Frank J. Wood Bridge: Summary of Alternatives

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BACKGROUND

The Frank J. Wood Bridge is a critical link spanning the Androscoggin River between the Towns of Brunswick and Topsham, carrying US 201 and ME 24 and about 19,000 vehicles a day. Just 500 feet upriver of the bridge is a power generation dam harnessing the power of Brunswick Falls. On the southern, Brunswick side of the bridge sits the 250th Anniversary Park on the east and the bustling Fort Andross Mill Complex (originally the Cabot Mill) on the west. The Topsham approach adjoins a bank on the west side, and a dentist office and the Bowdoin Mill Complex (originally the Pejepscot Paper Company) on the east side. Both the Fort Andross and the Bowdoin mill complexes house a variety of shops, businesses, and restaurants, and the Frank J. Wood Bridge is a key pedestrian connection between the two of them and between the larger business districts and communities on each side. The bridge links the hearts of the two communities across the Androscoggin River, connecting Brunswick and Topsham.

Figure 1: The Frank J. Wood Bridge spanning the Androscoggin River between Brunswick and Topsham

The Frank J. Wood is the central of three vehicular crossings of the Androscoggin River between Brunswick and Topsham. About 2 miles upstream, I-295 crosses the river; it has interchanges with U.S. 1 on the Brunswick side and ME 196 on the Topsham side. Less than 1 mile downstream, ME 196 (also known as the Coastal Connector) crosses the river. In addition to these vehicular crossings, the historic Swinging Bridge is a pedestrian crossing of the river about ½ mile upstream of the Frank J. Wood Bridge. Figure 2 shows all of these crossings.

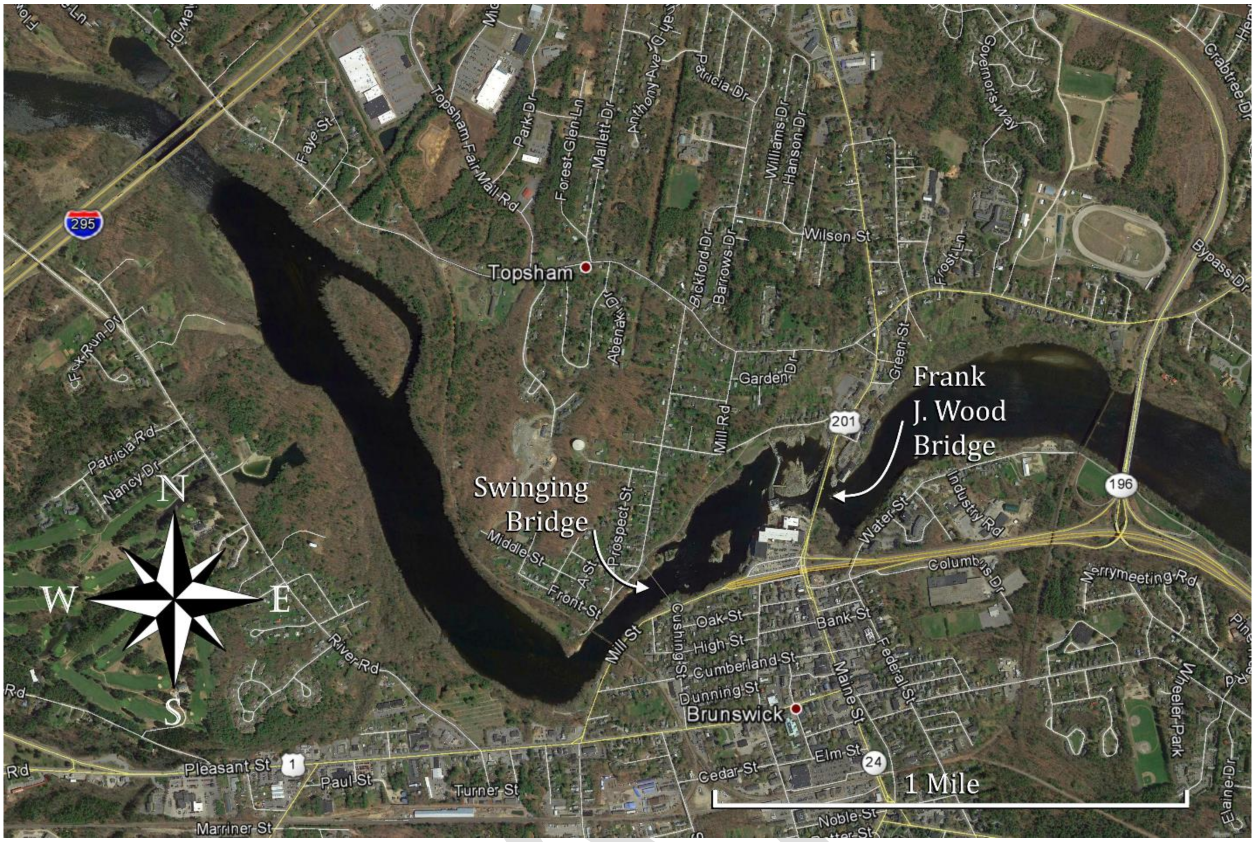

Figure 2: Androscoggin River crossings between Brunswick and Topsham

The Frank J. Wood Bridge is an 85-year-old, 805-foot-long, three span steel through-truss bridge with spans of 310’-310’-175’. It was rehabilitated most recently in 1985, 2006, and 2015. It is a “fracture critical” structure, indicating it is vulnerable to sudden collapse if certain components fail, in this case the truss diagonal and bottom chord members and their connections and the floor beams. Because of this designation, more detailed inspections are required. Detailed inspections by MaineDOT in 2012, June 2016 and August 2016 found many deteriorated areas. A load rating done by MaineDOT in 2013 and updated in August 2016 found some floor system members are no longer adequate for Maine’s legal loads. The bridge is now posted for 25 tons. There is corrosion and section loss in the steel floor system supporting the deck (the transverse cross beams, longitudinal stringers, and transverse floor beams). The floor system , bottom chords,and the concrete deck are currently in poor condition, and the bridge has a FHWA Sufficiency Rating of 25.4. Corrosion at the deteriorated areas is continuing and accelerating, and will do so until the bridge is rehabilitated comprehensively.

Because of the ongoing deterioration of the structural steel, MaineDOT plans to do temporary repairs to address the worst issues so the bridge can maintain its current load rating for up to five years. Steel will be added to the worst sections of the floor system beneath the deck and missing and deteriorated rivets will be repaired or replaced. These temporary repairs are needed to keep the 25 ton weight limit from being reduced more. As maintenance, this 5-year repair will be funded separately from the longer-term “capital improvement” project. However, a long-term solution needs to be implemented within the 5 year timeframe this maintenance buys. This report examines what the alternatives are for the long-term solution.

The travelway through the truss is 30 ft wide, with two 11 ft travel lanes and 4 ft shoulders. Though there are sidewalks on both sides of the road within a few hundred feet of the bridge, the existing bridge carries a single sidewalk on the west side of the bridge. Because the outer 2 feet of the shoulders is made of an open steel grid, the usable shoulder width for bicycle travel is reduced to just 2 ft.

This bridge is eligible for listing on the National Register of Historic Places as a contributing element of the Brunswick-Topsham Industrial Historic District. It is also adjacent to the National Register-Listed Pejepscot Paper Company , National Register – Eligible Cabot Mill and National Register – Eligible Summer Street Historic District.

Accident data from 2009-2013 shows 27 accidents at the intersection of Maine Street and Bow/Cabot Street in Brunswick and 11 accidents at Summer Street and Main Street in Topsham. Also, there were 24 accidents just off the bridge on the Brunswick approach. The accident reports show that these accidents were primarily caused by driver inattention and distraction or by following too closely. In general, these accidents do not appear to be influenced by the bridge.

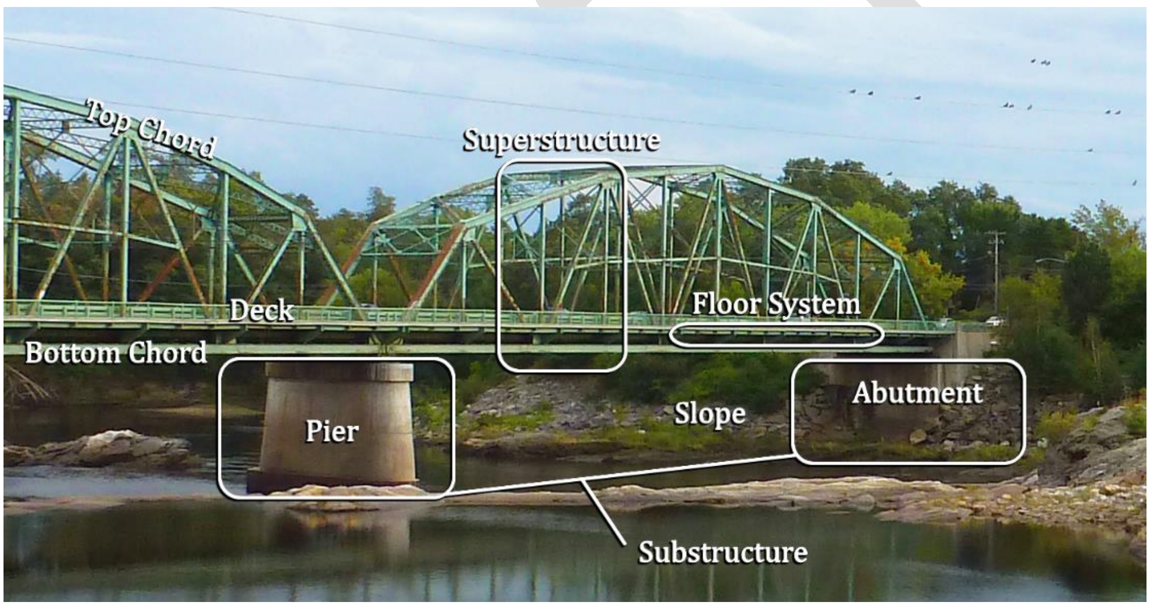

Figure 3: This report uses technical terms to describe various parts of the bridge. The superstructure is what many think of as a "bridge", including the steel floor system or girders below the deck, while the substructure is what supports the superstructure. The deck (what cars drive on) rests on the floor system, which is made up of floor beams, stringers, and sometimes crossbeams. The floor system carries load from the deck to the truss bottom chord.

PURPOSE AND NEED

The purpose of the project is to address poor structural conditions and load capacity issues on the Frank J. Wood Bridge and to address pedestrian and bicycle mobility and safety concerns.

Bridge improvements are needed to improve the condition ratings of the superstructure and deck from a rating of 4 (poor condition) to 7 (good condition). Because of the age of the bridge, 85 years old, and the considerable number of heavy loading cycles it has already experienced, steel fatigue concerns on critical tension members need to be addressed to continue to carry heavy truck traffic on the existing truss. Additionally, the floor beams and stringers need improvements to bring their load rating factors to a 1.0 for all MaineDOT legal loads.

This bridge is classified by the Federal Highway Administration (FHWA) as structurally deficient with superstructure and deck condition ratings of 4 out of 9 (poor condition). The 3 truss spans are fracture critical, meaning that failure of certain steel tension members could cause any of the 3 spans to collapse. Some of the steel truss bridge components are fatigue sensitive, susceptible to cracking and fracture as a result of heavy cyclic loading. The floor beams and stringers within the truss spans do not meet current design load or MaineDOT legal load standards.

Pedestrians on the east side of Routes 201/24 cannot cross the river without crossing the highway, and the existing mid-block pedestrian crossings are considered dangerous. Bicycle traffic is seriously limited by the narrow, 2 ft, paved shoulder.

SUMMARY OF ALTERNATIVES

The following alternatives were considered:

1. New 800 ft bridge on the existing alignment.
2. New 835 ft bridge on a curved alignment upstream of the existing bridge.
3. Rehabilitation of the existing steel truss bridge.
4. Rehabilitation of the existing steel truss bridge, including the addition of a new east-side sidewalk.
5. New 800 ft bridge on a parallel alignment downstream of the existing bridge.

A No Build alternative was also considered.

On Point Construction Services, a private consultant firm specializing in construction scheduling and estimating, joined the Project Team to review the constructability of the proposed alternatives, to develop construction schedules, and to estimate temporary bridge costs.

All of the alternatives were compared based on hydraulic requirements; environmental, historical, right of way, and utility impacts; maintenance of traffic, constructability, maintainability, and geotechnical site conditions; and construction, life cycle, and user costs.

NO BUILD ALTERNATIVE

The No Build Alternative serves as a benchmark for the other alternatives. Basic maintenance, such as the 5-year repairs listed in the August 2016 inspection report, is included.

The urgent repairs needed to keep the Frank J. Wood bridge in place for the next few years are only a temporary solution. The structural steel will continue to deteriorate at an increasing pace unless a comprehensive repair and paint project takes place.

A No Build Alternative does not fulfill the purpose and need for this project.

REPLACEMENT ALTERNATIVES

Alternatives 1, 2, and 5 would provide a new bridge. Many characteristics of the new bridge would be the same for each of the replacement alternatives; these will be discussed below before the specifics of each alternative are presented.

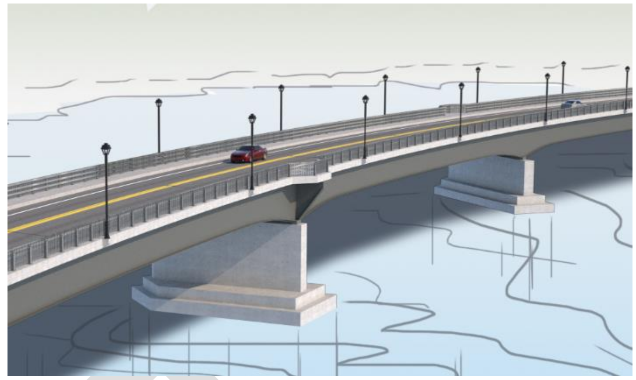
Figure 4: Artist's rendering of a steel girder bridge

A new bridge would be a multi-span steel girder bridge, with 4 or 5 spans. A steel girder bridge is considerably less expensive in Maine than alternative bridge types for this range of spans. To increase the life span of the new structure, the concrete deck would likely be reinforced with corrosion-resistant rebar and the steel girders would be metalized. Metalization of the girders will protect them from corrosion due to spray from the turbulent river beneath the bridge. The new bridge would have concrete wall abutments and solid shaft piers, all founded on the shallow bedrock at this site. New concrete bridge decks with high-performance membrane waterproofing and corrosion-resistant reinforcing bar are expected to last the service life of the new bridge or 100 years.

A replacement structure of this type will have low maintenance costs. The primary anticipated maintenance would be to mill and resurface the asphalt wearing surface at regular intervals and to paint the girders. Biannual inspections of a bridge of this type can be completed relatively quickly and at low cost.

Any new bridge would include 11 foot lanes, 5 foot shoulders, and 5 foot sidewalks on each side. Having sidewalks on both sides of the bridge would connect the existing sidewalks on the approaches and would improve safety by reducing the need for pedestrians to cross the road. Having 5 foot shoulders with no adjacent bridge railing or truss verticals would improve the bridge for bicyclists.

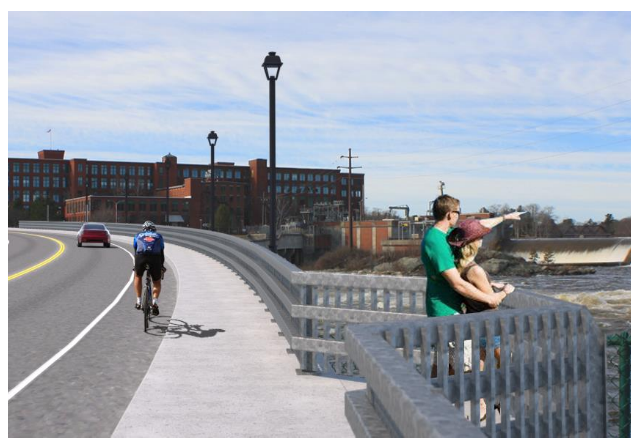
Figure 5: Rendering of a Possible New Bridge

For new bridges on this site, the contractor would need a work trestle for access to construct the cofferdams and piers, to erect the structural steel superstructure, to place deck concrete, and to remove the existing bridge. A cost premium of $1 million is included in the estimate for each new bridge to account for the added expense of a work trestle on this challenging site. Installation of a work trestle at this site is unique due to the exposed and highly variable bedrock, exposure to high velocity flows, and proximity to the upstream dam.

Railings for a new bridge would meet all standards for vehicle and pedestrian safety. Railings go through stringent testing programs to ensure appropriate safety in a variety of situations. Only those railings that meet appropriate criteria can be used on a new bridge, based on the specific constraints of this site. MaineDOT's standard 4-bar steel pedestrian and traffic rail (which meets a TL-4 performance level) is recommended for this bridge, but input from the Towns of Brunswick and Topsham and the Section 106 consulting parties would be considered for the final selection of the rail type. A TL-2 performance level bridge rail system would meet standards for this site.

During meetings with Officials from both Towns, requests were made to enhance the "River Walk Loop" that exists over the existing bridge and continues to the pedestrian bridge upstream of the dam. A new bridge at this site would include deck overlooks, where the sidewalk widens out to provide viewpoints of the river upstream and downstream. In addition, the bridge would be lighted and lamp posts and fixtures would be ornamental and closely match the street lighting in the approaches. The MaineDOT would consider input from the Towns of Brunswick and Topsham and the Section 106 consulting parties for the final selection of the bridge lighting during final design.

Alternative 1: New 800 ft Bridge on Existing Alignment

Alternative 1 is a new 800 ft, five span, steel girder bridge on the existing alignment. The new bridge would have the characteristics discussed above that are similar for any replacement bridge on this site.

Because the new bridge would be constructed on the existing alignment, the existing truss bridge would have to be removed completely before new construction could begin. The limitations on in-water work add to the construction duration. Without a temporary bridge, this alternative would have a traffic disruption period of over 2 years.

Given the large user costs and other impacts such a disruption would cause, a temporary bridge is required for this alternative. This adds another year to the construction duration, bringing the total construction time to 3.5 years. This also increases the river impacts—this alternative would need a work trestle and a temporary bridge beyond the impacts of the new structure itself. Permanent environmental impacts would include the wetland footprint impact of 4 piers and riprap protected abutment slopes within the river channel. Two of the piers would be located near the edges of the Brunswick side powerhouse outfall channel.

The construction cost of this alternative is estimated at $16,000,000 (including the cost of a temporary bridge).

Alternative 1 Summary:

- New 800 ft bridge on the existing alignment
- 11 ft travel lanes with 5 ft shoulders and 5 ft sidewalks each side
- Construction Cost: $16 million
- Life Cycle Cost: $16.7 million
- Construction Duration: approximately 3.5 years
- Maintenance of Traffic: on-site temporary detour
- In-Water Impacts: temporary work trestle, temporary bridge, new piers, new slopes at abutments

- Right-of-Way Impacts: minimal
- Utility Impacts: existing utilities relocated to new bridge
- Historic Impacts: existing truss bridge removed
- Brookfield Dam and Brunswick Fishway: no permanent effects
- Meets Purpose and Need

Alternative 2: New 835 ft Bridge on Curved Upstream Alignment

Alternative 2 is a new 835 ft, five span, steel girder bridge on a curved upstream alignment. A curved bridge reduces the length of approach roadway construction and reduces right of way impacts to abutting properties when compared to using a straight bridge in the same upstream location. This bridge alternative would have a short southern span to better align the spans to bridge the Brookfield power station outflow channel with a minimum of impact. The remaining four spans would be continuous haunched steel girder spans with a concrete deck. The span arrangement and number of piers would be selected to minimize footprint impact within the channel and within the FERC Boundary and to maximize the efficiency of steel girder superstructure. In addition, the existing hydraulic clearance over the river would be maintained as a minimum. To avoid an unacceptable rise in flood elevations along the Topsham bank of the river adjacent to the Bowdoin Mill area, Pier 3 would be skewed at 35 degrees to better align with the flow and the North Pier of the existing bridge would be retained.

The estimated construction duration for this alternative is approximately 2.5 years. No temporary bridge is required since traffic could be maintained on the existing bridge during construction. A short term (about 2 month) single lane northbound road closure and detour as described in the “Maintenance of Traffic” section for the New Alignment maintenance of traffic option would be needed during the final tie-in.

Figure 6: A Possible Curved Upstream Bridge

The four piers and the abutment slopes would be permanent wetland environmental impacts. Two of the piers would be located near the edges of the Brunswick side powerhouse outfall channel. Temporary environmental impacts would include the construction of a work trestle from the Topsham bank of the river out to the proposed Pier 2 location.

The construction cost of this alternative is estimated to be $13,000,000.

The life cycle construction cost of this alternative (Alternative 2 – Replacement Bridge on Curved Upstream Alignment) is estimated to be $13,700,000. The life cycle cost includes costs for future inspection and maintenance (painting and wearing surface replacement) anticipated to be needed out to 100 years.

Alternative 2 Summary:

- 835 ft replacement bridge on a curved, upstream alignment
- 11 ft travel lanes with 5 ft shoulders and 5 ft sidewalks each side
- Construction Cost: $13 million
- Life Cycle Cost: $13.7 million
- Construction Duration: approximately 2.5 years
- Maintenance of Traffic: on existing bridge
- In-Water Impacts: temporary work trestle, new piers, new slopes at abutments
- Right-of-Way Impacts: impacts to 3 properties
- Utility Impacts: existing utilities relocated to new bridge
- Historic Impacts: existing truss bridge removed
- Brookfield Dam and Brunswick Fishway: potential effects to be determined
- Meets Purpose and Need

Alternative 5: New 800 ft Bridge on Parallel Downstream Alignment

Alternative 5 is listed here, since like Alternatives 1 and 2 it is a new bridge. It would be a new 800 ft, five span steel girder bridge located downstream of the existing bridge on a straight alignment, between the current bridge and the Bowdoin Mill Complex parking lot. For all of the bridge alternatives, a hydraulic analysis was run to estimate how the river would behave with new piers added in the river. This analysis showed that a downstream replacement bridge will raise water levels at the Bowdoin Mill Complex, particularly the end of the mill building where the Sea Dog Brewing Company is located. The models suggested that during the design flood, floodwaters would rise more than 6 feet higher than existing conditions near the deck area of the Sea Dog. No reasonable approach to reduce that water rise could be found, so Alternate 5 was rejected.

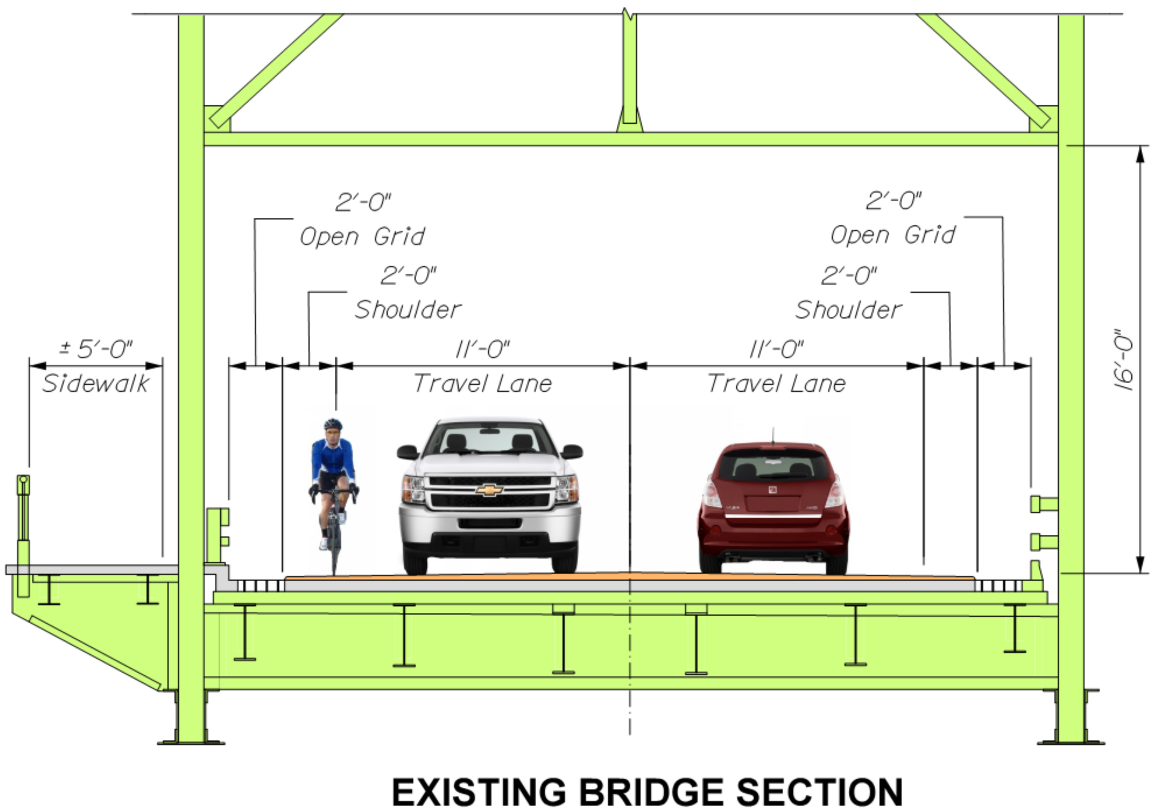

Figure 7: The existing truss bridge cross section

REHABILITATION ALTERNATIVES

Alternative 3 and Alternative 4 are both rehabilitation options, where the existing truss bridge is repaired. Detailed inspections of the bridge were done by MaineDOT in 2012, June 2016 and August 2016, and a load rating was done by MaineDOT in 2013 and updated in August 2016. These reports outline what needs to be done to bring the existing truss bridge up to the standards established as the "Purpose & Need" for this project, which were described above.

These repair needs will be described here, and the differences between the two rehabilitation alternatives will be discussed later. The needs are:

1. Replace the existing bridge deck (including crossbeams) with a new reinforced concrete bridge deck. The existing concrete-filled steel grid deck is in poor condition and the supporting transverse crossbeams are badly deteriorated (See Figure 8).

2. Repair the top of steel sidewalk support brackets. The top of each bracket is non-existent now due to corrosion or other past modifications. This requires replacing the sidewalk concrete deck as well.

Figure 8: Deteriorated crossbeams & deck

3. Replace the bridge joints. Although these were replaced in 2015, replacement of the existing deck will require these to be replaced.

4. Replace the entire steel floor system, including the longitudinal stringer beams and transverse floor beams. The new floor system would be composite with the new deck. The floor system is heavily deteriorated and is below load carrying standards (see Figures 9 and 10).

Figure 9: Hole in floor beam

Figure 10: Deteriorated floor beam

5. Replace the bottom flange angles of the bottom chord of the main trusses due to corrosion and distortion from pack rust, as seen in Figure 11. It is anticipated this work could be done one angle at a time without shoring while the deck is off the bridge.

6. Replace the lattice plates of the bottom chord, which are severely bowed due to pack rust. See Figure 12.

7. Remove the welded steel plates attached to truss vertical members. These are fatigue sensitive details on fracture critical members. Remediate these locations using cover plates. See Figure 13.

8. Paint the entire steel superstructure, including all above and below deck components. Doing a comprehensive paint job on this structure is expected to cost about $4,000,000.

Figure 12: Bottom chord lattice plate bowing

Figure 11: Bottom chord bottom flange corrosion

9. Replace all existing utility brackets that support the conduit and water lines on the bridge. See Figure 14.

10. Remove and reuse the existing pedestrian sidewalk rail and bridge traffic rails. They will have to be removed to replace the deck and floor system. The traffic rail on the sidewalk side meets current standards, while the rail on the other side does not. However, that rail is considered acceptable on this structure and adding a new traffic rail would reduce the travelway width further.

11. Replace the abutment back walls due to the overall poor condition of these elements.

12. Repair areas of stone masonry with missing and loose stones at the south abutment by encasing the masonry in concrete. See Figure 15.

13. Replace cracked concrete bearing pedestals at Pier 2 supporting the east side truss of Span 3 near the Topsham end of the bridge. This work will also include removal, refurbishing, and resetting of the truss bearing at this support. See Figure 16.

Figure 16: Damaged concrete pedestals

Once all of the listed repairs are completed, the structure will meet all current design strength requirements. All repairs would be completed using modern design standards and construction practices to help them last as long as possible.

The existing bridge deck is a lightweight, concrete-filled steel grid deck. To keep from adding more weight to the truss, a new bare concrete bridge deck without a paved surface will be required (additional research may show a conventional paved deck would be acceptable). To improve durability of the new deck, it would be reinforced with corrosion-resistant rebar. A drainage system that discharges below the bottom chord of the truss would be added to limit moisture and salt on the floor system and lower parts of the truss. The existing deck has open drainage which lets salt and water from the road drop right onto the steel.

The existing 30 ft available travelway matches the existing approaches and would provide two 11 ft travel lanes with 4 ft shoulders bound by rails located along the inside of the trusses. Using 10 ft travel lanes with 5 ft shoulders was considered but is not recommended. The Department considers 10 ft travel lanes as less safe than 11 ft lanes given the high traffic volume, almost 19,000 vehicles per day, that this bridge has.

A full road closure is needed to complete all major structural steel rehabilitation activities except painting. The construction and traffic disruption duration for this alternative without a temporary bridge would be approximately 20 months. User costs (see the Maintenance of Traffic section) and other impacts indicate a temporary bridge is needed for this alternative. When the temporary bridge is added in, construction duration for this alternative is approximately 3 years. The bridge would also be painted while the temporary bridge is in place.

Rehabilitating the existing bridge would preserve the existing river flow conditions and would have the least permanent environmental, right of way and utility impacts. It would also have the least impact to the National Register-Eligible historic bridge and districts. However, construction of a temporary bridge will still have temporary environmental impacts. Utilities on the bridge will have to be temporarily relocated on the bridge during the rehab process.

A bridge rehabilitation will require significant future maintenance. To get 75 more years of life, the bridge will need approximately 3 future paintings, 1 deck replacement, and 2 substructure rehabilitations, beyond the current project. All of these activities will disrupt traffic to varying degrees. Painting will disrupt traffic for approximately 8 months, and the deck replacement will disrupt traffic for approximately 6 months.

Based on past performance of the modern paint systems used by MaineDOT on similar truss bridges, the structural steel will need to be painted approximately every 20 years. The current paint systems used today perform very well, replacing the previous lead-based paint systems. The estimated current cost for painting this bridge is $4,000,000.

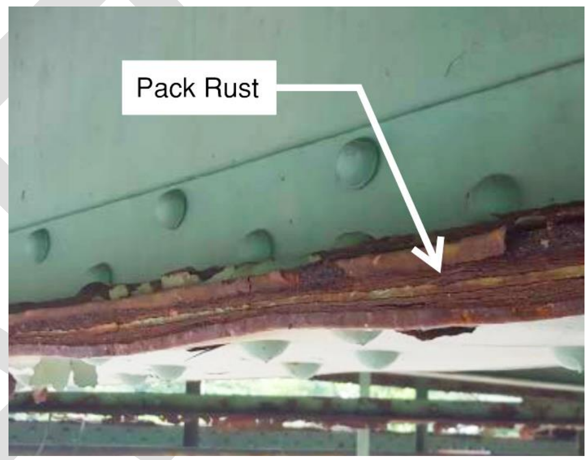

Figure 17: Pack rust is corrosion in the crevice between two plates of steel that are bolted or riveted together. As the rust progresses, it gradually pushes the pieces of steel apart, bending them and sometimes breaking bolts or rivets. To truly fix pack rust, the members need to be taken apart and thoroughly cleaned, which is a complex and expensive effort.

Built-up members (where multiple pieces of steel are riveted together to make a larger member) present a special challenge for paint systems. Over time, pack rust develops in the crevices between pieces of steel and gradually expands, pushing the plates apart (See Figure 17). It is impossible to remove this corrosion using the normal cleaning processes used when painting the steel. The best way to remove pack rust is to disassemble the member, clean the pieces, and then reassemble. That approach is time-consuming and expensive.

Alternative ways of removing pack rust have been tried, but none have been fully validated. One experimental methodology, based on heating the area and hammering the buckled section to drive out the rust, was investigated further. Mr. Vern Mesler, who developed the method, was consulted. He noted that more research was needed on the effects of this method on the steel itself. It is possible that it will make the steel brittle, a serious concern for fracture-critical members, but one that has not been studied.

On the Frank J. Wood bridge, the rehabilitation options would remove or replace all of the members that have developed significant pack rust so far. However, many built-up members will remain on the bridge that are susceptible to pack rust. Many of those likely already have some level of initiated pack rust. New paint spans the seams of the built-up steel members and prevents water and air from getting to the steel. However, once the paint cracks at all, existing pack rust will reactivate. To slow the advance of pack rust and other corrosion, future paint jobs will have to be budgeted for and done on a regular cycle of approximately 20 years.

Use of corrosion-resistant reinforcement would extend the life of a bare concrete deck, but without a high performance membrane and paved wearing surface that can be regularly replaced, 50 years of life is a good estimate. Based on the historic performance of similar aged bridges (currently 85 years old) and the age of the most recent major substructure rehabilitation (2006), additional substructure rehabilitations would be expected at years 20 and 50 following this current project.

Besides these major future maintenance efforts, there will be more frequent smaller repair efforts needed on the steel, bridge joints, and the aging substructure. This bridge will also require Fracture Critical Bridge Inspections, including fatigue detail inspections, costing about $60,000 every two years. These inspections will also disrupt traffic, requiring a single lane closure for 1 to 2 weeks. If cracks in fatigue sensitive or fracture critical members are found in these inspections, more frequent inspections or immediate repairs would be required.

Alternative 3: Rehabilitation of Existing Steel Truss Bridge:

Alternative 3 would rehabilitate the existing truss bridge as outlined above. It would still have only one sidewalk, so pedestrian mobility and safety would not be improved. The open grid decking along the outside of the existing shoulders would be replaced with a solid concrete deck, improving the situation for bicyclists (though not fully to current standards). This alternative meets Purpose and Need for this project but does not address the pedestrian mobility and safety concerns.

The construction cost of this alternative is estimated at $15,000,000. This cost includes a 15 percent contingency above the repair work that has already been identified. Rehabilitation projects nearly always discover issues not previously found in inspections, causing budget overruns.

The overall life cycle construction cost of this alternative, including estimates for all future maintenance on the bridge out to 75 years of life, is projected to be $20,800,000.

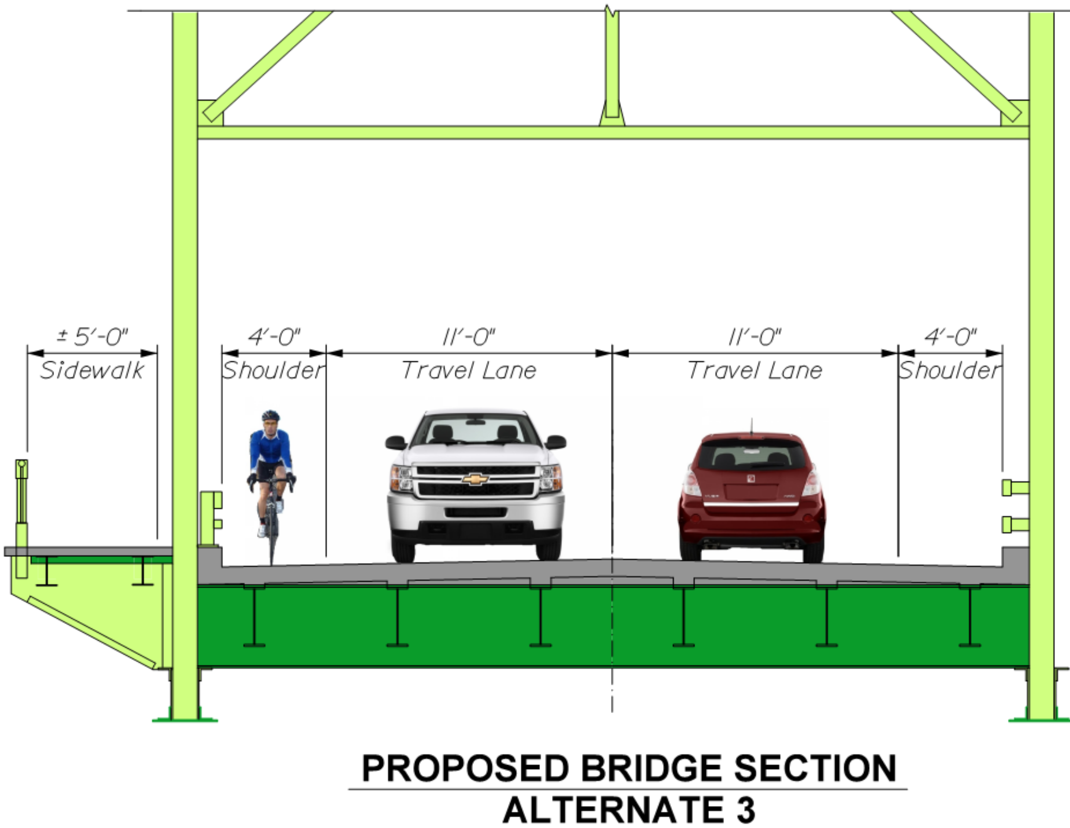

Figure 18: Alternative 3 cross section

Early in the investigation of alternatives at this site, this alternative was examined as a 30 year rehabilitation and either maintaining one lane of traffic on the bridge or allowing a 5 to 7 month bridge closure. A replacement after 30 years would yield the lowest life cycle cost of any rehabilitation option. Given changes to the rehabilitation scope since the latest bridge inspection and the associated user costs for maintenance of traffic, the initial cost of this alternative now includes a temporary bridge. The originally estimated construction cost of $8 million to rehabilitate the bridge now is $15 million after adding a full floor system replacement and an on-site temporary bridge detour.

Summary of Alternative 3:

- Rehabilitation of existing steel truss bridge
- 11 ft travel lanes with 4 ft shoulders each side and a 5 ft sidewalk on the West side
- Construction Cost: $15 million
- Life Cycle Cost: $20.8 million
- Construction Duration: approximately 3 years
- Maintenance of Traffic: on-site temporary detour
- In-Water Impacts: temporary bridge, Abutment 1 repair work
- Right-of-Way Impacts: minimal
- Utility Impacts: temporary support or relocations
- Historic Impacts: none
- Brookfield Dam and Brunswick Fishway: no permanent effects
- Meets Purpose and Need (but does not address pedestrian mobility and safety concerns)

Alternative 4: Rehabilitation of Existing Steel Truss Bridge with Added East Sidewalk

Alternative 4 is also a rehabilitation of the existing truss bridge, but with a second 5 foot sidewalk added on the opposite side of the bridge. This fully addresses the pedestrian issues at this site. Like Alternative 3, bicyclists would have 4 foot shoulders with adjacent traffic rails—not ideal, but better than the current condition for bicyclists. Alternative 4 adequately meets the Purpose and Need for this project.

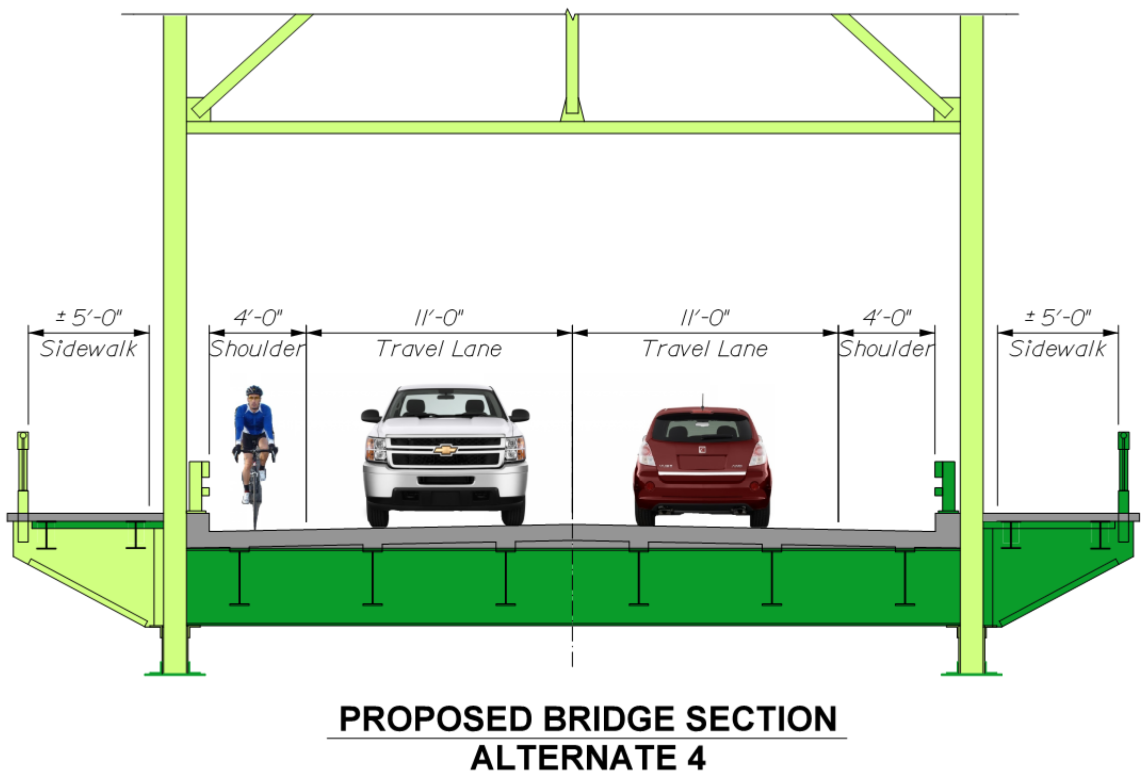

Figure 19: Alternative 4 cross section

To maintain the existing loading on the trusses while adding a new second sidewalk, weight will need to be taken off the truss elsewhere. Various lightweight concrete deck systems such as lightweight concrete, sandwich steel plate systems, and composite deck systems were considered, but a new lightweight concrete-filled Exodermic bridge deck would be recommended for this alternate. An Exodermic deck system can be as much as fifty percent lighter than a conventional concrete deck of the same span, is more durable than a lightweight concrete deck, and is more cost-effective than other lightweight systems. This alternative includes the addition of new structural steel framing, concrete deck, and pedestrian rail for the added 5 ft wide sidewalk on the east side of the bridge. Between the more expensive deck and the new sidewalk and framing, this option will have a construction cost about $2,000,000 more than Alternative 3.

The estimated construction duration for this alternative is approximately 3 years (similar to Alternative 3).

The construction cost of this alternative is estimated at $17,000,000. The life cycle cost of this alternative, including estimates for all future maintenance on the bridge out to 75 years of life, is estimated to be $23,200,000.

Summary of Alternative 4:

- Rehabilitation of existing steel truss bridge with added east sidewalk
- 11 ft travel lanes with 4 ft shoulders and 5 ft sidewalks each side
- Construction Cost: $17 million
- Life Cycle Cost: $23.2 million
- Construction Duration: approximately 3 years
- Maintenance of Traffic: on-site temporary detour
- In-Water Impacts: temporary bridge, Abutment 1 repair work
- Right-of-Way Impacts: minimal
- Utility Impacts: temporary support or relocations
- Historic Impacts: minimal
- Brookfield Dam and Brunswick Fishway: no permanent effects
- Meets Purpose and Need

Repurpose Existing Bridge and Build a New Replacement Bridge

An additional alternative suggested by the public was to '*Restore and repurpose the historic bridge for pedestrian and bicycle use, and as a public historic park. Build a new bridge on alternative alignment.'* This is a combination of two alternatives discussed above, Alternatives 2 and 3. All work to preserve the existing bridge under Alternative 3 would still be required, except possibly rehabilitating the sidewalk. Conservatively, the construction cost of this rehabilitation could be reduced to $9.5 million (with the removal of the sidewalk), and there would be no need for a temporary bridge. This alternative would also require the cost of a new replacement bridge, Alternative 2, at $13 million, for a total construction cost of $22.5 million. The question of future ownership and maintenance responsibility for the bridge would have to be addressed. Also, the effect on river water levels from having more piers permanently in the river channel would need investigation.

MAINTENANCE OF TRAFFIC

Four options were investigated to maintain traffic at this site during construction. They are not all feasible for all of the bridge improvement alternatives. Specifics for each alternative, along with estimated traffic disruption durations and user costs, were discussed with the each alternative.

1. <u>Complete road closure with a detour</u>. Detour all traffic along U.S. Route 1, State Route 196. The total detour distance is approximately 2.5 miles for through traffic and 3.7 miles end to end (see Figure 20).

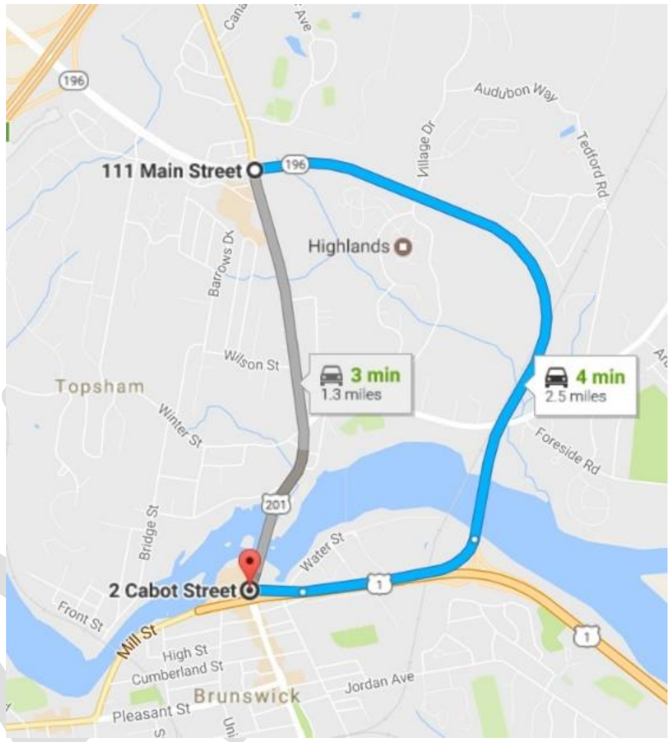

Figure 20: Traffic detour

2. <u>Single lane closure with staged construction</u>. One way, southbound traffic will be carried across the bridge on a 12-foot travelway and all northbound traffic will be detoured. This option can only work for certain construction activities, like painting. This traffic control method has been used successfully in the past on the Frank J. Wood Bridge.

3. <u>On-site detour on temporary bridge</u>. Construct a 2 lane temporary bridge parallel to the existing bridge and detour all traffic onto it. Traffic would only be disrupted during the construction of tie-ins to the existing roadway and to the new roadway upon conclusion of the project. These disruptions could be limited by requiring work be done during off-peak hours. Construction and removal of the temporary bridge would likely extend the total construction duration by about 1½ years (1 construction season for construction of the temporary bridge and half a season for its removal). The cost for a temporary bridge is estimated to be about $4 million.

4. <u>New alignment</u>. If a new bridge is constructed on a new alignment, the existing bridge could be used to maintain traffic during construction. Traffic would primarily be disrupted during construction of the final tie-in. Again, this could be mitigated by requiring work during off-peak hours. This option would result in the least traffic disruption.

Staged construction maintaining two-way traffic is not feasible due to the existing structure type and needed rehabilitation repairs. Alternating one-way traffic is not feasible because of the traffic volume and proximity of signalized intersections.

As mentioned earlier in this report, traffic disruption results in indirect costs to the users of the bridge and to the surrounding businesses. A way to quantify the cost of delays to the traveling public is to develop “user costs.” The average delay for vehicles is estimated and a fixed cost per hour is applied. The average delay was estimated at between 3 and 4 minutes, with delays at peak times higher and at off times lower. Based on these delays, the added length of the detour, and the number of vehicles traveling, the user cost for a complete road closure is estimated at approximately $22,000 per day and the user cost for a northbound lane closure is estimated at approximately $10,000 per day. The indirect costs to the surrounding businesses, which are not easily quantified, would add to those costs of traffic disruption further. These costs may then be compared to the costs of temporary bridges or other methods of mitigating traffic disruption.

UTILITIES

A hydropower dam operated by Brookfield Renewable Energy Partners (Brookfield) is located about 500 ft upstream of the existing bridge crossing. No impacts (including hydraulic impacts) to this facility are anticipated for any of the bridge improvement alternatives investigated.

Overhead utilities and a water main are carried by the existing bridge. Temporary support or relocation of these facilities within the limits of the existing bridge would be needed during a bridge rehabilitation.

With a bridge replacement, these facilities would need to be relocated. Some of the utility poles in the approaches would also need to be relocated. The overhead utilities would need to transition to underground in the approaches close to the replacement bridge ends. The overhead utilities and the waterline would be carried on the bridge below the bridge deck, between girders, out of sight.

RIGHT OF WAY

A bridge rehabilitation or bridge replacement on the existing alignment would not require permanent property impacts. However, temporary property rights would be needed for any temporary bridge.

Construction of a replacement bridge on a new upstream alignment would require permanent property acquisitions of parts of two properties on the west side of the south approach and one property on each side of the north approach. The south approach property impacts would include reconstruction of a retaining wall between the drive entrances to the small Fort Andross parking lot and the Brookfield hydroelectric station at the dam. The 250th Anniversary Park located at the southeast corner of the bridge is a Brunswick town park constructed on land leased from Brookfield. The only park impacts would be fill slopes within the existing State-owned right of way. The north approach would have a new 130-ft-long retaining wall along the northwest approach to limit impacts to the property and parking area. Reconstruction of the drive entrance to the Bowdoin Mill complex will require impacts beyond the existing MaineDOT right of way.

Temporary property rights would be needed to construct work access platforms like work trestles. These rights would be similar to temporary rights needed for a temporary bridge.

Additionally, for an upstream bridge replacement alternative, the abutments and three of the four bridge piers would be located within the limits of the Federal Energy Regulatory

Commission (FERC) Boundary of the dam. Temporary property rights would be needed for construction access along the north side of the approaches and within the FERC Boundary.

ENVIRONMENTAL

Protected species such as the shortnose sturgeon, Atlantic sturgeon, and Atlantic salmon are present in the project area, and all alternatives will likely adversely affect them. A formal Section 7 consultation with the National Marine Fisheries Service will be required. This project is within Essential Fish Habitat and permanent and temporary impacts need to be avoided or minimized. In-water work must be avoided during crucial migrating periods. This restriction is in place from April 7 to August 30, and will be a significant constraint on construction durations.

Any impacts to the Brunswick Fishway at the Brookfield dam will be carefully considered.

The existing bridge is eligible for listing on the National Register of Historic Places as part of the Brunswick-Topsham Industrial Historic District, which is considered National Register-Eligible. It is also abutting the National Register-Listed Pejepscot Paper Company and the National Register-Eligible Cabot Mill. Removal of the bridge would be an adverse effect to those protected resources.

If a temporary bridge is used to maintain traffic for either a bridge rehabilitation or bridge replacement, then temporary environmental impacts would be needed within the existing river channel to support the temporary bridge.

Figure 21: Two types of temporary impacts

Construction of a new replacement bridge would have environmental impacts that would need to be minimized or mitigated. Permanent impacts would include the piers and pier foundations within the channel. Foundation locations should avoid the Brunswick side powerhouse outfall river channel that leads to the dam fishway by taking advantage of ledge outcrops where possible. Also, if a temporary work trestle is needed for the construction of a new replacement bridge, temporary environmental impacts would need to be addressed.

Impact avoidance and minimization strategies will be determined through the ongoing Section 106, 4(f) and NEPA processes.

LIFE CYCLE COST ESTIMATE

Life cycle costs are considered in the comparison of bridge improvement alternatives. A life cycle cost estimate (LCCE) totals all estimated bridge costs throughout the life of each bridge improvement alternative and translates them to current dollar equivalents. The LCCE accounts for estimated construction costs on the current project and the translated present value of anticipated future inspection, maintenance, and rehabilitation. It also accounts for anticipated future bridge replacement dates for each alternative.

GRAPHIC COMPARISON

The graphic below compares Alternative 2 (the low cost replacement or new option) and Alternative 4 (the rehab option with two sidewalks). Three main areas are contrasted: maintenance of traffic during construction, future rehabilitation and maintenance, and total costs.