT and precasters to assess capabilities and investment required
X	3S	**Span lengths: 220, 360, 225** • New main piers upland of existing • Welded steel plate girders	• Four intermediate bents are eliminated • Easier new pier access • Spread footings • Crossovers likely not required during winter	• Challenging long span steel structure • Large steel girders with costly superstructure • Larger equipment required to erect	
	4C	**Span lengths: 220, 360, 225** • Cast – in – place, segmentally erected	• Could simplify erection challenges	• Expensive design and construction • Not typical for MT • Increased schedule requirements for construction duration • Inefficient span configuration and small volume will increase construction unit costs • Crossovers required during winter	• Need to provide equipment access for demolition of existing structure, which mitigates need for special construction techniques for new structure
	5S & C	**Span lengths: 180, 220, 220, 180** • One pier at mid-bridge in the middle of the river • Steel or spliced post-tensioned concrete girders	• Four equal span lengths provide options for prestressed or steel • Crossovers likely not required during winter	• Likely not an option for pier in the middle of the river • Difficult work bridge over tough water	• Spliced post-tensioned girders can be designed with constant depth sections over piers
	6S & C	**Span lengths: 260, 315, 232** • Match west main pier location, locate east main pier upland of existing • Steel or spliced post-tensioned concrete girders	• Four intermediate bents are eliminated • Pier height reduced for one main pier	• Crossovers required during the winter • Tall west main span pier • Challenging access to river for pier construction (160' piers in the river)	• Spliced post-tensioned girders will require variable depth girders over piers • Need to coordinate with MDT and precasters to assess capabilities and investment required
	7S & C	**Span lengths: 200, 295, 168, 148** • Match east main pier location, locate west main pier upland of existing • Steel or spliced post-tensioned concrete girders	• Eliminates three intermediate bents • Pier height reduced for one main pier	• One additional intermediate bent required • Crossovers required during the winter • Challenging access to river for pier construction (160' piers in the river) • Tall west main span pier	• Spliced post-tensioned girders will require variable depth girders over piers • Need to coordinate with MDT and precasters to assess capabilities and investment required
	8	**Specialty Structures** • (Deck arch, steel deck truss, network tied arch, etc.)	• Could simplify erection challenges	• Expensive design and construction • Higher maintenance, inspection, etc. • Not typical for MT	• Extended construction schedules will require extended traffic crossovers

Clark Fork Bridge Option 1



Description

- Span lengths: 110, 169, 210, 169, 148
- Match existing bent and pier locations, remove two upland bents
- Welded steel plate girders or spliced post-tensioned concrete girders

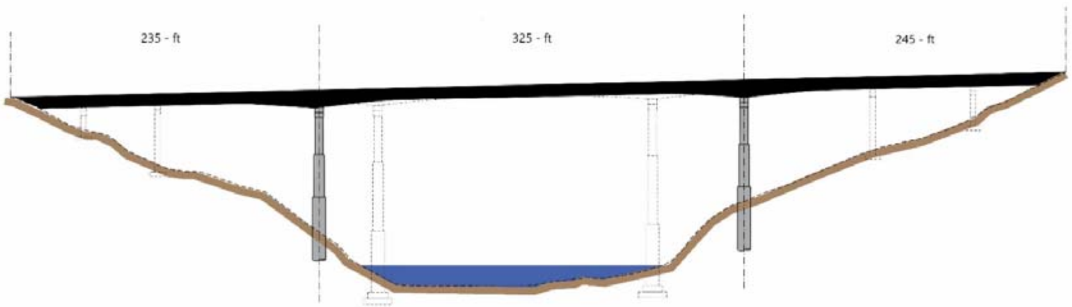
Advantages

- Short span with low superstructure cost
- Easier erection with lighter steel or concrete members

Disadvantages

- Challenging access to river for pier construction
- Crossovers required during the winter
- Very tall piers (160') located within waterway and additional projection of piers into waterway due to skew
- Potential environmental impact for bull trout, due to piers located further in the river
- Underwater pier/foundation inspection required

Clark Fork Bridge Option 2



Description

- Span lengths: 235, 325, 245
- New main piers upland of existing
- Welded steel plate girders or spliced post-tensioned concrete girders

Advantages

- Four intermediate bents are eliminated
- Easier new pier access
- Crossovers likely not required during winter

Disadvantages

- Challenging long span steel or concrete structure
- Large steel girders or prestressed concrete girders with costly superstructure
- Larger equipment required to erect

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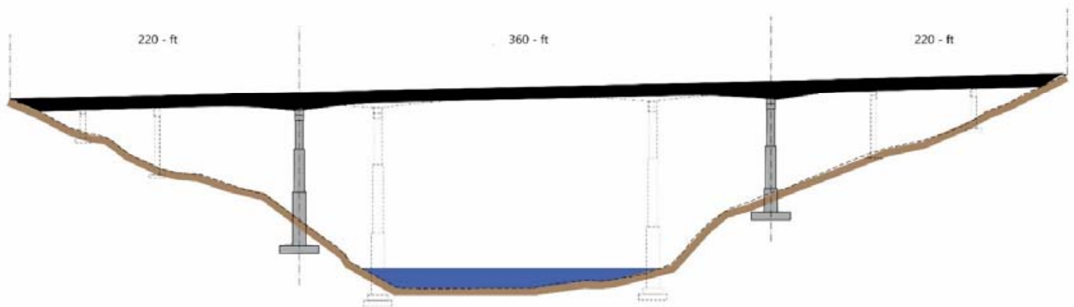
Clark Fork Bridge Option 3



Description

- Span lengths: 220, 360, 225
- New main piers upland of existing
- Welded steel plate girders

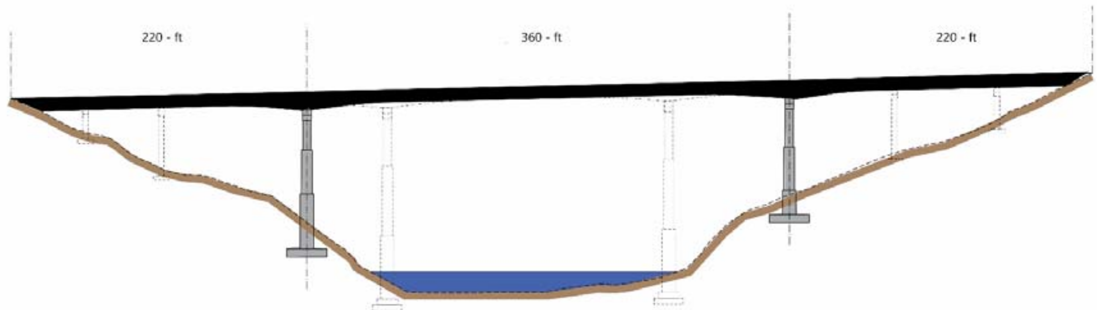
Advantages

- Four intermediate bents are eliminated
- Easier new pier access
- Spread footings
- Crossovers likely not required during winter

Disadvantages

- Challenging long span steel structure
- Large steel girders with costly superstructure
- Larger equipment required to erect

Clark Fork Bridge Option 4



Description

- Span lengths: 220, 360, 225
- Cast – in – place, segmentally erected

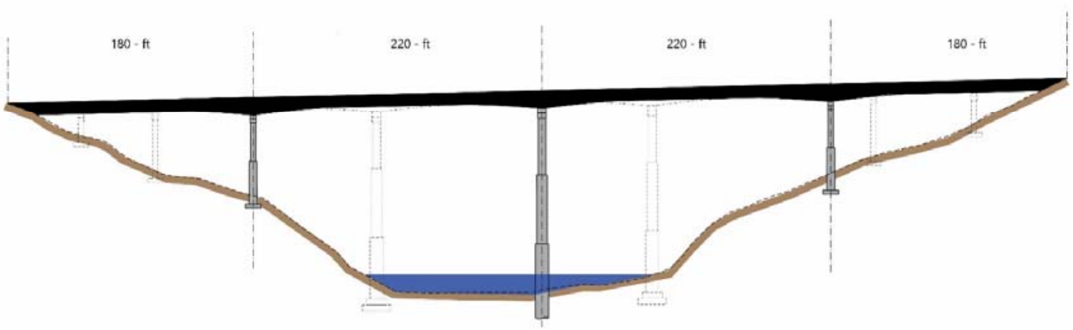
Advantages

- Could simplify erection challenges

Disadvantages

- Expensive design and construction
- Not typical for MT
- Increased schedule requirements for construction duration
- Inefficient span configuration and small volume will increase construction unit costs
- Crossovers required during winter
- While this option simplifies erection challenges, it does not eliminate access and removal challenges

Clark Fork Bridge Option 5



Description

- Span lengths: 180, 220, 220, 180
- One pier at mid-bridge in the middle of the river
- Steel or spliced post-tensioned concrete girders

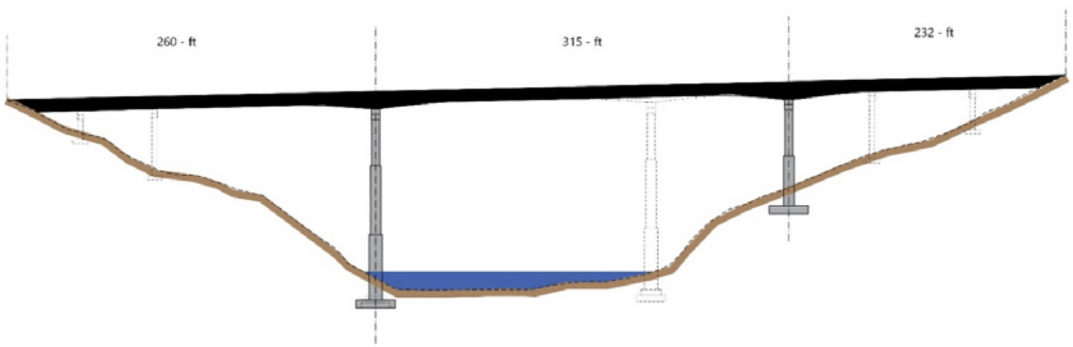
Advantages

- Four equal span lengths provide options for prestressed or steel
- Crossovers likely not required during winter

Disadvantages

- Likely not an option for pier in the middle of the river
- Difficult work bridge over tough water

Clark Fork Bridge Option 6



Description

- Span lengths: 260, 315, 232
- Match west main pier location, locate east main pier upland of existing
- Steel or spliced post-tensioned concrete girders

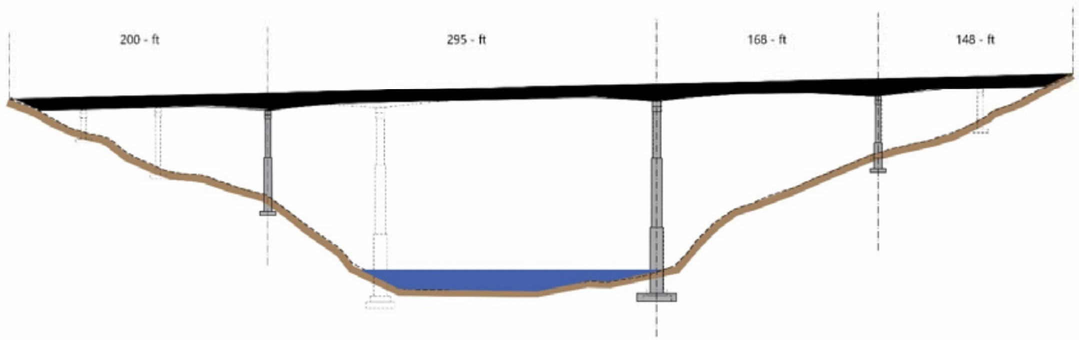
Advantages

- Four intermediate bents are eliminated
- Pier height reduced for one main pier

Disadvantages

- Crossovers required during the winter
- Tall west main span pier
- Challenging access to river for pier construction (160’ piers in the river)

Clark Fork Bridge Option 7



Description

- Span lengths: 200, 295, 168, 148
- Match east main pier location, locate west main pier upland of existing
- Steel or spliced post-tensioned concrete girders

Advantages

- Eliminates three intermediate bents
- Pier height reduced for one main pier

Disadvantages

- One additional intermediate bent required
- Crossovers required during the winter
- Challenging access to river for pier construction (160’ piers in the river)
- Tall west main span pier

Clark Fork Bridge Specialty Structure Options

Description

- Deck arch, steel deck truss, network tied arch, etc.

Advantages

- Aesthetics

Disadvantages

- Expensive design and construction
- Higher maintenance, inspection, etc.
- Not typical for Montana
- Extended construction schedules will require extended traffic crossovers

Further Study	Option	Description	Advantages	Disadvantages	Comments
X	1S	**Span lengths: 110, 170, 170, 170, 125** • Match existing bent and pier locations, remove two upland bents • Welded steel plate girders	• Short span with low superstructure cost • Easier erection with lighter steel members • Pier locations match up with EB Bridge	• Challenging for shafts or piling placed near existing timber piling • Tall main span piers • Crossovers likely required during the winter	
X	1C	**Span lengths: 110, 170, 170, 170, 125** • Match existing bent and pier locations, remove two upland bents • Prestressed concrete girders	• Standard prestressed girder cost • Cost effective superstructure • Precast production can be optimized for construction schedule • Pier locations match up with EB Bridge	• Challenging for shafts or piling placed near existing timber piling • Tall main span piers • Crossovers likely required during the winter	
X	2S	**Span lengths: Wall, 210, 240, 175, Joint, 95** • New main piers near bank edge • Welded steel plate girders	• Four intermediate bents are eliminated • Locates tall river piers outside of existing footings with timber piles • Crossovers likely not required during winter	• Longer span steel structure with slightly costlier superstructure and increased girder weight	• Main span will be reviewed/ adjusted for spans between 210' and 240' • Option and spans will also be adjusted with considerations of eliminating the joint and abutment wall
X	2C	**Span lengths: Wall, 210, 240, 175, Joint, 95** • New main piers upland of existing • Spliced post-tensioned concrete girders	• Four intermediate bents are eliminated • Locates tall river piers outside of existing footings with timber piles • Precast production can be optimized for construction schedule • Crossovers likely not required during winter	• Longer span concrete structure • Larger prestressed concrete girders with costlier superstructure • Larger equipment required to erect	• Need to investigate whether spliced post-tensioned girders will require constant depth or variable depth girders over piers • Need to coordinate with MDT and precasters to assess capabilities and investment required • Main span will be reviewed/ adjusted for spans between 210' and 240' • Option and spans will also be adjusted with considerations of eliminating the joint and abutment wall
	3S	**Span lengths: 200, 260, 208, Joint, 95** • Match west main pier location, locate east main pier near high water location • Welded steel plate girders	• Five intermediate bents eliminated • Spans balanced for steel design. Typical steel size and details • Pier height reduced for one main span pier • Crossovers likely required during winter	• Shallow structure depth likely required at abutment 4 if road cannot be lowered • River pier shafts or piling conflicts with existing timber piling	
	3C	**Span lengths: 200, 260, 208, Joint, 95** • Match west main pier location, locate east main pier upland of existing • Spliced post-tensioned concrete girders	• Five intermediate bents eliminated • Pier height reduced for one main span pier • Precast production can be optimized for construction schedule • Crossovers likely required during winter	• Shallow structure depth likely required at abutment 4 if road cannot be lowered • River pier shafts or piling conflicts with existing timber piling	• Spliced post-tensioned girders will require variable depth girders over piers • Need to coordinate with MDT and precasters to assess capabilities and investment required
?	4S	**Span lengths: 210, 350, 100, 95** • New main piers upland of existing • Welded steel plate girders	• Six intermediate bents eliminated • Easy new pier access and shorter piers • Piers located outside river channel	• Challenging long span steel structure • Large steel girders with costly superstructure • Vertical clearance at abutment 4 may be compromised. • Uplift in backspans • Inefficient span lengths required, costlier superstructure	
	4C	**Span lengths: 210, 350, 100, 95** • Cast – in – place, segmentally erected	• Could simplify erection challenges	• Expensive design and construction and not typical for MT • Limited benefit for access with removal of existing structure required • Increased schedule requirements for construction duration • Crossovers required during winter • Inefficient span configuration and small volume will increase construction unit costs	• Need to provide equipment access for demolition of existing structure, which mitigates need for special construction techniques for new structure
	5	**Span lengths: 160, 216, 216, 172** • One pier at mid-bridge in the middle of the river	• Four span shorter lengths provide options for concrete or steel • Likely the most cost-effective bridge	• Likely not an option for a mid-river pier • Vertical clearance at abutment 4 may be compromised	
	6	**Specialty Structures** • (Deck arch, steel deck truss, network tied arch, etc.)		• Expensive design and construction • Higher maintenance, inspection, etc. • Not typical for MT	

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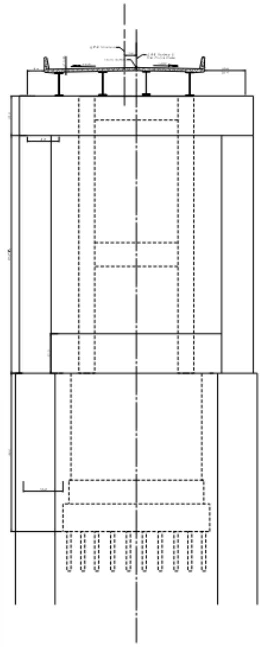
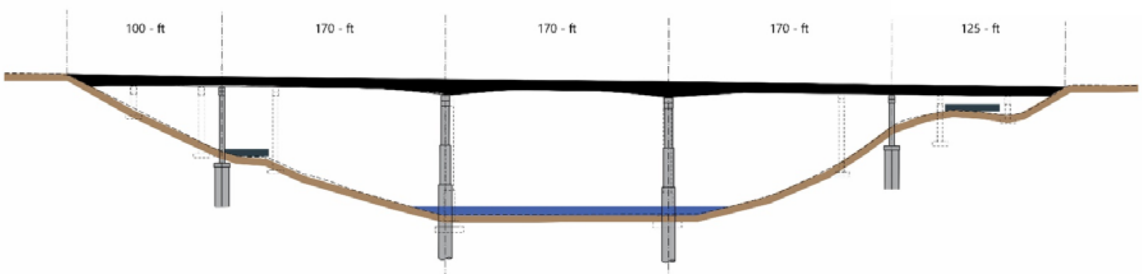
Cyr Bridge Option 1





Description
- Span lengths: 110, 170, 170, 170, 125
- Match existing pier locations, remove two upland bents
- Welded steel plate girders or prestressed concrete girders

Advantages
- Short span with low superstructure cost
- Cost effective superstructure
- Easier erection with lighter members
- Pier locations match up with EB Bridge

Disadvantages
- Challenging for shafts or piling placed near existing timber piling
- Tall main span piers
- Crossovers maybe required during the winter

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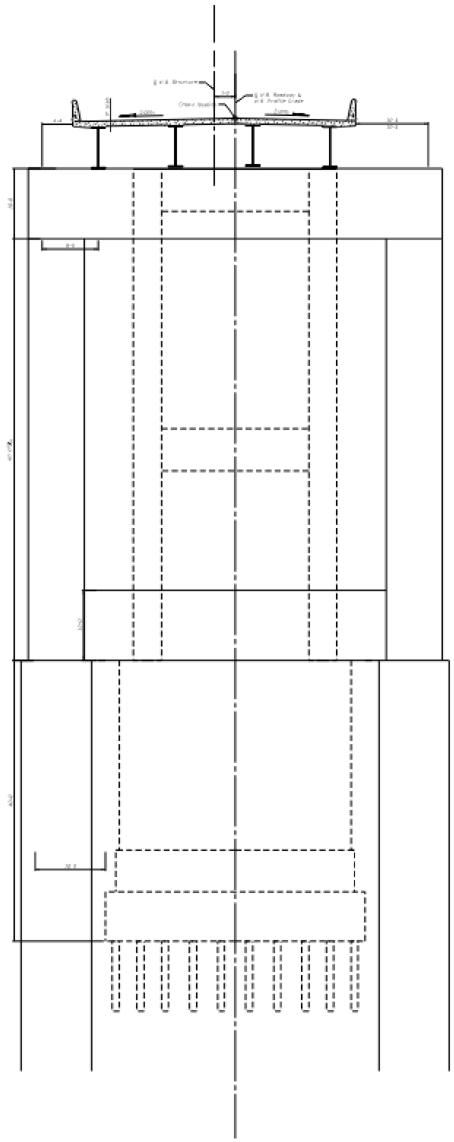
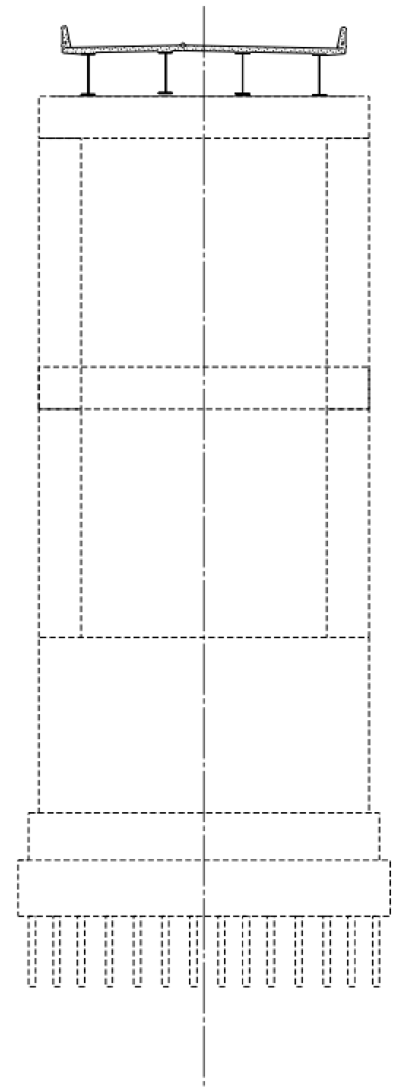
Cyr Bridge Option 1





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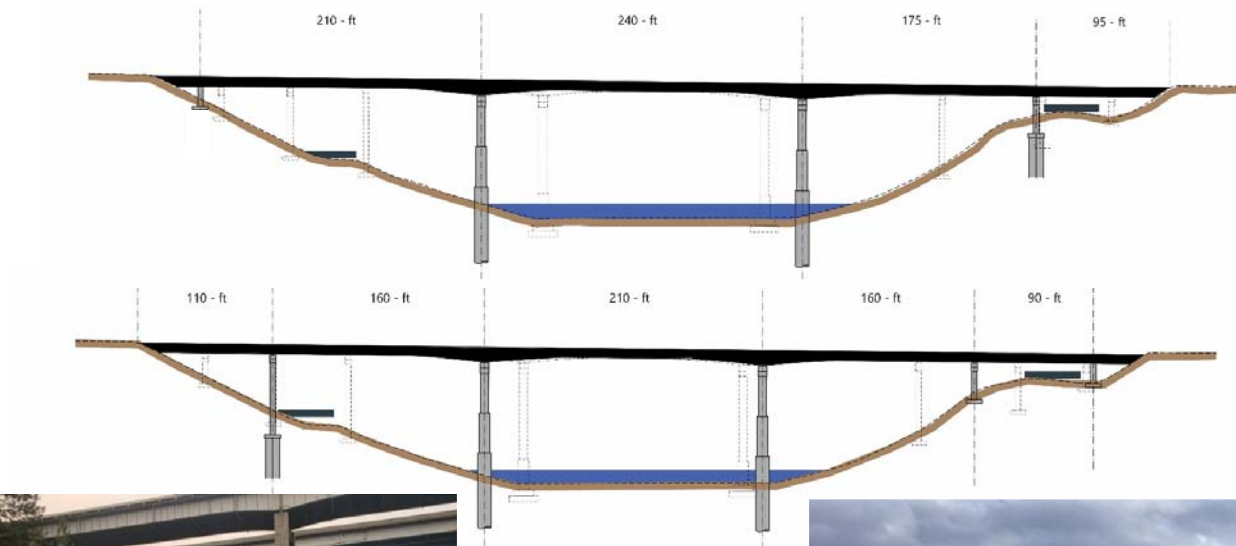
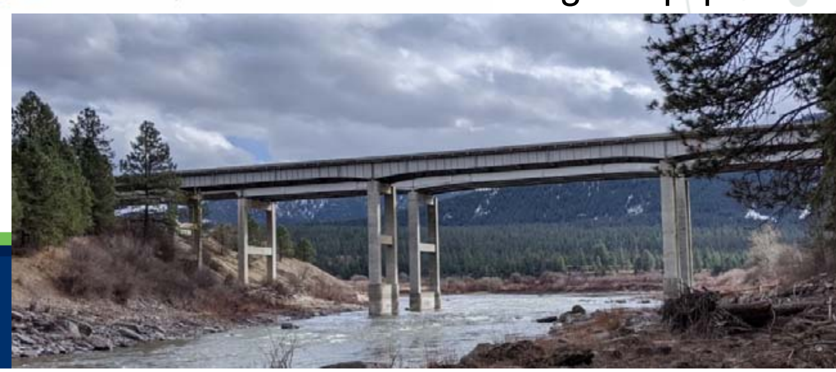
Cyr Bridge Option 2





Description

- Span lengths: Wall, 210, 240, 175, Joint, 95
- New main piers near bank edge
- Welded steel plate girders or spliced post-tensioned concrete girders

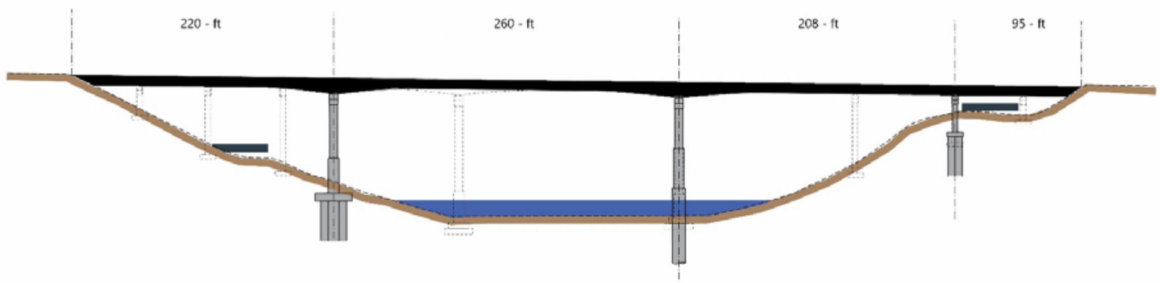
Advantages

- Four intermediate bents are eliminated
- Locates tall river piers outside of existing footings with timber piles
- Crossovers likely not required during winter

Disadvantages

- Longer span structure with slightly costlier superstructure and increased girder weight
- Larger equipment required to erect

Cyr Bridge Option 3



Description

- Span lengths: 200, 260, 208, Joint, 95
- Match west main pier location, locate east main pier near high water location
- Welded steel plate girders or spliced post-tensioned concrete girders

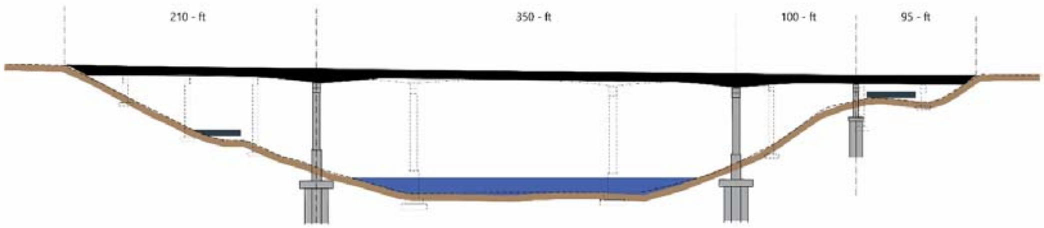
Advantages

- Five intermediate bents eliminated
- Spans balanced for design. Typical steel size and details
- Pier height reduced for one main span pier
- Crossovers maybe required during winter

Disadvantages

- Shallow structure depth likely required at abutment 4 if road cannot be lowered
- River pier shafts or piling conflicts with existing timber piling

Cyr Bridge Option 4



Disadvantages (CIP Segmental)

- Expensive design and construction
- Limited benefit for access with removal of existing structure required
- Not typical for Montana
- Increased schedule requirements for construction duration
- Crossovers required during winter
- Inefficient span configuration and small volume will increase construction unit costs

Description

- Span lengths: 210, 350, 100, 95
- New main piers upland of existing
- Welded steel plate girders or cast – in – place, segmentally erected concrete

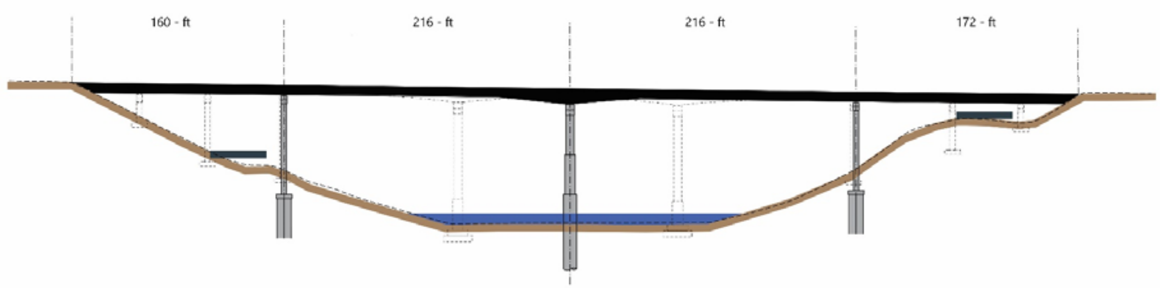
Advantages

- Six intermediate bents eliminated
- Easy new pier access and shorter piers
- Piers located outside river channel
- Segmental could simplify erection challenges

Disadvantages (Steel)

- Challenging long span steel structure
- Large steel girders with costly superstructure
- Uplift in backspans
- Inefficient span lengths required, costlier superstructure
- Scour risks with perched pile cap

Cyr Bridge Option 5



Description
- Span lengths: 160, 216, 216, 172
- One pier at mid-bridge in the middle of the river

Advantages
- Four span shorter lengths provide options for concrete or steel
- Likely the most cost-effective bridge

Disadvantages
- Likely not an option for a mid-river pier
- Vertical clearance at abutment 4 may be compromised

Cyr Bridge Specialty Structure Options

Description

- Deck arch, steel deck truss, network tied arch, etc.

Advantages

- Aesthetics

Disadvantages

- Expensive design and construction
- Higher maintenance, inspection, etc.
- Not typical for Montana

Old Highway 10

Existing Alignment

Elizabeth Lane / Old Highway 10 Bridge Decisions

- Realign a portion of Old Highway 10?
- Accommodate wildlife passage if feasible?

Replace structure at same length

Maintain Highway 10 alignment

Realign Highway 10

Meeting Minutes
I-90 Structures – West of Alberton
MMI #0275162; NHPB 90-1(239)65; UPN 9786000

Date: **July 9, 2021 – 9:30am**

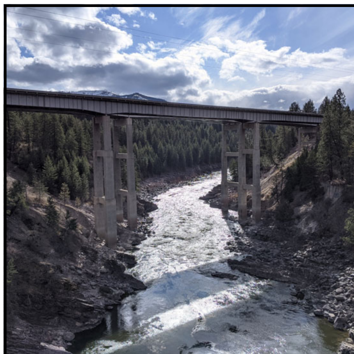
Attendees:

☒ Stephanie Brandenberger, MDT
☒ Jason Senn, MDT
☒ Bret Boundy, MDT
☒ Andy Cullison, MDT
☒ Scott Helm, MDT
☒ Jeff Jackson, MDT
☒ Jacquelyn Smith, MDT
☒ Paul Axtell, DBA
☒ John Turner, DBA
☒ Jim Scoles, MMI
☒ Jason Millar, MMI

Purpose: A meeting was held on this date to provide an overview and facilitate discussion on the Foundation Reuse Report for I-90 Structures – West of Alberton project. Refer to the attached presentation for an outline of the topics discussed throughout the meeting.

The meeting began with John leading the discussion on an overview of the Foundation Reuse Report, followed by a discussion on structural elements by Jim. The remaining portion of the meeting was dedicated to discussions on the following:

- Spread footings are acceptable to be investigated for the project.
- New foundations out of the water would be beneficial to the department for future inspection requirements.
- Although replacing the superstructure to the same width would provide significant savings to the project, the group determined that the savings would not warrant the substandard typical section and lack of increased safety. In addition, providing a new superstructure on the existing foundations could require significant substructure rehabilitation or replacement of the entire bridge at some point in the future.
- It was preferred by the group not to further advance the option of foundation reuse for all structures on the project for the following reasons: scour risks at Cyr, reduced and difficult to determine service life, substandard structural detailing/ reinforcing, deficiencies in a few elements while the majority of the bridge is replaced with an entirely new superstructure and (mostly) new substructure, limited cost savings vs. risks and life expectancy, and potential project delays and effort investigating reuse options further.



I-90 Structures – West of Alberton
NHPB 90-1(239)65
UPN 9786000

Evaluation of Foundation Reuse
Clark Fork River Bridges

MONTANA MDT DEPARTMENT OF TRANSPORTATION

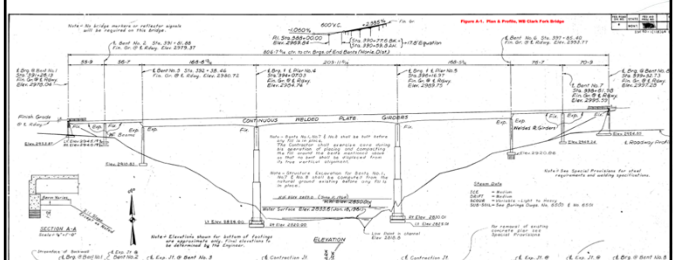
Morrison Maierle

DAN BROWN AND ASSOCIATES

Evaluation of Foundation Reuse
Clark Fork River Bridges, I-90

- Potential for foundation reuse at the main piers of the Clark Fork Bridge (Piers 4 and 5) and the Cyr Bridge (Piers 5 and 6)
- Factors considered:
  - capacity
  - design features from as-built plan drawings
  - scour assessment
  - enhancement options
  - Compared to what?

WB Clark Fork Bridge

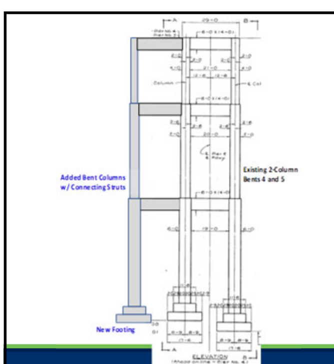


Bearing Stress Analysis, Pier 4, CF Bridge

Foundation Response	Strength I		Strength V	
	Existing	Widened	Existing	Widened
Maximum Bearing Stress (ksf)	14	25	107	87
Minimum Bearing Stress (ksf)	0	0	0	0
Has Uplift? (Y/N)	Y	Y	Y	Y
Longitudinal Eccentricity e_L (ft)	3.7	4.4	5.6	5.8
e_L / L*	0.17	0.20	0.26	0.27
Transverse Eccentricity e_T (ft)	0.0	0.0	7.9	6.7
e_T / B*	0.00	0.00	0.45	0.38

*Max permissible per AASHTO LRFD BDS 10.6.3.3 for footings on rock = 0.45;
* > 0.5 = unstable

Above is based on considering the unreinforced seal course as part of the footing



Feasible Options

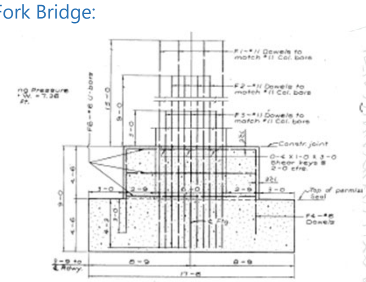
- Add overturning/uplift resistance by adding micropiles
- Add a 3rd column and footing to the existing pier

. . . compared to:

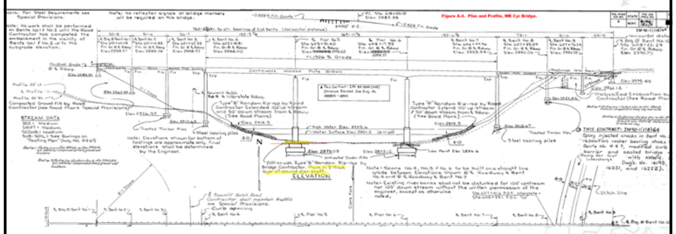
- Drilled shafts outboard of existing footings
- New spread footings bearing on rock; possibly including anchors or micropiles

Major issue for reuse at Clark Fork Bridge:

Unreinforced seal course



WB Cyr Bridge



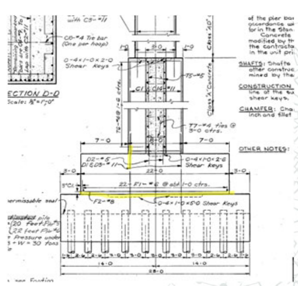
GROUP Analysis, Pier 5, Cyr Bridge

Load Case	Max Axial (kips)	Min Axial (kips)	Max Combined Bending + Axial Stress (ksi)
STR-I Existing	64	35	0.7
STR-I Widened	95	44	2.0
STR-V Existing	74	-15 (uplift)	0.9
STR-V Widened	100	-22 (uplift)	2.0

Demands on individual piles are generally within current code allowances when differences between ASD (1960's) and LRFD (now) are taken into account

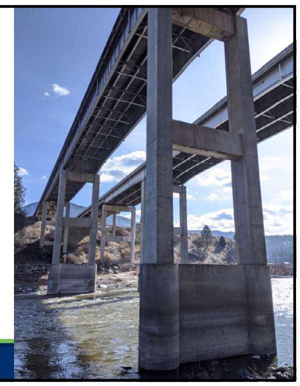
Major issue for reuse at Cyr Bridge:

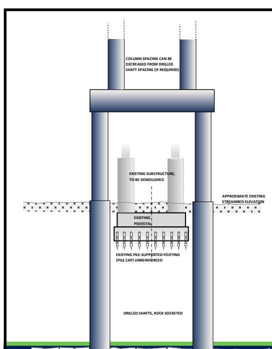
Unreinforced pile cap



Other Factors: Cyr Bridge

- Scour: predicted to undermine footings and expose piles
- 7-ft thick unreinforced pile cap/footing
- Feasibility and cost of retrofitting existing pile-supported foundations, including condition assessment
- Reliability of 60+ year old timber piles is questionable





Any reuse options would have to be compared to:

- New bent columns on drilled shafts outboard of existing foundations
- New pile group on steel piles driven to rock

Loading & Upland Bents

- Estimated loads were calculated for the existing and widened typical sections, using the current design code and older AASHTO loading (HS-20)
- Upland intermediate bents exhibited large variances in current loading, eliminating reuse of upland bents from cost, ease of construction access, current inspection reports, etc.

Structural Elements

- Detailed analysis of structural capacities is required if reuse is considered further
- Unreinforced footings/ pile cap
  - No footing seal reinforcing
  - Uncertainties if cast in wet or dry
  - No below grade inspection information

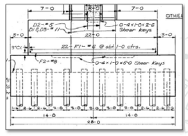


Figure 3. Cyr Structure 01385

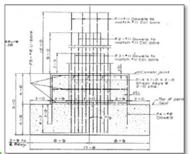
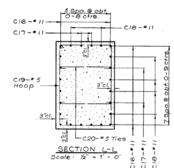
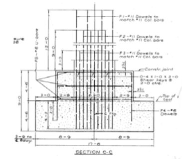


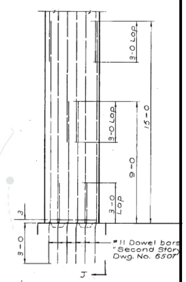
Figure 4. Clark Fork Structure 01379

Detailing Considerations

- 1965 Reinforcing details
  - Development length and lap splices
  - Confinement
  - Temperature and shrinkage

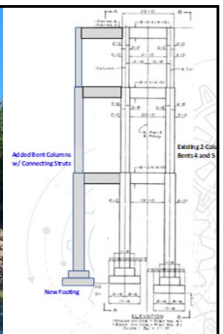






Costs

- Estimated savings
  - Potential savings of approximately $500k each main span pier for entire pier reuse
  - Cost estimate based on typical widening and loading
  - Majority of savings from elimination of pier/foundation removal, additional structure cost similar to full bridge replacement
  - Strengthening or rehabilitation likely would eliminate any savings



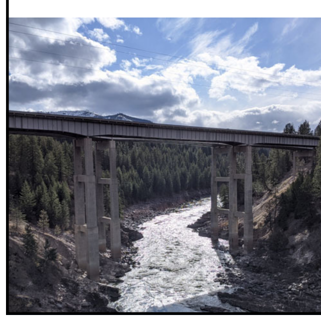
SUMMARY: WB Clark Fork Bridge

- Existing main pier footings may be suitable for reuse but would require significant additional study, and likely enhancement.
- Enhancement options include:
  - Micropiles through existing footings
  - Add a third footing and new column
- Major issue is unreinforced seal course
- Reuse limits the center span length to its current configuration

SUMMARY: Cyr Bridge

- Factors that do not favor foundation reuse include:
  - Scour
  - Unreinforced pile cap/footing
  - Cost of retrofitting existing pile-supported foundations, including condition assessment
  - Uncertainty regarding existing timber piles
- Good news
  - Access for construction of new main pier foundations appears more favorable at Cyr; provides more options for the replacement bridge

Questions?



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