HOOD RIVER – WHITE SALMON INTERSTATE BRIDGE

STRUCTURAL CONSIDERATIONS FOR PEDESTRIAN CROSSING ON THE EXISTING BRIDGE

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PREPARED FOR

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1. EXECUTIVE SUMMARY

As requested by the Port of Hood River (Port), HNTB Corporation (HNTB) conducted a brief review of the more significant structural issues and opportunities related to adding a safe and viable pedestrian and bicycle crossing separated from vehicular traffic onto the existing Hood River-White Salmon Bridge (bridge). This document briefly explains how pedestrian and bicycle (ped/bike) facilities might be structurally added to the existing bridge and separated from vehicular traffic. The intent was to provide sufficient information to allow the Port to decide if there was a need to further investigate structural solutions. The investigation by HNTB included the following steps:

- Review and reference previous studies and reports related to ped/bike crossing alternatives.
- Identify high-level structural issues, constraints, limitations, and retrofit needs.
- Conceptually explain the reasonable structural concepts that might meet the project need.
- List out unknowns, assumptions, and further studies needed to improve the estimate of feasibility.
- Provide a single, concept-level, and order of magnitude cost estimate for the structural work necessary to provide this ped/bike crossing for the most reasonable alternative.

HNTB is uniquely positioned to provide this expert opinion to the Port given HNTB's:

- Long term work history on the bridge;
- Detailed understanding of the recent and historical modifications made to the bridge;
- Current and active understanding of the bridge condition and rate of deterioration;
- Intimate understanding of the lift-span operations on this bridge and similar bridges;
- Wealth of regional and national expertise on similar bridge types and design and construction of bridge retrofits of this nature.

The following are the key conclusions of the study:

- The steel trusses have a limited reserve structural capacity to support added loads.
- The lift span would require significant mechanical and electrical equipment upgrades and structural retrofit or full replacement to support the added loads and configuration.
- The steel trusses would require full engineering evaluation and structural strengthening to support added loads.
- If a ped/bike facility is added to the bridge the bridge may need to be load limited for vehicles.
- The substructure (piers) and subaqueous (underwater) foundations have an unknown ability to support additional vertical and lateral loading and require further investigation.
- The cost to design and construct a ped/bike facility is estimated to be over $10M (pending the feasibility from further investigations).

2. BACKGROUND

2.1. PURPOSE

The primary purpose of this study was to provide insight to the key structural issues to allow the Port to decide if there is a need to further investigate structural solutions for pedestrian and bike facilities supported by the existing bridge and separated from vehicular traffic. This document presents background, issues, alternative structural concepts, and conclusions for the addition of a safe and viable ped/bike crossing supported by the existing bridge. HNTB did not perform a structural analysis or engineering on the bridge as part of these services. There are a number of elements of the bridge that would need engineering evaluation to determine if they can sustain the additional weight required to support ped/bike facilities. This document should not be understood to imply that HNTB believes that this project is feasible, reasonable, or should be undertaken by the Port. It is the Port's decision to weigh the benefits and costs and decide if further investigations are warranted. Additional analysis is necessary to refine the cost and assess feasibility.

2.2. PROJECT NEED

The bridge is a long, very narrow, two-lane, steel deck truss with a vertical lift span near the middle of the bridge, as seen in Figure 1. The bridge is owned, operated, and maintained by the Port. Currently the bridge is not suitable for safe ped/bike traffic. The bridge is an important transportation link connecting the States of Oregon and Washington across the Columbia River. Local stakeholders and interest groups have expressed an interest in a ped/bike crossing for many years.

This river crossing between Bingen and Hood River is essential to the economic vitality and quality of life throughout the Mid-Columbia region encompassing both sides of the Columbia River. The Port has commissioned this evaluation because:

- Reasonable alternative pedestrian/bike crossing of the Columbia River do not exist;
- Replacement of the existing bridge is expected to be very costly and adequate funding is not expected to be available for many years;
- The Port has a responsibility to operate and maintain the bridge for the safety of all users until a new bridge is constructed; and
- The Port understands the significant interest that many area stakeholders have in adding safe pedestrian and bicycle crossing to the bridge.

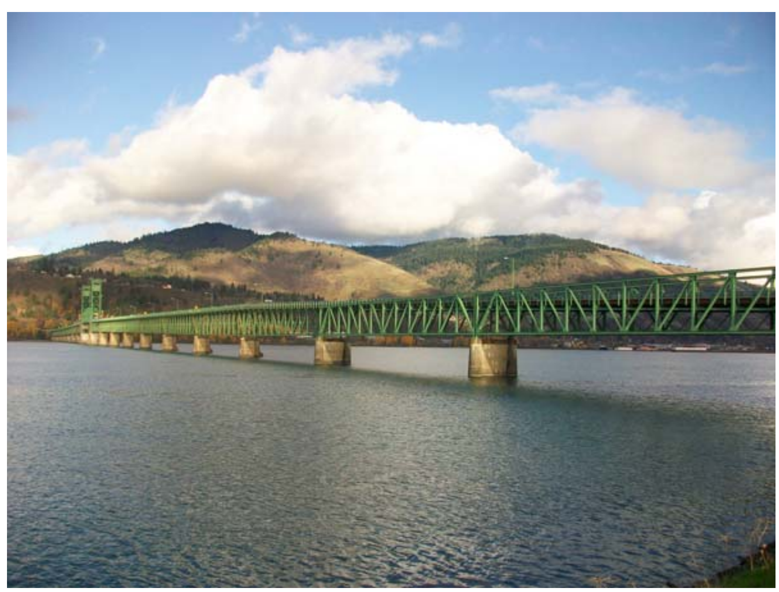


Figure 1. Hood River–White Salmon Interstate (Columbia River) Bridge as seen from the Oregon bank

It is important to emphasize the lack of an alternate Columbia River crossing. It is a 45-mile alternate detour route to the west across the Columbia River at the "Bridge of the Gods" in Cascade Locks and 46-mile alternate detour to the east at The Dalles. If the bridge was closed or weight limits were decreased, the residents, businesses and governments of Hood River and Klickitat Counties would be severely impacted.

It is equally important to emphasize that it is not safe for pedestrians or bicyclists to cross the bridge. The lanes and distance between bridge rails is so narrow that vehicles often rub up against the bridge rail to avoid on-coming traffic causing vehicle and bridge damage. Vehicles often have mirrors knocked off from contact with the ancillary items (signs, gates, light posts, etc.) as seen in Figure 2 as well as the lift span truss.

Figure 2. Extremely narrow bridge roadway and steel open grid deck are unsafe for ped/bikes

In summary, there is a need to add safe passage for pedestrians and bicyclists and the communities on both sides would benefit from a viable ped/bike connection.

2.3. RELATED STUDIES & REPORTS

The SW Washington Regional Transportation Council has led ongoing efforts to evaluate the feasibility of a new bridge replacement crossing, which is estimated to be $200M to $250M. However, the current consensus is that funding may not be available to replace the bridge in the near future. Therefore, the Port is moving forward with the assumption the bridge should be maintained between 15-30 years of continued service life. For this reason, the Port is also considering alternatives for safe and viable ped/bike facilities on the existing bridge. Additional background behind the study for a new crossing can be found at http://www.rtc.wa.gov/studies/SR35/.

A report titled "Non-Motorized Crossing Alternatives at the Hood River Bridge" was published September 29, 2009 for The Port of Hood River & Hood River Valley Residents Committee (HRVRC) by Alta Planning & Design. This report was an update to a previous 1999 report by HNTB title "Non-Structural Alternatives for Bicycle and Pedestrian Use of the Hood River Toll Bridge". The more recent 2009 report considered alternatives to a structural ped/bike solution based on user safety and convenience, cost-effectiveness, potential liability concerns, and impacts on traffic operations. Based on the 2009 report, it was recommended that the Port, HRVRC, and surrounding communities pursue one of two alternatives:

- Establish a new or expanded fixed-route transit service that serves communities in both Washington and Oregon and crosses the Hood River Bridge multiple times a day, with bicycle racks installed on all transit vehicles serving the route. The service should operate year round to facilitate commute and medical trips as well as non-motorized bridge crossings.
- If a year round fixed-route transit service is determined financially infeasible, it is recommended that the Port pursue development of informal rideshare pick-up and drop-off sites combined with a

seasonal fixed-route transit service.

2.4. OVERVIEW OF BRIDGE STRUCTURAL HISTORY

The 4,418-foot long steel deck-truss bridge was originally constructed in 1924 and was reconstructed in 1938. When the Bonneville Dam was constructed circa 1937 the bridge was also reconstructed to accommodate the increased water pool elevation. To allow for increased vertical navigational clearances the main span of the bridge was converted to a vertical lift span. As part of this 1938 reconstruction project, an outer "auxiliary" truss was added to the adjacent spans to help stabilize the bridge during vertical lift operations. Foundations supporting the piers underwater were also modified to increase the resistance against additional forces resulting from the raising of the water elevation and the bridge height. The first three approach span partial through-trusses on the Oregon side were added during this major upgrade. The bridge has since undergone a number of maintenance, repair, rehabilitation, and modernization projects including the current targeted painting project, various deck replacements (most recently 2004), approach span widening on the north end, and bridge railing replacements. The lift span of the bridge has not been structurally upgraded since 1938, but electrical and mechanical upgrades have been made through the life of the bridge. The bridge was designed for loads anticipated in the 1920s and 1930s.

2.5. BRIDGE LOAD RATING

Structural load rating calculations were performed on the bridge in 2000. The structural load rating includes an estimate of the vertical dead load (self-weight of the bridge) and live load (vehicles) on the truss spans. Bridge load ratings are strictly for determining a "snapshot" of the bridge's superstructure (e.g., steel truss) capacity to carry vehicular loading. The load rating does not consider the rate of deterioration, lateral loading on the bridge (such as wind and seismic events) and a number of structural components. A load rating is a federally-mandated, specific procedure that requires that only the primary components of main superstructure elements (those that span between supports, such as the trusses) are evaluated for the ability to support specified vehicle loading. For this bridge, only the beams, stringers, girders, floorbeams, and trusses that span between piers and foundations were evaluated. For this reason, the load rating does not provide a complete picture of the ability of the bridge to carry additional loading, such as the added weight from a ped/bike facility.

The results of the 2000 load rating indicated that the bridge components evaluated could sustain repeated loading from Oregon Legal Vehicles (i.e., trucks) with the margin of safety required in the federal load rating process. The results also indicated Oregon Permit Vehicles (special heavy load trucks) require special consideration and, depending on the weights of axles, may not be permitted on the bridge. The results also indicated the bridge is substandard compared to year 2000 design vehicles and design codes. This result was not surprising and common for a bridge of this vintage. More recent bridge codes require new bridge designs to resist heavier vehicles and a plethora of loading conditions and combinations not considered from 1924 through 1938. The load rating results were significant because additional loading on the steel trusses, such as a heavier deck, would trigger the need to post the bridge with load limits for Oregon Legal Vehicles (commonly allowed trucks). A weight limit posting would adversely affect the local and regional economy by restricting the weight of vehicles allowed across the bridge.

2.6. CURRENT CONDITION OF BRIDGE

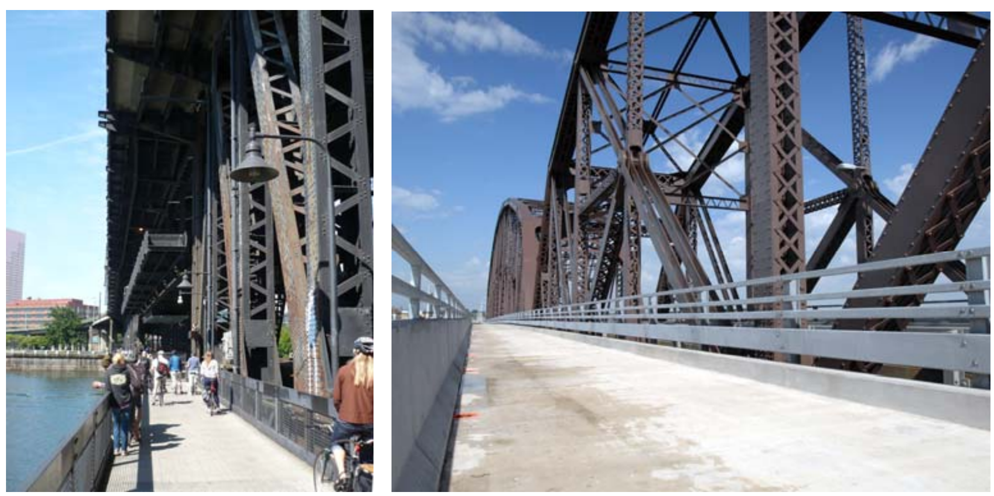
HNTB completed a detailed investigation in June 2011 into the current condition of the bridge and provided an estimate of the bridge deterioration and anticipated work over the next 30 years. There are three different types of bridge inspections conducted at federally mandated intervals: routine NBIS bridge inspections, fracture critical inspections, and underwater inspection reports. The bridge inspection reports are available from 1999 to present from the Federal Highway Administration (FHWA) website (www.fhwa.dot.gov).

In lay terms, the bridge is overall in fair condition. The recent lower chord painting project is a positive step toward extending the life of the bridge steel trusses and future projects are anticipated to continue to effectively maintain the safe operation of the bridge. In general, the steel superstructure components of the bridge exhibit typical wear from traffic. With continued preventative painting, the steel trusses are expected to not corrode. A fatigue analysis of the steel has not been conducted. The substructure of the bridge is not in as good of condition as the steel superstructure. The exact condition of the concrete in the pier, substructure, and subsurface and subaqueous foundations is not known and would need to be further investigated.

Given the fact the bridge is almost 90 years old and current bridges are designed for a service life of 75 years it is important to understand that the bridge has a finite life and is closer to the end of its service life than the beginning. It is not feasible to determine the exact life of the bridge. With continued routine inspection, maintenance, repair, and rehabilitation, and barring any extreme event (e.g., ship impact, earthquake) the bridge is expected to continue operating as it has in the recent past.

3. STRUCTURAL ALTERNATIVE CONCEPTS

HNTB considered four basic configurations for adding ped/bike facilities to the existing bridge. A brief description and comparison of these concept alternatives is listed in Table 1 below. Alternative 1 is similar to the work shown in Figure 3 below. This type of project has been successfully executed on steel trusses that have reserve structural capacity. Trusses that were designed for railroad loads, but later converted to vehicular loads have been successfully retrofit to carry ped/bike structural additions. Trusses that were once used for vehicular loads have been successfully converted to exclusive ped/bike use.



[a] **[b]**

Figure 3. Example HNTB steel truss bridge widening projects with added ped/bike facilities [a] UPRR Steel Bridge, Portland, Oregon [b] McKinley Bridge, East St. Louis, Illinois.

Table 1. Concept alternatives considered for structural ped/bike facilities on the existing bridge

Alt.	Description	Benefits	Top Issues
1	Attach a new steel structure that overhangs outboard of the existing roadway and is supported by the existing trusses	• Simplified construction techniques • Limited traffic disruptions • Separated ped/bike facility	• Structural feasibility: existing truss not likely able to support added load and will need retrofit • Conflicts with ancillary items
2	Widen and reconfigure the roadway to center the sum of the lanes and a new ped/bike way on the bridge	• Loads centered on the trusses, substructure, and foundation	• Structural feasibility: existing truss not likely able to support additional load and will need retrofit • Replace lift span including tower • Replace ancillary lift-span items
3	Create a new superstructure (e.g., a truss similar to the existing) supported by a substructure/ foundation widening outboard the existing truss	• No dependency on the existing superstructure – separate load path for ped/bike facilities	• Structural feasibility: existing substructure and foundation not configured to support additional load and will need retrofit • Potential in-water work • Retrofit or replace lift span including mechanical, electrical, structural • Visual aesthetic impacts
4	Locate the ped/bike facilities through the center of the truss below the roadway	• Loads centered on the truss • Ped/Bike isolated from vehicular traffic • Public safety for isolated walkways	• Structural feasibility: existing truss not likely able to hold additional load and will need retrofit • Potential modifications to conflicting truss bracing full length of the bridge • Safety with open grid deck above • Navigational clearance impacts

4. STRUCTURAL ISSUES

4.1. LIMITS OF TRUSS CAPACITY

Interpreting the results from the structural loading rating the steel truss on the bridge does not have reserve capacity to carry additional loads in its current configuration. In order to counter-act the additional dead weight of a new ped/bike facility the weight of vehicles that cross the bridge would have to be limited. Some heavy legal vehicles would not be allowed. The exact load limit would have to be determined through engineering analysis and detailed inspections, and the bridge posted. This would adversely impact the local, regional, and multi-state transportation network. However, weight limiting the bridge is not the only alternative, as further explained below.

It is assumed that a ped/bike structure added to one side of the bridge would not be added to the opposite side. An imbalance of loading would results that would require careful analysis of the bridge. Counter-balancing this load by adding weight to the opposite side would only add more vertical dead load and likely exceed the capacity of the truss including any reasonable retrofit scheme to increase the truss capacity.

4.2. ROADWAY WIDTH, DECK & BRIDGE RAILING

Given the substandard and sometimes unsafe width of the deck for two lanes of vehicular traffic it is necessary to either widen the deck to add ped/bike facilities or separate the facilities. To bring the roadway width up to the minimum standard lane widths would require replacement of the lift span through truss and the partial through-trusses in spans 1-3 on the Oregon side. The assumption is made that if a project was undertaken to add ped/bike facilities that the roadway would not be widened as the part of this project. It is also assumed that ped/bike facilities would be added only on one side of the bridge and be approximate 8-foot in width. A more narrow width would require deviations from federal standards.

4.3. LIFT SPAN

The lift span of the bridge presents a number of issues when considering adding ped/bike facilities on the bridge. In particular, the lift span steel through-truss and lift span towers are in direct conflict with where ped/bike facilities would typically located. To avoid the truss and towers a structure would have to be added out-board of the truss and weave around the towers. Furthermore, the access stairs to the lift span control house would have to be avoided.

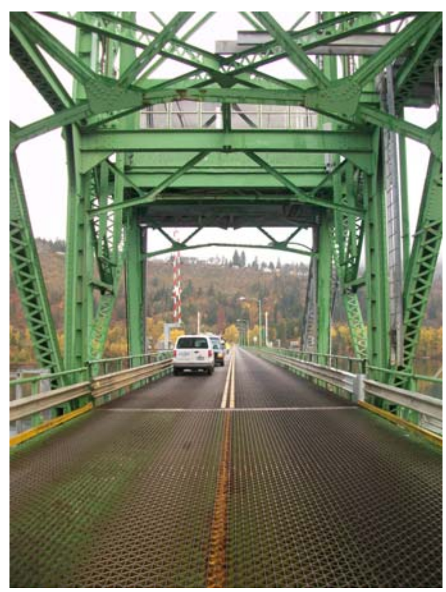


Figure 4. North lift span portal and tower with control house as viewed from lift span roadway.

Of more significance are the limitations and modifications of the lift span balance. The electrical, mechanical, and structural components that operate the lift of the bridge would need to be replaced to lift the added weight of the ped/bike structure attached to one side of the truss. Given that the structure would be added to one side of the truss a significant amount of weight would have to be added to the opposite side of the truss to balance the span during lifting. This added weight on both sides is very likely more than the lift span truss can hold. An alternate concept would be to hang a structure below the bridge deck. This solution would still require evaluation and upgrading of these same components. It is assumed that to add ped/bike structure on the lift span that the span would either be significantly retrofit or replaced to carry additional loading.

4.4. OREGON APPROACH THRU-TRUSSES

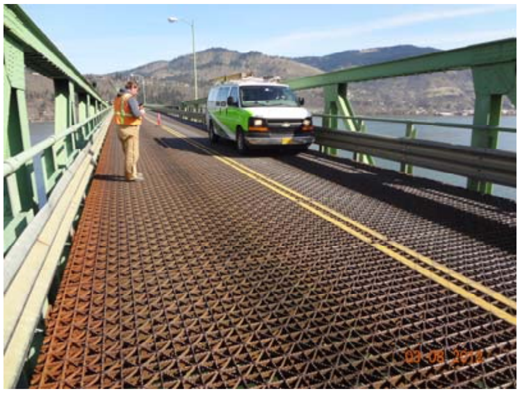


Figure 5. Oregon Spans 1-3 partial through trusses.

On the Oregon side of the bridge there are three unique spans of the bridge that are partial "through-trusses" as shown in Figure 5. These partial through-trusses have steel truss superstructure above the roadway surface that cannot be removed. In these spans it is assumed the pedestrian facilities are outboard of the partial through-trusses.

4.5. SUBSTRUCTURE & FOUNDATION

There are a number of in-water concrete piers for this bridge, as shown in Figure 6. In order to provide ped/bike facilities on the bridge the existing substructure and foundation need careful evaluation. The piers of the bridge were designed in the 1920's and 1930's and are not expected to meet current design standards. Investigations into the quality and condition of the concrete would be necessary to understand the quality and rate of deterioration. Engineering calculations for loading conditions on the existing piers would be necessary to determine the load effects and feasibility of supporting additional load. To date, no calculations have been performed. It is quite possible that retrofit would be required.

Figure 6. Typical lift-span pier (Pier 12) visible during a bridge lift.

5. NON-STRUCTURAL ISSUES

HNTB did not evaluate the non-structural issues associated with adding ped/bike facilities on the bridge. The following is a preliminary list of some of the non-structural issues that would need to be considered:

- Lift span electrical and mechanical need to be evaluated and likely replaced.
- In-water, on barge construction is expensive.
- ADA compliance on approaches to the ped/bike facility at each end of the bridge would likely require approach walls and ramp structures.
- Safety, security and emergency egress would need to be evaluated.
- US Coast Guard clearance is needed for any changes to the vertical clearance.
- Railroad coordination and permit would be required.
- Collection of drainage and treatment of runoff would likely be required.

- Environmental compliance during construction is necessary.
- Lighting would need to be replaced and added for security.

6. CONCEPT LEVEL COST

HNTB does not have sufficient data to determine quantities or detailed cost estimates for these services. In order to arrive at a reasonable determination of the cost associated with one or more alternatives an engineering evaluation would be necessary to confirm or deny key assumptions. Based on HNTB's experience with similar types of projects, bridges of this scale, and an understanding of the bridges condition, it is anticipated the cost of a structural solution to adding ped/bike facilities to the existing bridge is over $10M. This estimate could rise or fall with further investigation and assumes that it is feasible to retrofit the existing steel superstructure, substructure and foundations to meet the new load demands.

7. RECOMMENDATIONS

In summary, HNTB recommends the Port consider the issues, constraints, assumptions and weigh against the benefits and funding sources to determine if it is justified to move forward with a more detailed feasibility study. HNTB is prepared and able to provide additional services from concept design, through final design, construction and can provide a more detailed investigation as needed. The next step toward further investigation is to update the bridge load rating to meet current federal procedures. This updated load rating should include an evaluation of the steel gusset plates and essential structural connections to determine if the structure has reserve structural capacity. Bridge piers and foundations should also be evaluated.

8. LIMITATIONS & ASSUMPTIONS

HNTB performed these services under the Hood River Interstate Bridge On-Call Services contract. The recommendations presented herein are for planning purposes and do not imply that the bridge has a known lifespan or structural capacity. A full structural analysis was not conducted. The myriad complexities of bridges result in an inherent inability to predict how long it will take for every piece of the bridge to exceed a useful or safe lifespan. At any time the bridge may exhibit damage, have undiscovered flaws, or unforeseen deterioration (e.g. stress fractures in steel components). In addition, vehicular loading on the bridge can accelerate presently unforeseen damage in unpredictable ways. Additional investigations are required to make a more firm assessment and more accurate cost estimate.

In addition, the following limitations and assumptions apply:

- The Port represent that HNTB may rely on any previously developed studies, reports, calculations, and data in the performance of these services. HNTB did not independently verify information or conclusions drawn from previous studies, reports, and calculations.
- HNTB did not confirm by calculation the structural adequacy of the bridge under these services.
- HNTB did not confirm by calculation the seismic or other lateral load effects on the bridge.
- HNTB assumed and did not confirm by calculation the existing bridge foundations are in reasonably good condition and will not require significant in-water retrofit.
- Because HNTB has no control over the cost of labor, materials, equipment furnished by others, or over resources provided by others to meet project schedules, HNTB's opinion of probable costs shall be made on the basis of experience and qualifications as a practitioner of its profession. HNTB does not guarantee that proposals, bids, or actual project costs will not vary from HNTB's cost estimates.