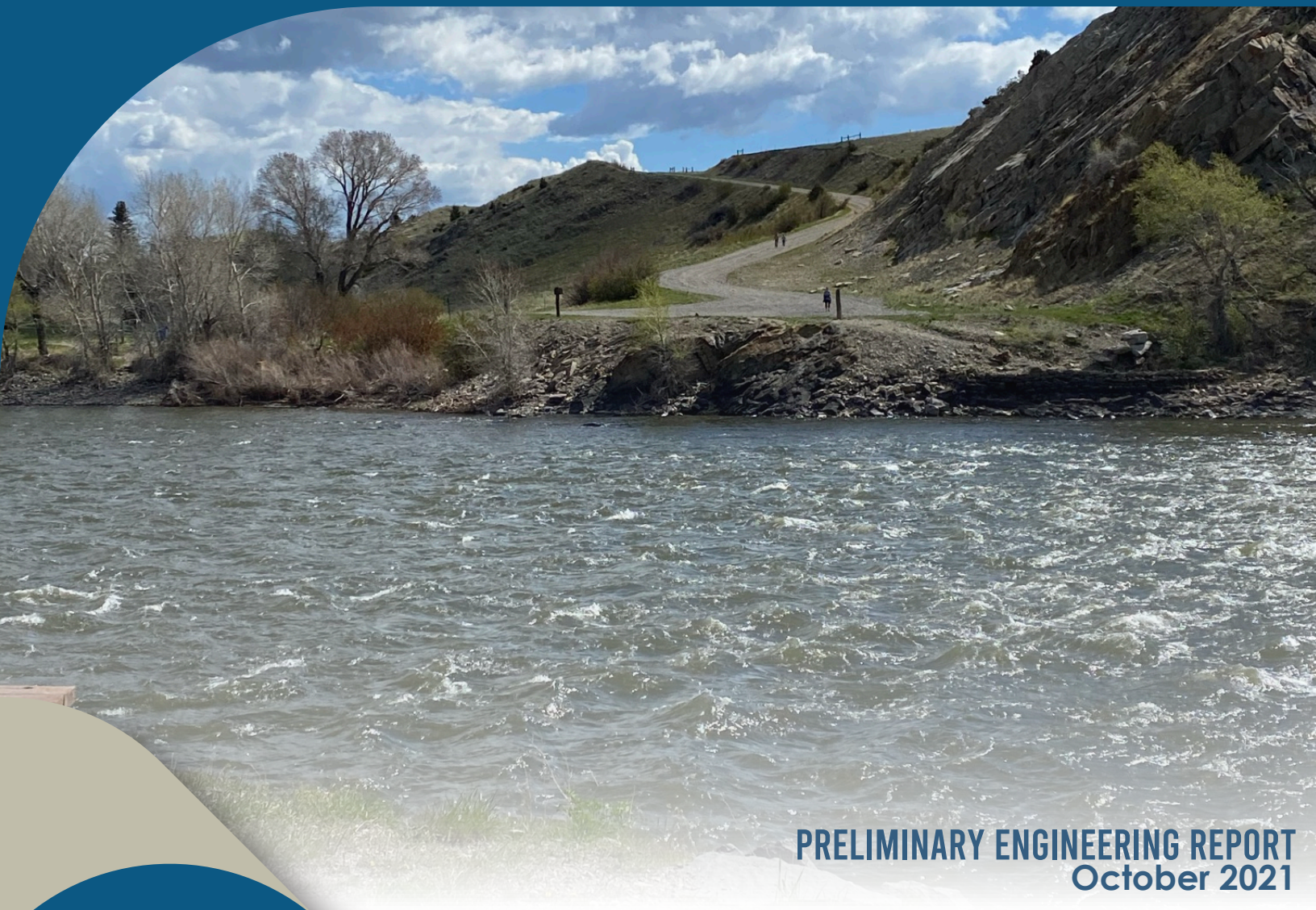
Yellowstone River Pedestrian Bridge at Mayor's Landing

Park County, Montana



PRELIMINARY ENGINEERING REPORT
October 2021

PROJECT OWNER:

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Table of Contents
Yellowstone River Pedestrian Bridge at Mayor's Landing
Preliminary Engineering Report

I. Executive Summary

Communities that prioritize and incorporate pedestrian and non-motorized trails into their active transportation and infrastructure plans are providing a foundation focused on healthy recreation and transportation opportunities. Trails create safe, attractive and accessible places for people of all ages and abilities to walk, hike, jog and cycle. In addition, trail systems can become a source of community identity and pride.

Park County is responsible for bridges over waterways and has been proactive in identifying long-range goals to create a system of interconnected trails throughout the County, as illustrated in the current Park County Growth Policy and the Park County Active Transportation Plan. Creating interconnected trails leads to more widespread use of existing infrastructure as neighborhoods and recreation areas become more readily accessible.

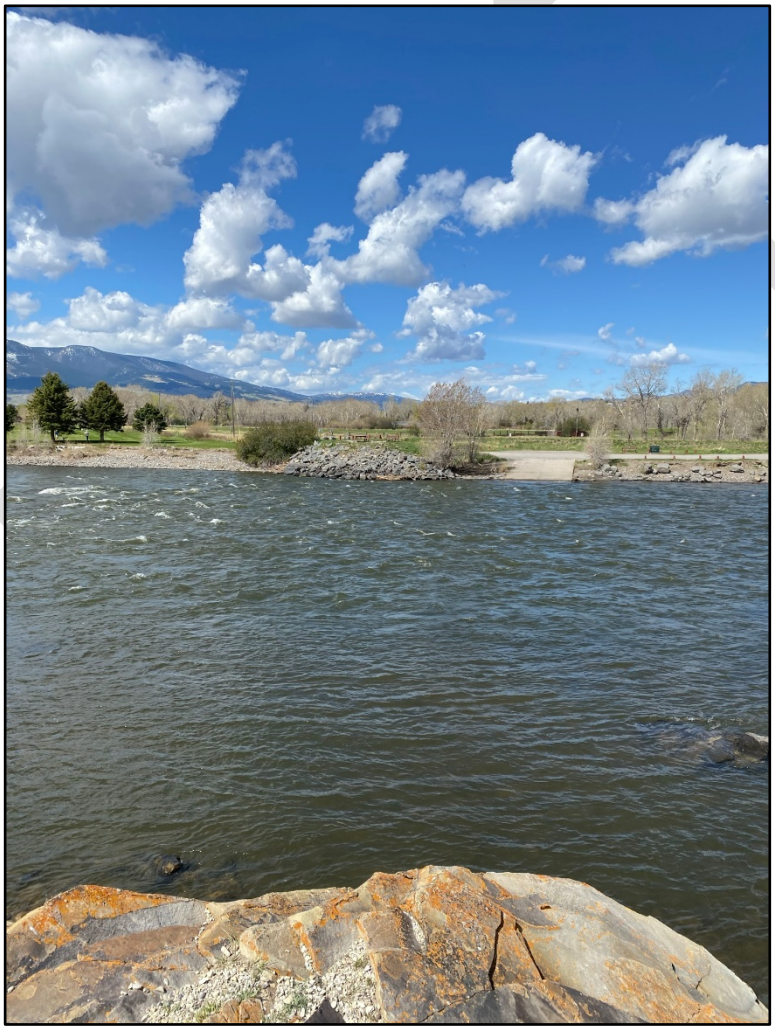

Figure 1: Location of proposed pedestrian bridge over the Yellowstone River.

The installation of a pedestrian bridge over the Yellowstone River, connecting Moja Campbell Dog Park at Mayor's Landing with Meyers River View Trail, Meyers Lane, and the Livingston HealthCare campus, is specifically identified in the Park County Active Transportation Plan. The proposed bridge will "provide users the opportunity to connect to several existing trails and recreation areas including the Moja Dog Park at Mayor's Landing, the Meyers-Watson Trail, the Old Boulder Road, and Bureau of Land Management acreage."

The primary benefit of the proposed pedestrian bridge is to provide a linked alternative transportation system on the east end of Livingston for pedestrian and bicycle traffic; however, additional benefits of the project include:

- Alleviating pedestrian/vehicle conflicts
- Economic boosts to local businesses
- Extended access for school students and educators for classroom or exercise activities
- Convenience and ability to experience the Yellowstone River and its many ecological attributes

Five alternatives have been considered to be the most economical and viable, long-term solution for the proposed bridge, and include:

Alternative 1: Single span steel tied arch truss
Alternative 2: Single span steel cable stayed bridge
Alternative 3: Single span prefabricated steel bridge
Alternative 4: Multiple span prefabricated steel bridge
Alternative 5: Multiple span prestressed concrete bridge

Alternative 3 is the preferred alternative. The single span, prefabricated steel bridge has the lowest present worth, minimally impacts recreationists on the Yellowstone River, and has the lowest maintenance costs.

The Opinion of Probable Cost for **Alternative 3**, Table 1, shows a line-item estimate of the total project cost, including design, construction, and contingency allowance. The total project cost is $4,381,825.

Table 1

Yellowstone River Pedestrian Bridge at Mayor's Landing
Park County
Opinion of Probable Cost (OPC)
October 21, 2021
Alternative 3 - Single Span Prefabricated Steel

Item No.	Estimated Quantity	Unit	Description	Unit Price	Total Price
MOB / DEMOB					
1	1	LUMP SUM	Mobilization and Demobilization	$400,000.00	$400,000.00
2	1	LUMP SUM	Bonding and Insurance	$60,000.00	$60,000.00
3	1	LUMP SUM	Traffic Control	$10,000.00	$10,000.00
ABUTMENTS					
4	1	LUMP SUM	Work Bridge	$500,000.00	$500,000.00
5	40	CUBIC YARD	Structure Excavation, Type II	$75.00	$3,000.00
6	80	LINEAR FEET	(2) Drilled Shafts, 6' diameter	$900.00	$72,000.00
7	100	LINEAR FEET	Drilled Shaft Casing	$800.00	$80,000.00
8	85	CUBIC YARD	Class "Drilled Shaft" Concrete	$400.00	$34,000.00
9	110	CUBIC YARD	Class "Structure" Concrete	$800.00	$88,000.00
10	430	CUBIC YARD	Riprap - Class III	$130.00	$55,900.00
SUPERSTRUCTURE					
11	1	LUMP SUM	Furnish 310' Superstructure	$1,512,500.00	$1,512,500.00
12	1	LUMP SUM	Install Superstructure	$250,000.00	$250,000.00
13	96	CUBIC YARD	Class "Deck" Concrete	$900.00	$86,400.00
14	4	EACH	Furnish & Install Bridge Approach Sections	$1,500.00	$6,000.00
15	340	CUBIC YARD	Bridge End Backfill	$70.00	$23,800.00
CIVIL / ROADWORK					
16	610	CUBIC YARD	Unclassified Excavation	$60.00	$36,600.00
17	30	TONS	Asphalt Pavement	$1,000.00	$30,000.00
18	40	CUBIC YARD	6" Minus Gravel Base	$50.00	$2,000.00
19	15	CUBIC YARD	1" Minus Gravel Surfacing	$75.00	$1,125.00
20	2	ACRE	Seeding & Fertilizing	$2,000.00	$4,000.00
21	4	EACH	Furnish & Install Bridge Terminal End Sections	$1,500.00	$6,000.00
22	4	EACH	Removable Bollards	$1,500.00	$6,000.00
			SUB-TOTAL CONSTRUCTION COST		**$3,267,325.00**
			Preliminary Engineering	10%	$326,800.00
			Geotechnical Engineering	0.5%	$16,400.00
			Flood Plain Permitting	0.6%	$19,700.00
			Construction Administration	3%	$98,100.00
			Contingency	20%	$653,500.00
			TOTAL PROJECT COST		**$4,381,825.00**

II. Problem Definition

A. Identify the Area Served by the Bridge

1. Location of Bridge

The proposed location of the Yellowstone River Pedestrian Bridge is in Section 18, Township 2 S, Range 10 E. The structure crosses the Yellowstone River at Mayor's Landing on the west riverbank and Park County owned property on the east riverbank, near Meyers Lane.

Vicinity maps are enclosed in **Appendix A**, as well as the portion of the Glengarry quadrangle United States Geological Survey (USGS) map showing the project location. The bridge latitude and longitude are 45°39'57" and 111°32'20" respectively, and the deck elevation will be approximately 4,480 feet above mean sea level.

2. Physical Characteristics of the Area

This structure will be located at the end of View Vista Drive (Mayor's Landing) on the west and Meyers Lane on the east, just outside the limits of the City of Livingston. The proposed bridge alignment will be located in approximately the same location as Buchanan's Bridge, which was washed out in a 1918 flood, rebuilt, and then burned through alleged vandalism in the 1950's.

The terrain at the bridge site is generally characterized by steep rocky banks, with primary vegetation being native shrubs and trees (see maps, **Appendix A**). According to the Natural Heritage Program, there are mapped wetlands adjacent to the east end of the structure; however, due to elevation and construction methods, no impacts to wetlands are anticipated. (see map, **Appendix B**). The project area is located within a FEMA Zone AE special flood hazard area with base flood elevation, as well as within a regulatory floodway (see map, **Appendix B**).

Soil characteristics at the project site were taken from the Department of Natural Resources Conservation Service (DNRC) Web Soil Survey. The soil survey indicates that conditions at the project site are primarily clay loam with shallow bedrock and sandy loam with shallow cobbles. In addition to the DNRC Web Soil Survey, well log information taken from the Montana Bureau of Mines and Geology (MBMG) shows the location of water wells drilled in the project vicinity. The corresponding well logs indicate that soils in the area are generally comprised of clay, gravel, shale and sandstone. Web Soil Survey information and nearby well logs from MBMG can be found in **Appendix B**.

Although geotechnical investigation is not generally part of the preliminary engineering report activities, based on the bridges located both upstream and downstream of the proposed bridge, a drilled shaft foundation will best suit the project site. Drilled shafts, also known as drilled piers, are high-capacity deep foundation systems that can more easily go through rocky soils, where driven piles may be deflected.

The river channel at the bridge site is approximately 300-feet wide and flows generally south to north in the project vicinity. The river is the principal tributary of the upper Missouri River and drains areas of Yellowstone National Park and the mountains and high plains of southern Montana and northern Wyoming.

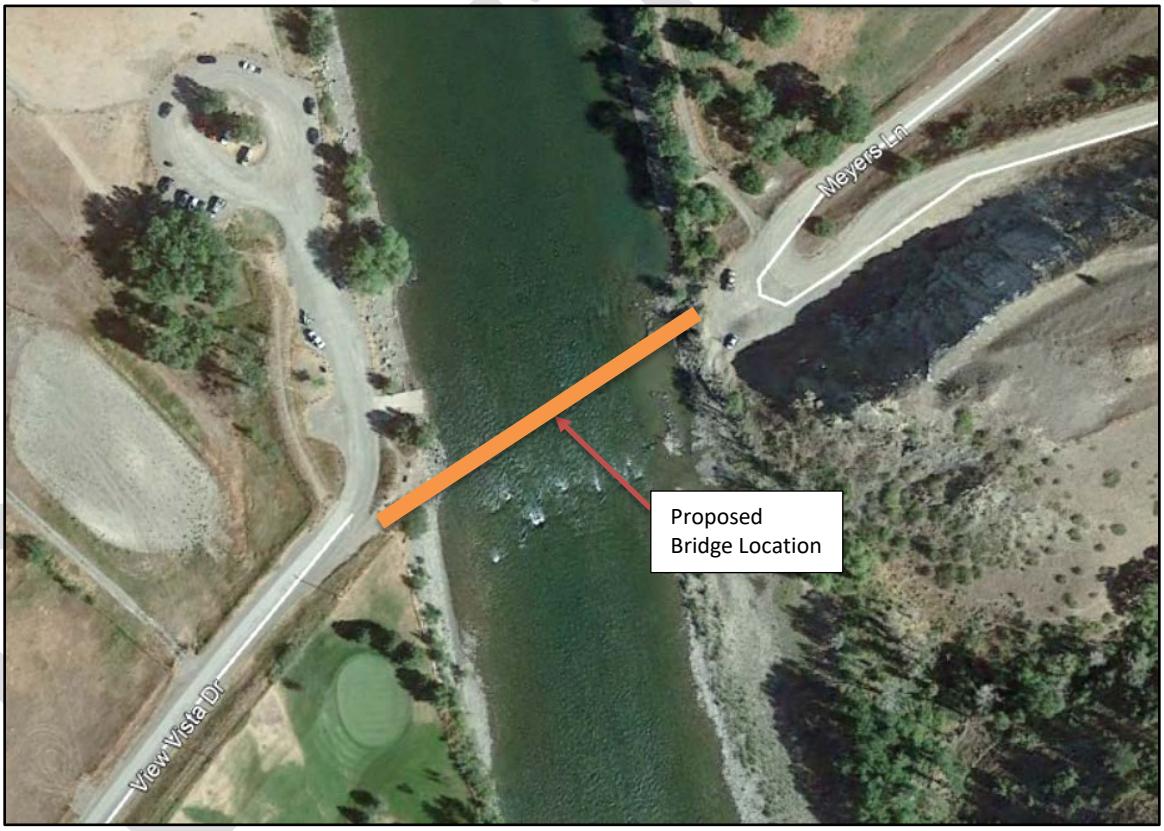

Figure 2: Aerial view of proposed pedestrian bridge location

3. Users of the Bridge

a. Use of the Structure

As the proposed bridge will provide connectivity of existing parks and trails within the community, it is anticipated that the structure will be heavily used by residents walking, cycling and hiking. In addition to adjacent parks and trails, the bridge will provide connectivity to the

Livingston HealthCare campus, Bureau of Land Management (BLM) land, and State of Montana land.

Along with use by pedestrians and non-motorized vehicles, the bridge may be designed for use by emergency vehicles. In the unlikely event that upstream and downstream bridge crossings are compromised or closed, and accounting for the proximity to Livingston HealthCare facilities, the bridge could provide emergency access during catastrophic events.

The Park County Active Transportation Plan identifies the Yellowstone River Pedestrian Bridge as a "project with pending grant applications". In addition, existing planning documents for Park County and the City of Livingston identify plans for general trail expansion, as identified below.

The Park County Growth Policy, adopted in 2017, identified the following objective and actions:

- *Objective 10.2: Continue partnerships with the City of Livingston to develop Active Transportation facilities in and around the city.*
- *Action 10.2.1: Identify city and county shared priorities.*
- *Action 10.2.3: Work with the city on grant applications for Active Transportation facility and infrastructure funding.*

Similarly, the City of Livingston Growth Policy contains this objective:

- *Objective 8.1.1: Ensure trail and sidewalk connectivity within and around the City.*

Finally, the bridge may be designed to accommodate a water main extension, providing water system redundancy for the City of Livingston. Additional information concerning the water main is included in **Section II.B.4 Utility Location or Relocation**.

b. Number of Users

While the number of users is difficult to assess, it is anticipated that individuals taking advantage of the new pedestrian bridge will be significant.

As part of the City of Livingston Parks & Trails Master Plan, which was completed in 2011, a survey of local residents was completed to better understand the users of recreational facilities within the City. The majority of respondents indicated that they regularly take part in walking, bicycling, and hiking. In addition, the majority of respondents indicated that they utilize the parks and trails within Livingston on a weekly basis.

The Park County Active Transportation Plan, completed in 2015, also conducted a needs assessment survey, which had very similar results. 50% of survey responses indicated that existing walking paths are utilized on a weekly basis, and 41.6% indicate use of hiking/biking trails on a weekly basis. 58% of survey respondents think that walking paths and hiking/biking trails should be improved and/or expanded throughout the County. In addition, when asked what the one thing was they would improve about Park County trails, 40% of respondents indicated they would increase the number of trails.

The responses to the above referenced public outreach illustrate that recreationists in Park County and the City of Livingston are very active, and providing connectivity of existing parks and trails is a considerable benefit to an already lively trail system.

c. Growth Areas and Population Trends

Census results show that the population of Park County was 15,752 in 2010, and 17,191 in 2020, indicating a 9.9% increase in population during that time frame. The City of Livingston had a population of 7,094 in 2010 and 8,040 in 2020, resulting in a 14.1% population increase during the same time frame.[1]

Based on information provided in the Park County Growth Policy, it is anticipated that population growth in the County will likely range from 10%-18% between 2014 and 2036, illustrating the continued need for additional recreation infrastructure throughout the community.

Many communities throughout Montana continue to have declining populations; however, as Park County and the City of Livingston are experiencing a trend of significant population growth, it is important to continue to improve the infrastructure to encourage continued growth and economic development.

B. Need for the Project and Problems to be Solved

1. Current and Future Trail and Bridge Standards

In 2014, Park County adopted Transportation Standards in an effort to lend a measure of uniformity to future projects within the County (**Appendix J**). The Standards provide the minimum requirements for the design, construction and reconstruction of transportation infrastructure, which

[1] United States Census Bureau, "Decennial Census P.L. 94-171 Redistricting Data", http://census.gov/programs-surveys/decennial-census/about/rdo/summary-files.html

includes, but is not limited to, roads, bridges, culverts and trails. The Standards provide design guidance for Multi-Use and Recreational Pathways, stating that facilities should be built to ADA standards and the minimum standards set forth in the AASHTO Guide for the Development of Bicycle Facilities.

Specifically related to bridges, the Park County Transportation Standards outline specifications for hydraulic conveyance, geotechnical and structural design standards:

Hydraulic Conveyance: Bridge openings shall be designed to have adequate hydraulic conveyance capacity as to not adversely affect the headwater elevations during a 100-year flood by more than 6 inches. In addition, bridge openings shall be sized such that the bridge meets the following free board requirements:

Freeboard: 24" @ the 25-year design event
12" @ the 50-year design event

Geotechnical: Where a comprehensive geotechnical investigation is deemed a requirement by the County Commission/Design Engineer, a reputable geotechnical engineering firm shall be retained to determine the engineering properties of the soils through the use of borings, test pits, sampling and other methods. The geotechnical report shall be stamped by a professional engineer registered with the State of Montana.

Design and construction shall conform to the following design standards unless otherwise modified or amended in this document:

- AASHTO LRFD Bridge Design Specifications
- LRFD Guide Specifications for the Design of Pedestrian Bridges
- Montana Department of Transportation Standard Specifications for Road and Bridge Construction

In February 2021 the City of Livingston adopted a Public Works Design Standards and Specifications Policy (see **Appendix J**), which also states that "all bike lanes/paths shall be designed in accordance with the Guide for the Development of Bicycle Facilities (AASHTO, latest edition)."

2. Safety Considerations

The proposed bridge will follow the AASHTO LRFD Bridge Design Specifications for the design of a combination pedestrian/bicycle guardrail

system for the structure. The Specifications outline the geometry and live loads necessary to meet all safety requirements.

Although the bridge is intended primarily for pedestrian and bicycle traffic, it may provide emergency vehicle access in the event that both upstream and downstream structures are compromised or closed. To prevent everyday vehicular traffic from using the bridge, signing and bollards will be installed following the guidelines outlined in the AASHTO Guide for the Development of Bicycle Facilities.

3. Impact on Public and Emergency Services

As previously mentioned, the bridge is primarily intended for pedestrian and bicycle traffic; however, it may be designed to accommodate emergency vehicle access as well. This will provide greater redundancy in local access crossing the Yellowstone River, as there are only two existing bridges that cross the River and provide access between the City of Livingston and the Livingston HealthCare campus. The additional bridges are located on Interstate 90, upstream of the proposed bridge, and on US Highway 89, downstream of the proposed bridge.

4. Utility Location or Relocation

There are currently no utilities crossing the Yellowstone River in the vicinity of the bridge; however, the bridge may be designed to accommodate the attachment of a water main to the structure. Currently, the water main that services the Livingston HealthCare campus is at the end of a water main, with no redundancy of water supply in place. Therefore, in the event that the water main is compromised prior to reaching the campus, the facilities will be left with no water supply. The installation of the water main across the Yellowstone River will create a loop in the water supply system, providing redundancy in the system and safeguarding the facilities against a break in water supply.

Placement of the water main over the Yellowstone River, and the water main extension in general, will require application and approval by the Montana Department of Environmental Quality (DEQ) following Circular DEQ-1 Standards for Water Works. The Standards specify that “above-water crossings must be adequately supported and anchored, protected from damage and freezing, and accessible for repair or replacement.”

5. Floodway

The proposed location of the bridge is located in a FEMA Special Flood Hazard Area, Zone AE, with a calculated base flood elevation. In addition, the location is identified as a Regulatory Floodway, which means the river

channel and adjacent land must be able to discharge the base flood without increasing the water surface elevation.

The proposed bridge will span the Yellowstone River and use the existing built-up channel banks, which are remaining from the original vehicular bridge, to minimize impacts to the floodplain. The proposed bridge may be a single span or a multiple span structure, both of which provide their own unique benefits and challenges related to the floodway.

Providing a single span bridge over the Yellowstone River will minimize impacts to the river and floodway, which is a significant benefit to the overall project. As the bridge is located in a FEMA Special Flood Hazard Area, with a base flood elevation, FEMA mandates that no increase in water surface elevation may occur as a result of the bridge installation.

In comparison, installation of a multiple span bridge for this Yellowstone River crossing requires additional bridge foundation elements; however, it is often more cost effective due to the composition of shorter superstructure elements. The challenge of a multiple span structure at this location is that installation of intermediate foundation elements within the channel will result in a rise of the water surface elevation. In this event, the Park County floodplain administrator can request that a Conditional Letter of Map Revision (CLOMR) is obtained from FEMA as a condition of the floodplain development permit. The CLOMR is a method of receiving FEMA approval of the proposed project. After the bridge is constructed, a Letter of Map Revision (LOMR) application is submitted to FEMA and an as-built hydraulic model is prepared to illustrate the modified flood inundation mapping. This process adds significant cost and time to the overall project schedule.

The project has been discussed with the Park County Floodplain Administrator to ensure adherence to all floodplain regulations and avoid issues with obtaining the floodplain permit.

As previously mentioned, the proposed bridge structure will utilize built-up channel banks from the original vehicle bridge to mitigate floodplain impacts. The built-up channel banks in this location also dictate high flow conveyance, therefore no preliminary hydraulic analysis was performed as all alternatives utilize this same hydraulic opening. The base flood elevation of 4473 feet near the proposed bridge crossing from the FIRM was utilized to estimate a minimum of four feet of freeboard. This was determined by using the approximate elevation of the previously built-up channels banks of 4477 feet. This quick analysis ensures all preliminary designs are adequate to pass the required flood event.

C. Environmental Considerations

The proposed bridge crosses the Yellowstone River and will be approximately 310-ft long and 12-ft wide. On the west side of the river, the bridge will tie into property currently owned by the City of Livingston and on the east side of the river, the property is owned by Park County. Therefore, no land acquisition will be required.

According to the Montana Natural Heritage Program (see **Appendix F**), there are 23 species of concern in the project vicinity. In addition, one special status species is located within the project vicinity, which is the bald eagle. Permitting regulations will ensure construction of the bridge will not impact the species of concern or the special status species.

The Montana Sage Grouse Habitat Conservation Program website was consulted to determine if the project is located within an area of concern. Based on the map, the project vicinity is not located within a Sage Grouse Executive Order Habitat Classification (see **Appendix B)**.

Permits will be obtained from the U.S. Army Corps of Engineers (404 and Section 10), Montana Fish, Wildlife and Parks (SPA 124), Park County (floodplain) and, if necessary, the Montana Department of Environmental Quality (Authorization 318). The level of impact to wetland areas is expected to be nonexistent; therefore, no wetland mitigation is anticipated.

The project is located within a Special Area Management Plan (SAMP) area for the Upper Yellowstone River in Montana, which has been designated by the Army Corps of Engineers. This SAMP was developed to address the cumulative effects of projects along the Yellowstone River within the Special River Management Zone (SRMZ). While this project is covered under the Army Corps of Engineers Nationwide Permit (NWP) 14 for Linear Transportation projects, additional regional conditions for this NWP within the SRMZ state that new facilities will be reviewed under the individual permit process.

Because the proposed bridge will be built at the same location as Buchanan's Bridge, and there is the potential for historic findings at the project site, it is probable that the State Historic Preservation Office will require the completion of a Cultural Resource Report for the project area. This report will identify and assess both archaeological resources within the project area and any historic structures within and near to the project area. If historic elements are identified and will be disturbed or eliminated during the installation of the proposed structure, the Army Corps of Engineers will guide the project through the Section 106 process, which evaluates the effects of projects on historic properties. The Section 106 process allows the Advisory Council on Historic Properties,

interested parties, and the public the chance to provide comment on the project regarding the protection and maintenance of historic properties in their community.

The following agencies will be contacted for comments concerning the Environmental Assessment: Montana Fish, Wildlife & Parks; US Fish and Wildlife; State Historic Preservation Office; Department of Environmental Quality; Department of Natural Resources Conservation; National Heritage Program; US Army Corps of Engineers; and Montana Department of Transportation. Comments can be found in **Appendix F**.

Best Management Practices (BMP's) will be implemented to prevent dust and sedimentation during construction, and water will be used for dust abatement as directed by the inspector. A Montana DEQ-Pollutant Discharge Elimination System (MPDES) Permit will be obtained prior to construction. Furthermore, erosion and sediment control plans will be included as part of the contract specifications. Sediment control barrier will be placed on the downhill edge of all disturbances.

D. General Design Requirements

The new structure will meet or exceed the following Park County bridge design standards:

Design Load	= 90 psf Pedestrian Load
	= HL-93 (Emergency Vehicle)
Hydraulic Requirements	= 50-year design flood
Freeboard	= 24" @ 25-year design event &
	= 12" @ 50-year design event

The vertical placement of the bridge is based on the existing road grade elevations that remain from the original vehicular bridge. The bank elevations are, on average, 7-ft above the ordinary high-water mark and anticipated to provide 4 feet of freeboard during the 100-year event; therefore, achieving freeboard requirements will not be an issue.

As mentioned previously, the proposed bridge crossing exists within a detailed floodplain; therefore, BFE elevations, along with hydraulic cross sections, are provided along the entire section of river surrounding the bridge site. By utilizing the built-up banks from the previous vehicle bridge, little to no channel impact is anticipated with the construction of any proposed bridge alternative. Utilizing the estimated grade from the original vehicle bridge and BFE, 4 feet of freeboard is anticipated. Based on this information the new bridge length was determined for this report.

Single span bridge alternatives will meet the no-rise requirement set forth within the Park County Floodplain Regulations. Alternatively, it is anticipated that multiple span options, requiring an intermediate pier or piers, will be required to follow the LOMR/CLOMR process in order to account for the change in floodplain elevation. Upon selection of a design alternative and final design, the Flood Insurance Study utilized to create the FIRM for the project area will be utilized to model existing and proposed conditions. This study provides river hydrology used in the FIRM as well as all hydraulic data used in the creation of the FIRM.

A geotechnical investigation will be performed prior to the design and construction of the new structure to ensure appropriate practices are in place for the existing soils.

The new structure will follow all design requirements set forth in the AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges, the AASHTO LRFD Bridge Design Specifications, and the AASHTO Guide for the Development of Bicycle Facilities.

III. Alternative Screening Process

The Alternative Screening Process considers all reasonable and economic bridge design alternatives. Based on the previous discussion, in **Section II.C**, concerning the benefits and challenges of both single span and multiple span bridges, both options will be considered, as follows.

Single Span Bridge Options

In addition to the information provided in **Section II.B.5, Floodway**, there are additional site-specific items that would benefit from a single span pedestrian bridge. The Yellowstone River is deemed a Navigable Waterway by the Army Corps of Engineers; therefore, keeping intermediate bridge supports out of the Yellowstone River is a benefit to the many recreationists that utilize this popular stretch of the river. Also, just downstream of the proposed bridge location, and on the west channel bank, is an existing boat ramp that is heavily utilized. Installation of a single span bridge will eliminate impacts to the boat ramp, allowing for continued use. Finally, all of the bridge types identified as a single span option require a cast-in-place concrete deck.

1. Tied-Arch Truss Bridge

   A tied-arch bridge is an arch bridge in which the horizontal forces in the bridge are resisted by tie rods, extending from the steel arch to the low beam. This configuration eliminates the horizontal forces at the abutments, and specialized bridge foundations are not necessary. The tied-arch bridge provides a single span up to 310-ft and is popular for its aesthetic appeal. The design is unique

and eye-catching, adding character to any community. In addition, the design uses prefabricated components, which means portions of the bridge can be constructed elsewhere prior to on-site construction commencing. Utilizing prefabricated components results in a shorter on-site construction time.

Figure 3: Tied-Arch Truss

2. Cable-Stayed Pedestrian Truss
   A cable-stayed truss is designed for single-span bridge lengths ranging from 200-400 feet. The bridge itself is very lightweight and provides a unique architectural effect in which the bridge itself appears to be floating. Bridge suppliers offer multiple tower designs, which allows the owner to customize the bridge and enhance aesthetics. The height of the towers is typically one quarter of the span length, which will equate to an approximate 77-ft tower for the Yellowstone River bridge.

Figure 4: Cable-Stayed Truss

3. Prefabricated Steel Structure
   A prefabricated steel Connector Truss (Contech Continental Bridge) is considered one of the most familiar truss designs for pedestrian bridges, which features a parallel top and bottom chord. This bridge type can be customized by selecting rail type and bridge finish option that best reflects the needs of the community. Due to the nature of the design, this structure cannot be designed to carry emergency service vehicle loads and is adequate for pedestrian only loading.

Figure 5: Connector Truss

Multiple Span Bridge Options

Further, because the Yellowstone River is highly utilized for recreation, installation of intermediate foundations could hinder navigation of the river. It is often more acceptable by the permitting agencies to provide a long center span with two shorter approach spans, which leaves the majority of the channel unobstructed. However, this places the additional foundation elements near the existing channel banks and would likely hinder use of the existing adjacent boat ramp.

4. Prefabricated Steel Structure
   Prefabricated steel pedestrian bridges allow for rapid installation, which reduces site construction time and generally has lower supply and installation costs. As previously discussed, it would be most beneficial to investigate a three-span structure, comprised of a long center span with two short approach spans.

   There are a number of truss designs that will accommodate a maximum span length of 250-feet, which would allow the owner to select a design that is most attractive to their community. The following photos identify bridge design options that are available for a multiple span prefabricated steel bridge.

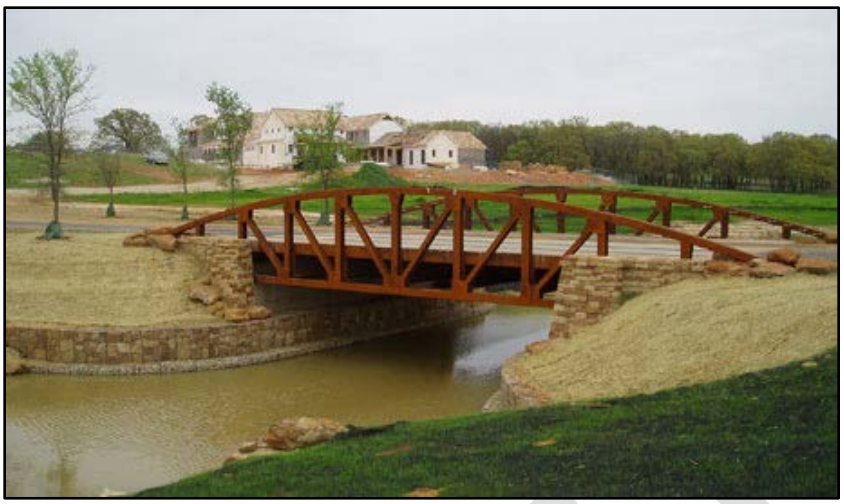

Figure 6: Capstone Truss

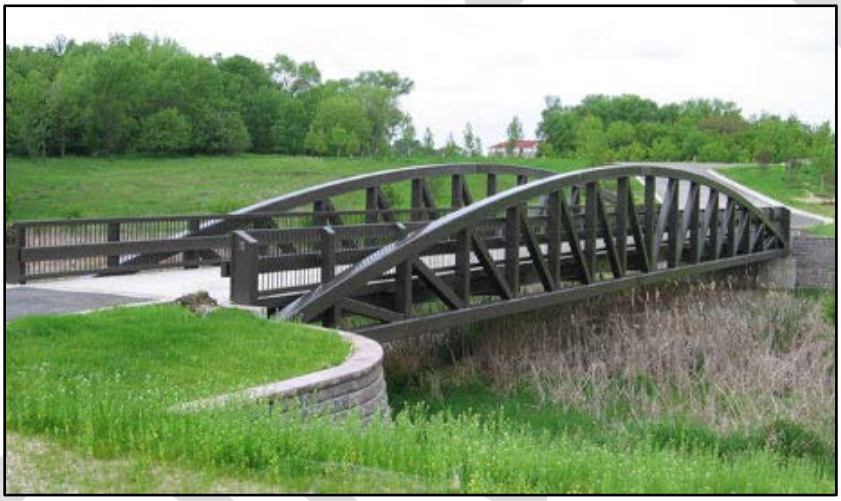

Figure 7: Keystone Truss

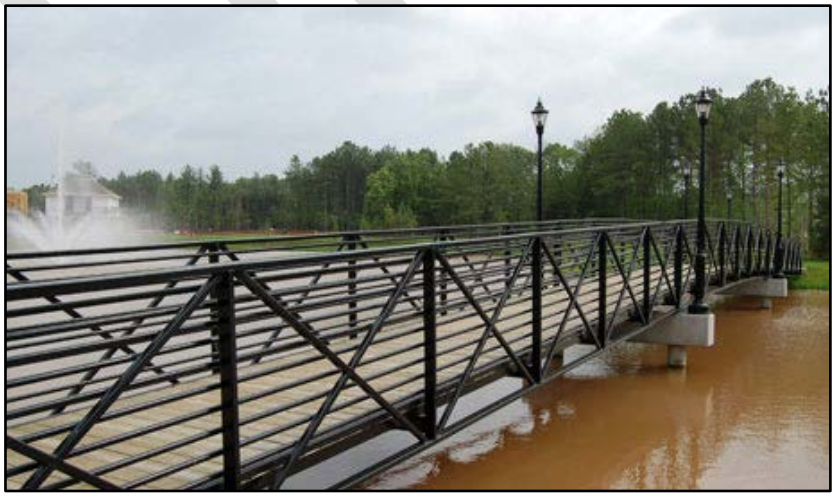

Figure 8: Link Truss

Figure 9: Gateway Truss

5. Prestressed Concrete Structure
   Prestressed concrete beams are widely used for bridge construction, especially in Montana. However, due to the span requirement of the proposed bridge, beam options are limited. A bulb-tee beam allows for the top of the beam flange to be used as the finished surface of the bridge deck, which allows for easy construction, but with a maximum span length of 120-feet, this beam would not provide the large clear span that can be obtained by using a steel structure.

   A prestressed concrete MTS girder shape will allow a maximum span of 260-feet, which closely matches the maximum span of a steel structure; however, this type of concrete beam requires a cast in place concrete deck. As the single span steel structures also require a cast in place concrete deck, a prestressed concrete structure will be evaluated.

<u>Foundation Options</u>

1. Driven Piles
   Driven piles commonly consist of either steel H-piles or pipe piles and are frequently used for bridge foundations throughout Montana. Steel piles can be used with either cast in place concrete caps or precast grade beams, can be used in most soil conditions. They are a good choice when larger gravel or cobbles are anticipated. Pipe piles can be used in most soil conditions as well but are better suited for soil types without large gravel or cobbles.

   While the final decision on a substructure option will be made after the geotechnical investigation has been completed, for the purpose of this report steel H-piles will be considered; however, the cost to purchase and drive either type of steel pile is similar.

2. Concrete Spread Footing
   A concrete spread footing can be used at most bridge locations and is recommended where the soil conditions consist of rock or hard gravel-based soils. If ground water is anticipated, dewatering and cofferdams may be necessary. Construction methods may also require shoring to prevent surface water from entering the excavation hole.

   Due to the location of the bridge within a floodway, the potential for the bridge to be impacted due to flooding is significant, and without driven steel piles the bridge would be highly susceptible to foundation movement or failure due to erosion of the riverbanks. In addition, the necessary foundation bearing capacity required for a large span bridge is substantial. Therefore, a spread footing foundation will not be evaluated as part of the alternative analysis.

3. Drilled Shaft Foundation
   A drill shaft is a deep foundation often used where significant scour is expected, where there are limits on in-stream work, or where driven piles are not economically viable due to high structural loads. They are constructed by excavating cylindrical shafts into the ground and filling them with reinforcing steel and concrete.

   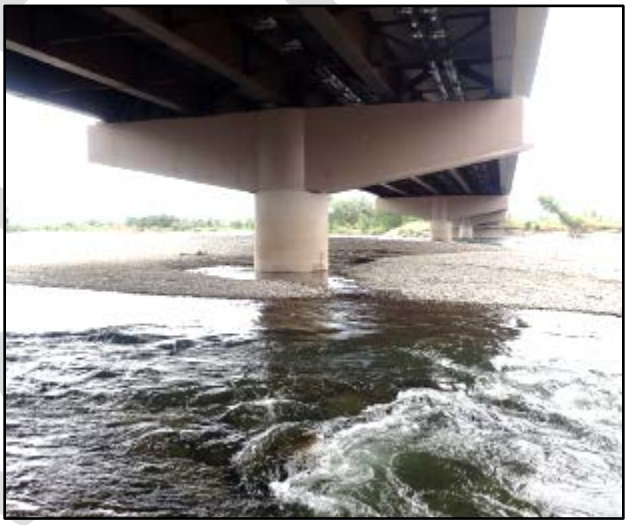

   Figure 10: Drilled Shaft Foundation

   The vehicular bridge directly downstream from this proposed bridge, which was built in 2013, employs a drilled shaft foundation. Due to the size of the proposed structure and the sensitivity of work in or near the Yellowstone River, drilled shafts will be evaluated as a foundation option.

4. Cable Stayed Bridge Foundation
   Use of a cable stayed bridge requires a foundation design unique to the structure. Caissons are sunk into the ground and towers are erected above ground. The towers are used to anchor the cables, which support the weight of the structure. This type of foundation is typically designed and supplied by the bridge manufacturer. This foundation will only be used for the cable stayed bridge option.

Drilled shaft foundations will be the only substructure option for all bridges identified, with the exception of the cable stayed bridge. Because the downstream

bridge uses a drilled shaft foundation, the probability is high that a Geotech will recommend the same foundation for this structure.

Summary

Single span and multiple span bridges will be further explored for the proposed pedestrian bridge over the Yellowstone River. The superstructure and substructure options that will be considered in the alternative analysis are listed below:

Superstructure Options

Option 1: Single span steel tied arch truss
Option 2: Single span steel cable stayed bridge
Option 3: Single span prefabricated steel bridge
Option 4: Multiple span prefabricated steel bridge
Option 5: Multiple span prestressed concrete beam bridge

Substructure Options:

Option A: Drilled shaft

This will result in five options as described in the alternative analysis section.

IV. Alternative Analysis

A. Description

Each of the bridge layouts were designed using existing channel width, channel elevation and channel bank configuration. Channel slopes of 1.5:1 were used in determining the span length of the bridge, as this most closely matches the existing channel bank slopes.

The existing channel opening created by the previously built-up channel banks were used to determine that a bridge with a 310-foot length is required to match the existing channel banks. This span allows the new structure to have the least amount of impact on the detailed floodway.

B. Schematic Layout

Schematic layouts of the proposed bridge options will be enclosed in **Appendix D**. The four combinations are listed below:

Alternative 1: Single span steel tied arch truss
Alternative 2: Single span steel cable stayed bridge
Alternative 3: Single span prefabricated steel bridge
Alternative 4: Multiple span prefabricated steel bridge
Alternative 5: Multiple span prestressed concrete beam bridge

C. Regulatory Compliance and Permits

The new bridge will meet all current regulatory, compliance and permit requirements. The permits that may be required for this new structure are listed below:

Montana Stream Protection Act (SPA) 124 Permit

Any agency of federal, state, county or city government proposing a project that may affect the bed or banks of any stream in Montana must apply for this permit. The purpose of the law is to protect and preserve fish and wildlife resources and to maintain streams and rivers in their natural or existing state.

This permit requires the review and approval of the structure layout by the Montana Fish, Wildlife and Parks.

404 Permit: Federal Clean Water Act

Any person, agency, or entity, either public or private, proposing a project that will result in the discharge or placement of dredged or fill material into waters of the United States must apply for this permit. The purpose of this law is to restore and maintain the chemical, physical, and biological integrity of the nation's waters.

As previously stated, the project is located within a Special Area Management Plan (SAMP) area for the Upper Yellowstone River in Montana, which has been designated by the Army Corps of Engineers. While this project is covered under the Army Corps of Engineers Nationwide Permit (NWP) 14 for Linear Transportation projects, additional regional conditions for this NWP state that new facilities will be reviewed under the individual permit process.

Section 10 Permit: Federal Rivers and Harbors Act

Any person, agency, or entity, either public or private, proposing any alteration of, or any construction activity in, on, under or over any federally listed navigable water of the United States.

Work requiring authorization by the U.S. Army Corps of Engineers includes suspending structures and utility lines over navigable waters, and work within the Ordinary High-Water Mark of navigable waters. Depending on final design, the project may meet the conditions of a Nationwide Permit.

318 Authorization: Short-Term Water Quality Standard for Turbidity

Any person, agency, or entity, either public or private, initiating construction activity that will cause short term or temporary violations of state surface water quality standards for turbidity must apply for this permit. The purpose of this permit is to protect water quality and minimize sedimentation.

Although this permit is administered by the Department of Environmental Quality, the authorization may be waived by the Montana Fish, Wildlife and Parks during its review process of the SPA 124 permit. Most often, for a bridge project this permit is not applied for directly and is obtained through the SPA 124 permit process.

County Floodplain Permit

Detailed hydraulic calculations in combination with the project layout will be submitted to the Park County Floodplain Administrator for review and approval. The purpose of this permit is to promote the health, safety and general welfare of the residents, and to minimize public and private losses due to flood conditions in the Regulated Flood Hazard Areas. This permit is issued by the local floodplain administrator.

As previously mentioned, installation of a multiple span bridge for this Yellowstone River crossing will result in a rise of the water surface elevation, which requires a revision to the current Flood Insurance Rate Map (FIRM) to show changes to the floodplain, floodway, or flood elevations. This requires a Letter of Map Revision (LOMR) or Conditional Letter of Map Revision (CLOMR). The LOMR/CLOMR is required when physical changes to the river channel or channel banks affect the hydraulic characteristics of the waterway, resulting in a modification of the base flood elevation. This process adds significant cost and time to the overall project schedule.

D. Land Requirements

There is no need for land acquisition as part of this project as the land on the west end of the proposed project is currently owned by the City of Livingston, and the land on the east end of the proposed project is owned by Park County. Because this project is being coordinated by Park County, the City of Livingston, and Livingston HealthCare, no issues with land acquisition are anticipated.

E. Environmental Considerations

Section II.D – Environmental Considerations includes a detailed discussion of the various environmental considerations for this project. Regarding the alternative analysis for each of the options explored, the single span options will impose the least impacts to the existing project site; however, all of the options will promote efficient construction methods, minimize duration of construction, and consequently, will tend to minimize impacts at the project site.

Each alternative will have minimal impacts to wetlands and none of the options are expected to require wetland mitigation, which is triggered when wetland impacts are greater than 0.10 acres.

F. Construction Problems

Challenges for this project include the following items:

- Placement of a bridge over a federally listed navigable water, as well as within a FEMA Flood Zone, will require careful placement of the bridge and increased communication with the permitting agencies.
- The proposed bridge span of 310-feet may require unique construction methods for structure installation. The use of large cranes, work structures, falsework or launching mechanisms may be necessary to complete construction.
- Complexity of a cast in place concrete bridge deck, which is labor intensive.

A utility locate will be performed before a topographic and utility survey is conducted. Furthermore, the contractor will make assurances prior to construction by having all utilities located.

G. Cost Estimates

1. Project Costs

Detailed cost estimates will be prepared for all alternatives and will be included in **Appendix E**. The estimates will identify the structure cost to accommodate pedestrian only traffic and the cost to accommodate pedestrian/emergency vehicle traffic. The cost estimates will take into account the administrative, financial, engineering and construction costs involved with the project. Unit costs will be collected from MDT average bid prices, as well as bid tabs for recent projects in Park County. In the absence of a geotechnical investigation and recommendations report, the estimated substructure costs are the items subject to the greatest margin of error. However, based on the experience of the Engineer in the design, cost estimating and review of actual costs for bridge projects, the estimated substructure costs are felt to be realistic and sufficiently accurate for the purpose of comparing preliminary alternatives and project planning and budgeting. A detailed project cost estimate will be completed for the preferred alternative.

2. Present Worth Analysis

The cost estimates will include detailed unit costs for the capital improvements of this project. In addition, a brief narrative of the O&M costs included with each superstructure alternative using a present worth analysis will be provided. O&M costs for the foundation are similar for every substructure option; therefore, only the cost for superstructure O&M will be differentiated. The O&M costs will be calculated based on a 100-year service life for a bridge. The cost indicated in the O&M narrative will be today's dollars.

Alternative 1: Single Span Steel Tied Arch Truss with Concrete Deck

- Assumes deck repairs for the concrete surface every 25 years after initial construction at a cost of $30,000 each for a total of $90,000
- Assumes additional riprap needed twice during the life of the structure at a cost of $15,000

Total O&M Costs = $105,000

Alternative 2: Single Span Cable Stayed Bridge with Concrete Deck

- Assumes deck repairs for the concrete surface every 25 years after initial construction at a cost of $30,000 each for a total of $90,000
- Assumes additional riprap needed twice during the life of the structure at a cost of $15,000

Total O&M Costs = $105,000

Alternative 3: Single Span Prefabricated Steel Bridge with Concrete Deck

- Assumes deck repairs for the concrete surface every 25 years after initial construction at a cost of $30,000 each for a total of $90,000
- Assumes additional riprap needed twice during the life of the structure at a cost of $15,000

Total O&M Costs = $105,000

Alternative 4: Multiple Span Prefabricated Steel Bridge with Concrete Deck

- Assumes deck repairs for the concrete surface every 25 years after initial construction at a cost of $30,000 each for a total of $90,000
- Assume debris removal/scour inspection at in-stream foundations every 10 years after initial construction at a cost of $5,000 each for a total of $45,000
- Assumes additional riprap needed twice during the life of the structure at a cost of $15,000

Total O&M Costs = $150,000

Alternative 5: Multiple Span Prestressed Concrete Bridge with Concrete Deck

- Assumes deck repairs for the concrete surface every 25 years after initial construction at a cost of $30,000 each for a total of $90,000
- Assume debris removal/scour inspection at in-stream foundations every 10 years after initial construction at a cost of $5,000 each for a total of $45,000
- Assumes additional riprap needed twice during the life of the structure at a cost of $15,000

Total O&M Costs = $150,000

Table 2

Present Worth Analysis				
Alternatives	**Capital Costs**	**O&M Costs**	**Service Life**	**100-Year Present Worth**
Alternative 1 Single span steel tied arch truss	$4,901,325	$105,000	100 years	$5,006,325
Alternative 2 Single span steel cable stayed bridge	$6,357,725	$105,000	100 years	$6,462,725
Alternative 3 Single span prefabricated steel bridge	$4,381,825	$105,000	100 years	$4,486,825
Alternative 4 Multiple span prefabricated steel bridge	$4,594,025	$150,000	100 years	$4,744,025
Alternative 4 Multiple span prestressed concrete bridge	$4,487,725	$150,000	100 years	$4,637,725

H. Basis of Selection of a Preferred Alternative

Selection of the preferred alternative will take into account environmental impacts and cost considerations. Points have been assigned to each category based on the following criteria:

- Technical Feasibility (Complexity)
  - (+1) point given for least complex
  - (-1) point given for most complex
- Environmental Impacts
  - (+1) point given for minimal impacts
  - (-1) point given for significant impacts
- Cost Effectiveness
  - Points assigned based on total cost, from lowest to highest

These factors and assigned ratings for each are summarized in Table 3.

Table 3

Alternatives	Service Life	100-Year Present Worth	Technical Feasibility	Environ. Impacts	Cost Effective	Total Points
Alternative 1 Single span steel tied arch truss	100 years	$5,006,325	-1	+1	+1	+1
Alternative 2 Single span steel cable stayed bridge	100 years	$6,462,725	-1	+1	0	0
Alternative 3 Single span prefabricated steel bridge	100 years	$4,486,825	+1	+1	+4	+6
Alternative 4 Multiple span prefabricated steel bridge	100 years	$4,744,025	+1	-1	+2	+2
Alternative 5 Multiple span prestressed concrete bridge	100 years	$4,637,725	+1	-1	+3	+3

Basis of selection results in Table 3 demonstrate that **Alternative 3**, single span prefabricated steel bridge, is the preferred alternative. All of the alternatives have a similar life span; therefore, planning for the least cost alternative is in the best interest of Park County.

V. Description of the Preferred Alternative

A. Site Location and Characteristics

The project site is located on at the end of View Vista Drive on the west and Meyers Lane on the east. Both riverbanks provide recreation opportunities, and the proposed bridge will improve access and connectivity of the existing infrastructure. The prefabricated elements of the preferred alternative will minimize construction time and lessen the impacts to the project site.

B. Design Criteria

Following is a list of the design criteria used for preliminary engineering and layout of the preferred alternative:

Design Guidelines:	AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges
Design Load:	HL-93 90-psf pedestrian loading
Design Flood:	50-year flood event
Trail Width:	12-foot clear width between guardrails
Channel Width:	Match existing / natural channel width

C. Environmental Impacts and Mitigation

Best management practices will be implemented to prevent dust and sedimentation during construction and erosion and sediment control plans will be included as part of the contract specifications. Sediment control barrier will be placed on the downhill edge of all disturbances.

State and federal agencies were provided information about this proposed project, as well as a request for comments concerning the project. All letters and responses are provided in **Appendix F**.

D. Cost Summary for the Selected Alternative

A cost summary for the selected Alternative will be included in the final report, and in **Appendix E**.

E. Public Participation

On September 20, 2021, a public meeting was held in the City/County Complex Community Room at 6:00 p.m. The purpose of the meeting was to present the general findings of the draft Preliminary Engineering Report and provide an opportunity for interested individuals to comment on the proposed project.

An additional public meeting will be held on November 1, 2021, in the City/County Complex Community Room at 6:00 p.m. The purpose of the meeting is to provide an opportunity for interested individuals to comment on the environmental checklist prepared for the proposed project.

The public meeting presentations, meeting minutes, and public hearing legal notices will be located in **Appendix H**.