Bridge Repurposing Study

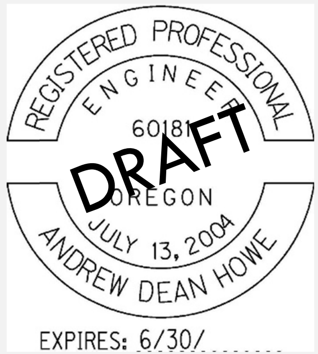
Willamette River (Van Buren Street) Bridge
Bridge No. 02728
Benton County, Oregon

June 14, 2019

OBEC Consulting Engineers, a DOWL LLC Company
920 Country Club Road, Suite 100B
Eugene, Oregon 97401

541.683.6090 | www.OBEC.com

DISCLOSURES



Prepared by	**Reviewed by**
Jacob McNutt, PE	Andy Howe, PE

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Introduction

The Oregon Department of Transportation (ODOT) has secured $69M between Bridge Fix-it and House Bill 2017 Bridge Seismic funding to construct a new highway bridge at or directly north of the existing Willamette River (Van Buren Street) Bridge (#02728), located on the east side of the City of Corvallis (City). ODOT has retained OBEC Consulting Engineers, a DOWL LLC Company, (OBEC) to serve as prime consultant for the new bridge design.

This Bridge Repurposing Study investigates the need for a new bridge and the possible outcomes of the existing bridge, should the City or other 3rd party choose to take ownership of the existing bridge at its present or relocated location. Additional project alternatives not listed in this document and not directly related to City or 3rd party ownership of the existing bridge are being concurrently examined or revalidated.

The alternatives presented in this study are intended to provide guidance to ODOT or other prospective bridge owner concerning potential costs to reuse the existing bridge. The three alternatives studied are (1) rehabilitating the existing bridge to serve non-motorized traffic over the Willamette River at its current location, (2) relocating the historic steel truss segments to serve as a public display or an over-land pedestrian facility, and (3) removing and disposing the existing bridge.

Background

The Van Buren Bridge has carried traffic across the Willamette River for more than 100 years. It was commissioned by Benton County, designed by the Coast Bridge Company, and constructed in 1913. The 4-span steel structure is the oldest swing-span, and only pin-connected swing-span, truss roadway west of the Mississippi River. The bridge originally consisted of a 171-foot Parker truss, a 249-foot truss swing-span, two 57-foot steel pony trusses, and 17 timber trestle spans. The western approach pony truss was severely damaged in the 1962 Columbus Day Storm, requiring replacement of the western pony truss. The swing-span portion consists of two 114-foot trusses with a 21-foot-wide pier that housed turntable machinery. The swing truss would turn 90 degrees to allow passage of vessels up and down the Willamette River, which was navigable through Corvallis and beyond. The turntable machinery has since been removed and the bridge has not rotated since the span was fixed in 1960 (as noted in the 2013 Oregon's Historic Bridge Field Guide). The bridge was previously determined and is currently considered individually-eligible for listing in the National Register of Historic Places, the nation's catalog of historically significant places.

Figure 1 shows a profile of the bridge drafted in 1940, *before* the western approach was damaged.

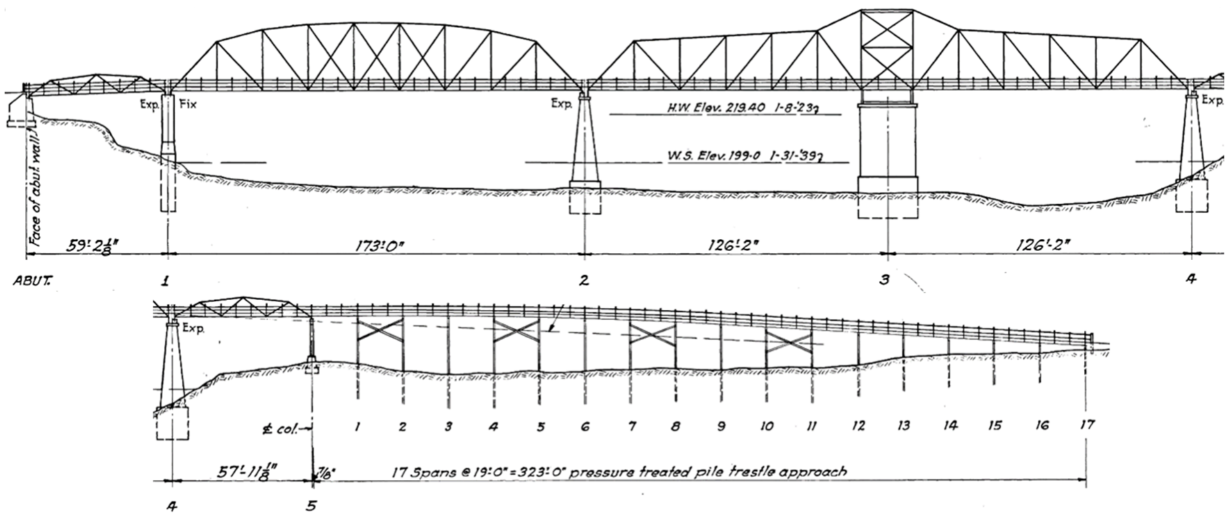

***Figure 1** - Van Buren Bridge*

Currently, the bridge carries a single lane of vehicular traffic eastbound on the Corvallis-Lebanon Highway (OR34, State Highway 210) with a pedestrian path on its south side. The existing Van Buren Bridge has been determined functionally obsolete according to the current bridge inspection report and seismically vulnerable according to ODOT Bridge Section's "Interactive Dashboard" web tool. The Sufficiency Rating of the bridge is currently 48.9. The current annual average daily traffic (AADT) is 10,800 vehicles per day according to the current bridge inspection report, attached as Appendix B.

The functional obsolescence of the existing bridge is related to its width and safety features. The existing roadway width is substandard and does not allow for the addition of lanes. The bridge rails, transitions, and approach rails are identified as substandard. Due to load capacity and geometric constraints, the bridge cannot be widened to correct deficiencies related to width without disassembly and replacement of nearly all structural members.

The bridge has been identified as seismically vulnerable due to the era in which it was designed and constructed, and the structural details used in its construction. The bridge contains many details that make it potentially vulnerable to damage, including collapse, during a seismic event. The bridge has not undergone seismic retrofitting, which would require retrofit of structural and foundation elements.

In addition to functional obsolescence and seismic vulnerabilities, the bridge has two further undesirable qualities: scour-critical foundations and a structural system that includes fracture-critical structural members.

Bridge scour is caused by erosion of the soil around and under the foundations. Scour can be an ongoing issue as the river bottom migrates over time and can rapidly occur during high water events. Chapter 1 of HEC 18 – Evaluating Scour at Bridges 5th Edition – 2012 published by the Federal Highway Administration states "The most common cause of bridge failures is from floods scouring bed material from around bridge foundations." Scour was not a design consideration at the time the Van Buren Bridge was constructed, and several remediation measures have been implemented in an attempt to overcome this shortcoming. However, the long history of scour exposure has caused some deterioration of the bridge. The bridge is currently on a bi-annual cycle of underwater inspections, the most recent of which identified numerous areas of concrete spalling on the piers and footings.

A fracture-critical member is any tension member whose failure would cause a cascading and catastrophic failure of the entire bridge. Prior to the Silver Bridge collapse in 1967, fracture-critical members and details were common. That collapse highlighted the risk of these members and triggered changes in material specifications (1973 adoption of minimum Charpy V-Notch Toughness in AASHTO M270) and fatigue design (1974 adoption of requirements for comprehensive fatigue design) and ultimately issuance of the 1978 AASHTO *Guide Specifications for Fracture Critical Non-Redundant Steel Bridge Members*. Today, fracture-critical members require frequent hands-on inspection. There are 60 such elements on the Van Buren Bridge, including eye-bars similar to the member that failed causing the collapse of the Silver Bridge. Many of these members have observable deterioration.

A detailed fatigue and fracture evaluation was performed for ODOT by OBEC in 1995, which analyzed actual structure stresses to estimate the remaining service life of the bridge. This analysis used strain gauges combined with material properties that were determined through testing steel coupons taken from non-critical sections of the structure. The report indicated that Span 4 (the 171-foot-long Parker Truss span) was the most critical span in the structure. This fatigue and fracture investigation showed that the structure has an estimated remaining service life range of 13 to 54 years. Annual inspection, with bi-annual fracture-critical member inspection, was recommended. Due to the bridge's configuration, repair or replacement of the critical bottom chord members is impractical without disassembly of the bridge. Addressing the finite fatigue life of the fracture critical details would require visibly changing the structural members that make the bridge unique. The 1995 report recommended replacement of the bridge within 10 years. No strengthening activities have been undertaken to overcome the shortcomings identified in the 1995 report.

Structural repair activities in 2007 were limited to repairs associated with addressing corrosion in conjunction with the repainting project undertaken at that time. The anticipated life of the painting work performed in 2007 is approximately 30 years. The structural repairs made at that time, while limited in scope, are anticipated to have an indefinite design life provided that the paint system is properly maintained.

Construction of a new highway bridge across the Willamette River is a considered option. Extensive development of the transportation system within the City, including the adjacent Harrison Street Bridge, which carries westbound traffic on the Corvallis-Lebanon Highway, may require the new bridge to be constructed at or adjacent to the existing Van Buren Street Bridge.

Alternative 1: Bridge Rehabilitation for Pedestrian Use

It is possible for a new bridge to be constructed parallel to the existing Van Buren Street Bridge, allowing the existing bridge to be used exclusively as a bridge for walkers, runners, skaters, cyclists, and other non-vehicular traffic (pedestrians). With this alternative, the bridge can remain in its historic location and become a designated, and signature, connector for pedestrians. However, the new bridge will include a traffic-separated, multi-use path, and the existing bridge will not be required for pedestrians to cross the river. The new bridge will obstruct northward views from the existing bridge.

To safely accommodate pedestrians on the existing bridge, it would need to be modified. This would require removing the existing sidewalk to prevent its use and retrofitting the main travel lane to incorporate pedestrian safety railing and loading requirements. The approach spans would need to be replaced to make room for the bridge and create new access to the existing bridge. Figure 2 shows a conceptual retrofitting scheme and is included with additional detail in Appendix B.

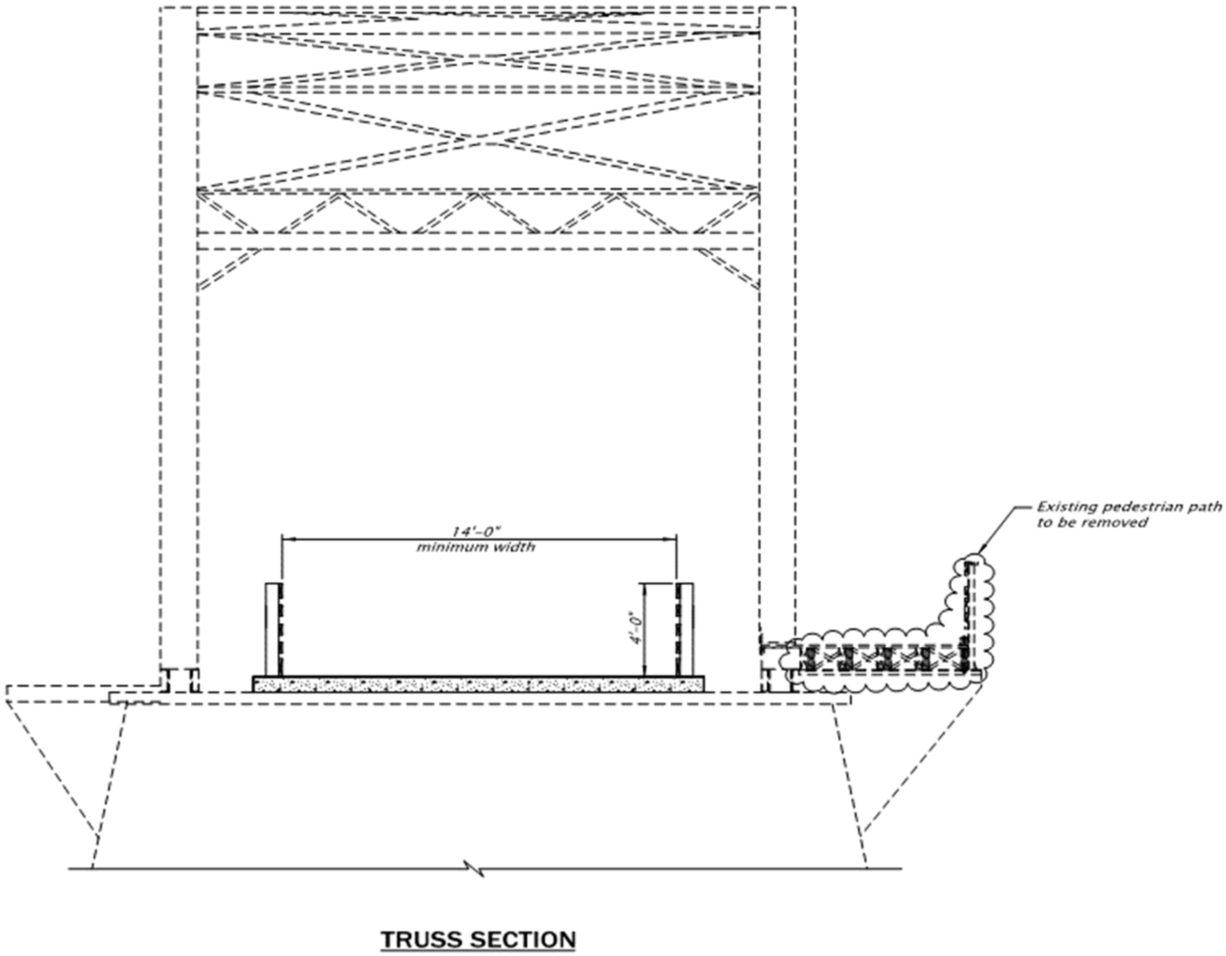

***Figure 2** – Conceptual Retrofitting Scheme*

While it may not seem readily apparent, the American Association of State Highway and Transportation Officials (AASHTO) code indicates that pedestrian loading can exceed the demands of vehicular traffic. The existing bridge is very robust for a structure of its period (in fact it was designed in 1912 for the same live load as a pedestrian bridge would be in 2019), however as design codes have evolved and the bridge has aged, it would need to be evaluated to verify the capacity of the structure in its current condition to carry pedestrian loads. It is possible that either structure strengthening or a load restriction through a reduction in useable width, or both, would be required for public safety. Conversion of the structure to pedestrian use would, with verification of the condition of existing members and implementation of appropriate repairs, if necessary, eliminate the concerns related to the finite fatigue life of the existing structure.

All the major limitations discussed above would need to be addressed for the bridge to serve as a pedestrian facility, including maintenance and inspection costs due to fracture-critical members and the scour-critical nature of the bridge. Additionally, the seismic vulnerabilities, river navigability, and reconstruction of the eastern and western approaches would need to be addressed.

No structure is maintenance free. Structural repairs can improve the condition and safety of the bridge; however, the fracture critical nature of certain structural elements cannot be changed without significantly altering the design of the structure. While pedestrian bridges are not part of the National Bridge Inventory (NBI), continuing routine inspection of this bridge on its current schedule is recommended to identify required maintenance activities and confirm its safety for continued use. In addition to the bi-annual underwater inspections, the bridge would need fracture-critical inspections performed on a bi-annual basis and pin inspection every 10 years. This maintenance work should be conducted on an ongoing basis, as required to maintain the safety of the bridge. The current bridge inspection report, dated June 6, 2018, detailing the condition and currently identified maintenance items, is attached in Appendix C. Bridge protective coatings (paint) are a maintenance item of significant cost. Significant portions of the bridge were painted in 2007, but the tops of floor beams, columns, and piles are still in need of paint.

As previously discussed, damage and collapse of the existing bridge are potential consequences of seismic activity unless seismic retrofits are performed. The primary risk of bridge collapse, aside from loss of the structure, is potential injury and loss of life for those using the structure at the time of an earthquake. In this scenario, the close proximity of the existing bridge to the new bridge increases the risk to include the risk of damage and collapse of the new highway bridge should the existing bridge collapse in a manner which causes it to strike the new bridge.

Seismic retrofit work falls into two categories: Phase I and Phase II. Phase I retrofits are intended to prevent the bridge superstructures from falling off their supports. These typically include seat width extensions, restrainer systems, and replacing unstable bearing devices. Phase II retrofitting involves strengthening or isolating substructures and foundation elements so that they survive the seismic event. The bridge requires seismic retrofitting to protect users on the existing bridge and reduce the risk of the existing bridge collapsing into the new bridge. While the Phase I retrofit work is anticipated to be relatively simple to accomplish, the anticipated Phase II retrofit work would likely include foundation strengthening above and below the mud line, column strengthening, and isolation. The need for strengthening the truss to resist seismic loads is considered small and has not been included directly in cost estimates but is considered to be within the budgetary allowance of the 40 percent for construction contingency. The deep foundations required for the Phase 2 seismic retrofit are anticipated to also adequately address concerns related to scour.

Despite its inability to rotate, the USCG permit for the existing bridge requires it to be opened within seven days of a request to allow for navigation of tall river traffic up and down the Willamette River. Retaining the existing bridge in its current location, while constructing a parallel highway bridge in close proximity, precludes rotating the existing bridge to allow tall river traffic to pass. The new owners would need to modify the terms of the current USCG permit to indicate a permanently lowered navigational clearance. At this time, it is unknown if a permit modification for the existing bridge is attainable. A request to open the bridge to tall river traffic has not been received in several decades and it appears possible to acquire the permit modification. However, doing so requires extensive coordination with the USCG and may result in additional project costs that are not quantifiable at this time.

Finally, retaining the existing bridge as a pedestrian bridge would require modification or reconstruction of the modified approach spans. Current options for the new highway bridge include alternatives that conflict with portions of the existing approach spans. This conflict is created by a need to minimize the offset from the existing roadway at the intersection with 1st Street at the west end of the bridge and the Highway 34 Bypass at the east end of the bridge. A cost for replacing the existing approach spans has been included in the rehabilitation cost estimate.

For clarity, costs are broken into two categories: upfront costs and annual costs. The upfront construction costs include retrofitting the bridge for pedestrian loading and safety, scour concerns, and seismic activity, and are estimated at $12.18M. The bridge was last repainted in 2007 at a cost of 1.86M. The cost to repaint the trusses will cost $2.5M in 2019 dollars. Maintenance activities, like painting, inspections, and repairs, sum to a cost of $152,000 each year. Outside the annual spot painting, the entire bridge will need to be painted on an estimated cycle of 30 years. Appendix A shows an itemized breakdown of both the upfront and annual costs.

The anticipated length of time to complete the rehabilitation work is approximately four years. Work would not necessarily proceed continuously. The seismic retrofit work would need to begin prior to construction of a new bridge adjacent to the existing bridge and superstructure repairs could not be completed until after completion of a new bridge and shifting of vehicular traffic to that structure.

Alternative 2: Bridge Relocation

A new bridge could be constructed in the same location as the existing bridge. In this case, the historic trusses could be relocated to public parks in the area. The steel truss spans would be dismantled and removed from their substructures, with every effort to preserve their historic nature, and then transported for public display or use. The relocated structure could serve as an historical exhibit or as a pedestrian facility if a new deck is placed. Some examples are shown below in Figures 2, 3, and 4.

Figure 2 *- Pierceville Bridge Relocation (PA)*

Figure 3 *- Goldman Bridge Relocation (TX)*

Figure 4 - *Fink Truss Relocation (VA)*

Several assumptions were made when developing the costs associated with relocating the bridge:

- A unique work bridge will be required to perform work on the existing Van Buren Bridge.
- Only steel truss spans will be relocated. The modified west approach and timber east approaches will not be relocated.
- All the deck materials will be removed on-site before the trusses are dislodged and moved. This common construction practice reduces the structure weight, allowing for smaller, more economical, cranes to be used.
- The bridge could be retrofitted with a concrete deck and safety railings for pedestrian use.
- The foundations will consist of cast-in-place concrete end bent caps supported on six 60-foot steel piles. This proposed foundation is designed for the vertical self-weight, pedestrian, and wind loads while neglecting seismic load considerations.
- The structures will require routine maintenance work totaling $145,000 annually, as shown in Appendix A. The routine maintenance work does include repainting the bridge, as previously described.

Figure 5 - *Crane Lift of Historic Truss*

A work bridge would be constructed so that the entire span can be stabilized and removed. The work bridge would likely be constructed on temporary pile foundations. The work bridge may or may not be able to be located in a position where it is useful for construction of the new bridge. Debris, dust, and sediment generated by the bridge removal operations would have to be contained to prevent contamination of the river and shorelines. The substructures would need to be removed to a depth of three feet below the river bottom.

Since no two sites are identical, there may be specific site considerations, which may also affect the cost of this overall alternative. However, specific final site preparations, such as site access, landscaping, and facility construction, are outside the scope of this study and would have to be developed prior to moving the bridge if this alternative is chosen.

Several Corvallis parks have been considered for relocating the existing bridge, as shown in Figure 6. The parks considered are Orleans Natural Area, Riverfront Commemorative Park, Shawala Point & BMX Track, Willamette Park and Natural Area, and Pioneer Park & Avery Park and Natural Area. These park locations were selected for an array of location and cost considerations, but do not include costs to span a river or significant waterway. This is not an exhaustive list of the area. Construction costs for each relocation area roughly fall into two bins: relocation without significant disassembly (limited to parks adjacent to the existing bridge location) and relocation requiring disassembly of the bridge (all other locations). These costs have been itemized and are found in Appendix A.

For all locations, the anticipated length of time required to disassemble, relocate, repair, and reassemble the existing bridge, including construction of new foundations, is estimated at between one and two years. This work would occur immediately after completion of a new vehicular bridge.

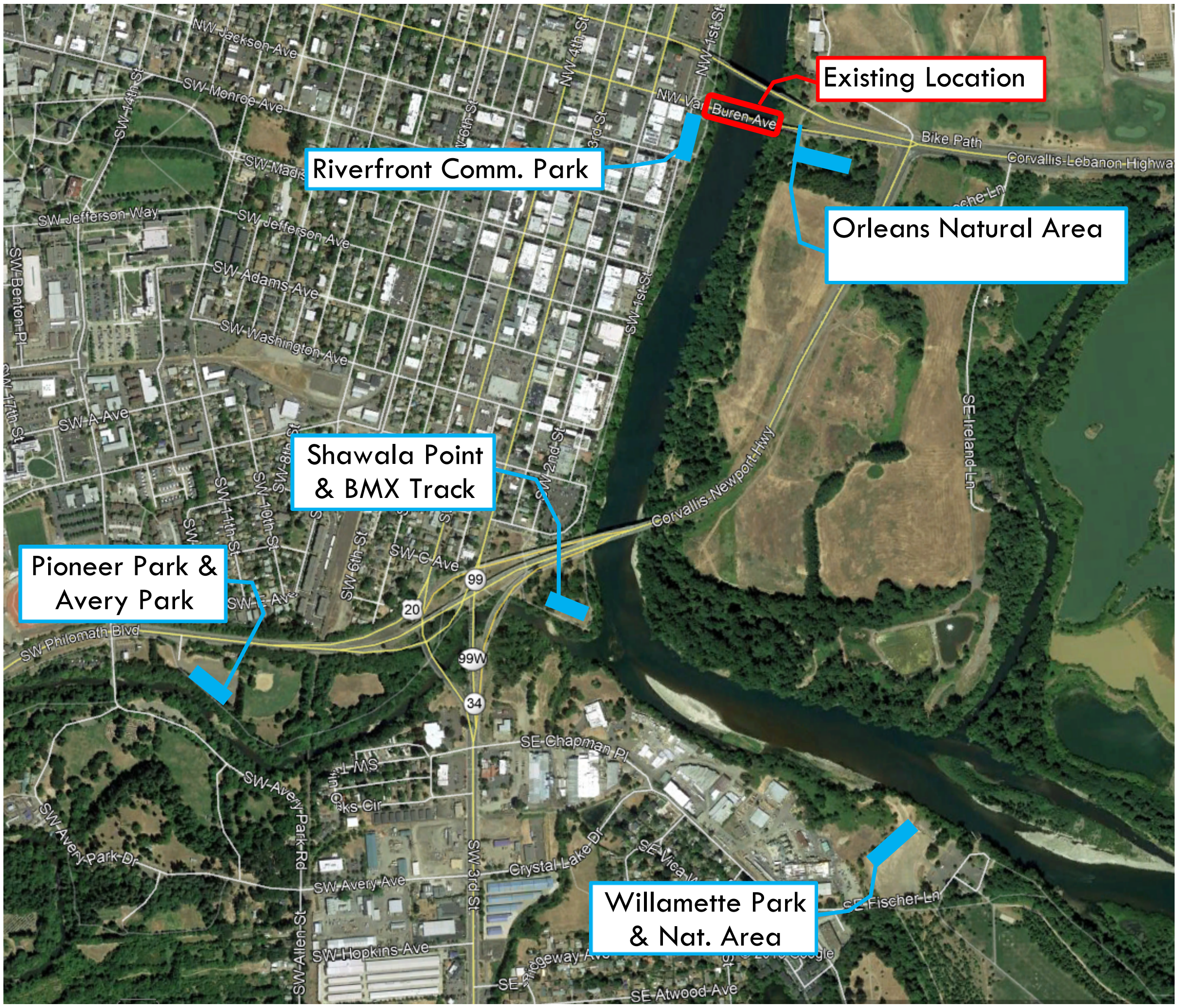

***Figure 6** - Prospective Relocation Sites*

Orleans Natural Area

The Orleans Natural Area includes more than 36 acres of undeveloped parkland, nestled between the Highway 34 Bypass to its east and the Willamette River on its west. A significant portion of the park is located in the Willamette River floodway, yielding riparian, wetland, and wet prairie habitats for visitors to enjoy. It is only accessible by foot or bicycle since it has no formal parking areas.

The main advantage of relocating the bridge to this site is its close proximity. This site requires relatively little logistical efforts; the bridge would only need to be moved longitudinally several hundred yards to reach a suitable location. The historical context of the bridge is highlighted in this setting, as it is very near its original location. Disadvantages of relocating the bridge to the Orleans Natural Area include its limited access and its archaeologically significant land, resulting in less public use. An independent archeological study of the area would be needed prior to placement of the trusses. The cost estimate to move the Van Buren Bridge to this location is $7.11M.

Riverfront Commemorative Park

Riverfront Commemorative Park is a narrow stretch of land between 1st Street and the western bank of the Willamette River. The park is roughly four and a half acres, with access for river-related recreation, special event viewing, art and fountain installations, and paved paths for easy access and use.

The park offers several benefits, chiefly its proximity to the Van Buren Bridge's current location, which eases relocation costs and preserves the historical context of the structure. Additionally, an information installation providing a brief history of the bridge is already located in the park. However, space is at a premium in the park, and the structure would occupy a large footprint. The estimated cost of relocating to this site is also $7.11M.

Shawala Point & BMX Track

Shawala Point is a peninsula at the confluence of the Marys and Willamette Rivers and is a part of Riverfront Commemorative Park. Originally the site of a mill, it has long since been used as an area for the public to enjoy river viewing and fishing. It is also connected to the Corvallis Dog Park and the Eric Scott McKinley Skate Park. The area is easily accessed and frequented by the public. The BMX Track is nearly six acres, offering a series of soil berms and trails for BMX enthusiasts, while also offering river viewing and natural areas for the public at large.

The primary benefits of this location are its proximity to the river and ease of access. Relocating the truss segments to a location near the Willamette River provides historical context to the role it played to the people located on either side of it. Shawala Point is frequently used and has excellent facilities for people to access the relocated segments. Additionally, since the bridge would be visible from both parks, it would be an added benefit to both. However, the distance the truss segments would need to travel is considerably longer, and at a larger cost than the two alternatives discussed previously. Other drawbacks of this site include a loss of historical context as the bridge moves farther from its original location. The estimated cost to relocate the Van Buren Bridge to this location is $10.29M.

Willamette Park and Natural Area

At 287 acres, the Willamette Park and Natural Area is the largest recreational area owned by the City. It is located at the southeast corner of the city, along the western bank of the Willamette River. It offers a variety of popular features, including exceptional river viewing and access, a disc golf course, off-leash dog areas, playgrounds, sports fields, and a network of multi-modal trails.

One benefit of using the Willamette Park and Natural Area as a relocation site is the numerous location options it offers. The park has a length of river-connected land that would provide a historical connection that placing the segments in a field could not. The cost estimate for moving the bridge to this location is $10.29M.

Pioneer Park & Avery Park and Natural Area

Pioneer Park is nearly 18 acres of parkland along the north shore of the Marys River in southern Corvallis. It features sports fields and fitness equipment and is easily accessed by a multi-modal path to Oregon State University and downtown Corvallis in addition to parking lots. Across the river is Avery Park with over 73 acres of recreational land. It hosts picnic shelters, playgrounds, riparian habitats, and the Avery House Nature Center.

Relocating the Van Buren Bridge here would provide a visual benefit to both areas since it will be located along the river adjacent to them. However, this location is a significant distance away from the original site, which will diminish the historical context of the bridge. The estimated cost of moving the bridge to this relocation site is $10.29M.

Alternative 3: Bridge Removal

If it is determined not feasible and prudent to maintain and preserve the existing bridge at its current location and no responsible party can be located to relocate, maintain and preserve the bridge, then it may be necessary to remove and demolish the bridge. Lacking agreement from a responsible party to maintain the existing bridge in place, the USCG will require ODOT to acquire a new permit for the existing bridge or require removal of the existing structure as a condition of constructing a new highway bridge.

Removal and demolition of the existing bridge would be similar to some construction activities required for relocating the truss portions of the bridge discussed in Alternative 2. Both alternatives would require similar work bridges and both would involve removal of piers and foundations.

Due to the non-redundant nature of the existing bridge, it cannot be easily dismantled or cut into pieces for transport. Truss removal could occur in two ways: (1) shore the trusses and disassemble them in place, more or less in the reverse order of their construction, or (2) remove the trusses intact for disassembly on dry ground. To the extent feasible, removal of large truss segments is anticipated. This method would involve stabilizing the truss to allow removal of deck, floor system, and bracing followed by extensive rigging and craning to support the trusses as they are individually freed from their substructure supports. The trusses would then be transported to a stable area, likely the east river bank, for reducing the structure to a size appropriate to transport. Demolishing the timber trestles would be considerably easier, not requiring much more than an excavator and trucks to haul debris. Removing the piers and columns to the required depth would likely require wire cutting within a cofferdam containment system. Any locations that will not be reused by a new bridge would be remediated as necessary.

A cost estimation for bridge demolition has been prepared and is included in Appendix B. The following items were included when developing the cost estimate: mobilization, work bridge construction, debris containment measures, and removal of superstructure elements and substructure components. It may be possible for a contractor to creatively use one work bridge for both demolition of the existing bridge and construction of the new bridge; however, this may not be possible and a unique work bridge is assumed to be necessary for both tasks. If demolition of the existing bridge is identified as the appropriate course of action, the cost of removing the existing structure will be incorporated into the construction package of building the new bridge.

The anticipated length of time to complete demolition work is less than one year, taking place immediately after completion of a new vehicular bridge. The estimated costs, including contingency, for this alternative is $4.46M. A cost breakdown is presented in Appendix B.

Conclusions

The intent of this report is to investigate and quantify repurposing the Van Buren Bridge, #02728, which carries vehicular and pedestrian traffic eastward from the City of Corvallis. Three alternatives were detailed and quantified, specifically (1) rehabilitating the structure to serve solely as a non-motorized pedestrian/bike connector, (2) relocating the historically significant steel trusses to public venues in the city, and (3) demolishing the entire bridge structure. Maintenance costs do include periodic rehabilitation projects, such as repainting the entire structure, that are anticipated to be required on an approximately 30-year cycle. Additional validation of other alternatives is an ongoing effort and will be concluded prior to any final decisions for the existing bridge or future bridge design. The associated costs are listed below, and itemized details are provided in

Appendix B. All the cost estimates include a 40 percent contingency, 18 percent allotment for preliminary engineering services, and 13.5 percent contribution for construction engineering services.

***Table 1** - Alternatives Cost Estimates (2019 Dollars)*

Alternative	Description	Initial Construction Cost	Maintenance Cost (per year)
1 - Rehabilitation	Retrofit bridge in place for pedestrian-only use	$12,177,000	$152,000
2a - Relocation	Trusses moved to Orleans Natural Area	$7,114,000	$145,000
2b - Relocation	Trusses moved to Riverfront Commemorative Park	$7,114,000	$145,000
2c - Relocation	Trusses moved to Shawala Point & BMX Track	$10,287,000	$145,000
2d - Relocation	Trusses moved to Willamette Park and Natural Area	$10,287,000	$145,000
2e - Relocation	Trusses moved to Pioneer Park & Avery Park and Natural Area	$10,287,000	$145,000
3 - Demolition	Remove entire existing structure	$4,461,000	$0