RIVER CROSSING BRIDGE CLEARANCE ASSESSMENT REPORT: MOVABLE SPAN OPTIONS

EXECUTIVE SUMMARY

The Interstate Bridge Replacement (IBR) program will replace the existing Interstate Bridge crossing the Columbia River between Vancouver, Washington, and Portland, Oregon. The *River Crossing Bridge Clearance Assessment Report: Movable Span Options* describes the implications of using a movable span bridge with a dynamic mechanical design to provide 178 feet of or unlimited vertical clearance as needed for vessel passage. Three movable span options were investigated from interdisciplinary perspectives, including design, construction, operations, environmental, and cost considerations. The movable spans would accommodate vehicular traffic, light rail transit (LRT), and a shared-use path (SUP) and would be among the largest of their kind in the world.

Figure 1. Double-deck Vertical Lift Bridge Example – Portage Lake Bridge, Houghton, MI

1) A **vertical lift span** (178 feet of vertical clearance) is similar to the type of movable span that exists on the crossing today, in which the span would rise vertically while remaining parallel with the deck. There would be two double-deck side-by-side bridges; the upstream bridge would have northbound I-5 lanes on the upper deck and a SUP on the lower deck, and the downstream bridge would have southbound I-5 lanes on the upper deck and two-way LRT on the lower deck.

2) A double-leaf **bascule span** (unlimited vertical clearance) would open in the middle, with each leaf rotating from a normal horizontal position to a nearly vertical position. To reach this position, each leaf would pivot around a horizontal axis on trunnion shafts attached to each side of the span. This option could be accommodated by a two-bridge double-deck arrangement similar to the vertical lift span or three single-deck bridges.

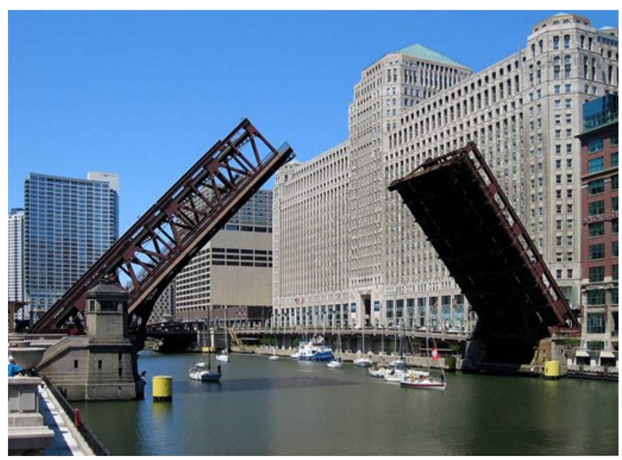

Figure 2. Double-deck Double-leaf Bascule Bridge Example – Wells Street Bridge, Chicago, IL

3) A **swing span** (unlimited vertical clearance) would open by pivoting on a central pier and then rotating in a horizontal plane around a center support (vertical axis). A single double-deck bridge with two swing spans would be required in order to carry highway, transit and active transportation while providing the necessary horizontal clearance. The double-deck spans would be approximately 550 feet long to provide the 400-foot-wide horizontal river navigation channel and approximately 150 feet wide to accommodate the width of both directions of I-5 on the upper deck and the LRT and the SUP on the lower deck.

Figure 3. Single-deck Double-swing Bridge Example – Coleman Bridge, York County, VA

Table 1 includes a summary of the considerations associated with each movable span option. For a comparison of all river crossing options and the IBR program's recommendation, please see the executive summary for the *River Crossing Option Comparison*. Key constraints and considerations associated with a movable span include:

- **Design.** In addition to the vertical clearance needs, the bridge design must also consider needs for horizontal clearance, aviation clearance needs, and highway and ramp connections and how connections would affect other modes (e.g., transit, active transportation).
- **Structural.** A movable span would require mechanical systems to operate the span.
- **Construction.** Incorporating a movable span would likely increase the duration of the construction schedule, and the construction cost and schedule and in-water work would significantly increase.
- **Operational.** A movable span would require higher maintenance costs, increased operational needs (e.g., 24-hour staff), and a higher risk of seismic damage.
- **Environmental.** While most environmental considerations would be similar to a fixed span, a movable span requires a larger and deeper pier foundation that would result in some greater impacts (e.g., impacts to aquatic species). Bridge openings would also increase vehicular idling and associated pollutant and greenhouse gas emissions.
- **Cost.** A movable span would increase the cost of a replacement bridge by $430 million to $630 million over the cost of a fixed span.

Table 1. Summary of Movable Span Considerations

	Lift Span	Bascule Span	Swing Span
Columbia River Navigation	• Provides **178 feet or unlimited vertical clearance** for navigation. • **Lower vertical clearance** (in the closed position) than that provided by a new Fixed Span Bridge. • Movable span operations, and thus river navigation operations, would likely have to be **restricted to specific days and/or times** to minimize impacts to vehicle traffic and transit operations.		
Aviation	• Lift span towers would **permanently penetrate** Pearson Field airspace.	• Leaves would **temporarily penetrate** Pearson Field airspace when open.	• **No impact** to Pearson Field airspace.
Alignment and Profile	• Movable span **would need to be on a straight portion of the bridge** (and level or near level grade), located south of the existing lift span over the relocated primary navigation channel between Piers 5 and 6. • Reduced grades **would increase the ease of ramp connections**, primarily on the Hayden Island end of the bridge. • Reduced length of grade change of the lower profile would **benefit freight and other vehicles** that might be affected by the lower speeds caused by steeper grades. • Reduced grades **would increase ease of access and operability** of the SUP.		
Structural Considerations	• Requires **more rigorous design efforts** and specialty contractors.		
	• Towers up to **60 feet taller** than vertical clearance required. • Counterweights in the towers **would require additional seismic design** considerations to mitigate earthquake impacts.	• Would be **one of the largest** double-leaf bascule spans in the world. • Potential for **operational problems** due to span imbalance, keeping counterweight pit dry, and center locks issues. • Must **resist seismic and wind loading** to a greater extent than other movable bridge types.	• Would be **one of the largest** movable spans of its type in the world. • Low profile and **does not require** expensive counterweights. • **Less massive piers** than a bascule or vertical lift bridge. • **More machinery** than a bascule or vertical lift bridge: an end-centering device and end-lifting devices.

<table>
<tr><th></th><th>Lift Span</th><th>Bascule Span</th><th>Swing Span</th></tr>
<tr><td>Geotechnical Considerations</td><td colspan="3">Requires more substantial river piers and pier foundations to support the span as compared to a fixed span because the movable parts are more sensitive to foundation settlement. This ensures smooth operation during repeated opening cycles over its lifetime.
Requires a stiffer foundation provided by increasing both the size of the pier’s footprint and number of drilled shafts contained therein.</td></tr>
<tr><td rowspan="2">Highway Traffic</td><td colspan="3">The cycle time for a bridge opening would be 20 to 30 minutes.
Daytime bridge lifts could impact traffic volumes for up to an hour or more; nighttime bridge lifts would not impact traffic volumes for multiple hours a day.
Crash rate is expected to be 3 to 4 times higher during a bridge lift than during normal operating conditions.
To reduce congestion and improve mobility, movable span operations would likely need to be restricted to nighttime openings.</td></tr>
<tr><td>--</td><td>Fastest cycle time to open and close the bridge resulting in less congestion.
Bascule span acts as a secondary barrier to traffic when open.</td><td>--</td></tr>
<tr><td>High-Capacity Transit</td><td colspan="3">Reduced train speed over bridge for safety reasons due to joints in the tracks.
Interruptions to operations during a bridge opening throughout 18-mile service network unless openings are restricted to nighttime only.
Extensive maintenance to keep communications systems operable.</td></tr>
<tr><td>Shared-Use Path</td><td colspan="3">Delay to SUP users during a bridge opening; no suitable detour route is available.
Lower elevation would be a benefit for path users.</td></tr>
<tr><td rowspan="2">Construction Considerations</td><td colspan="3">Extended construction schedule (approximately 1 to 2 years) due to in-water work, equipment, and specialized workforce required.</td></tr>
<tr><td>--</td><td>Additional schedule with three single-deck bridge configuration.</td><td>--</td></tr>
<tr><td>Operational Considerations</td><td colspan="3">More likely to result in misalignment or damage from a seismic event.
Requires a bridge operator on site.
Requires additional maintenance associated with mechanical and electrical systems.</td></tr>
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<tr><th></th><th>Lift Span</th><th>Bascule Span</th><th>Swing Span</th></tr>
<tr><td rowspan="2">Environmental Considerations</td><td colspan="3">Increased air quality pollutant and greenhouse gas emissions due to vehicular idling during a bridge opening.
Increased in-water work due to size of foundations would increase impacts to biological resources, hazardous materials, and historic structures and archaeological resources.
Challenging stormwater containment due to the bridge joints that allow the movable span to function.</td></tr>
<tr><td>Permanent visual impacts due to lift towers, similar to the existing I-5 bridges.</td><td>Additional displacement of benthic habitat with third bridge configuration.
Additional over-water shading with three single-deck bridge configuration.
Visual impact during bridge opening.</td><td>Increased land use and development impacts due to downstream location of bridge.</td></tr>
<tr><td>Conceptual Construction Costs Change Compared to the Fixed Span Equivalent</td><td>+$430,000,000</td><td>+$540,000,000 (three single-deck bridge)
+$490,000,000 (two double-deck bridge)</td><td>+$630,000,000</td></tr>
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