Construction Means & Methods for Bridge

I. River Construction Access & Minimization of Impacts

Construction of the Susquehanna River Bridge project will require temporary access within the river to construct a significant portion of each bridge including foundations, bridge piers and elements of the superstructure. The purpose of this report is to review and evaluate the access options that were considered for construction of the new bridge spans and demolition of the existing bridge. The report also discusses potential means and methods that will be implemented for both construction and demolition work, along with potential mitigation techniques that will lessen the temporary environmental impacts of the construction and demolition work.

I.A Access Alternatives

For the two new spans (West and East), each structure will require 22 piers for a total of 44 piers. Eleven of the piers will be on land with the remaining 33 positioned in the river. Temporary access is also required to demolish the existing bridge, including removal of trackwork, steel superstructure and existing masonry piers and abutments. Three methods of accessing the in-water construction work were evaluated: barge, causeway, and trestle. Each method was evaluated based on the water depth, geological considerations, , public safety, worker safety, and environmental impacts.

Barges, which are typically the least impactful to the environment, are the preferred method where water depth is consistently adequate (greater than 15 ft.) and site conditions enable barge positioning techniques that provide appropriate, consistent fixity. In shallower water levels, access can be accomplished by either a temporary trestle structure or earth/rock causeway. Trestles are structures comprised of a pile-bent foundation system that supports deck framing and a work platform positioned above the water and extending from the shoreline until the water is deep enough for barges, or site conditions render barges unsuitable. Causeways would extend similarly but would be comprised of clean earth and rock material placed over a geotextile or timber protective matting.

In the NEPA Environmental Assessment (2017), it was anticipated that access to the construction work in the river would be via a combination of barge and trestle where trestles would extend from the shoreline to a point where water was deep enough to accommodate barges for access.

After the initial NEPA EA Document, we considered instead of a trestle, using a causeway to access the in-water work. A causeway could be constructed in a relatively brief period, would buffer the surrounding river from the noise and sediment produced by construction of the pier foundations, and shorten the duration resources would be exposed to potential impacts.

However, through the Joint Evaluation (JE) process and comments from the resource agencies, it was clear that the causeway was more impactful due to the amount of fill being placed within the river bottom. Direct fill into the river would impact SAV and anadromous fish. Therefore, this alternative was eliminated from further consideration and will be used only for grading the transition from shoreline to trestle.

Based on the discussions at the JE meetings (and prior to CMAR engagement) it was determined that the use of barges and trestles would be the least impactful and their use was maximized to the extent feasible. As such, the original JPA permit application was based on accessing in-river construction via a combination of barge and trestle where trestles would extend from the shoreline to a point where water was deep enough to accommodate barges.

Since the original application, Amtrak has engaged a Construction Manager At Risk (CMAR) that will ultimately be responsible for construction and demolition work for the project. Whereas the original in-river access scheme is least environmentally impactful, the CMAR raised concerns that its application at this site creates multiple safety exposures for both the general public and bridge construction workers.

The proximity of the new bridge to the existing bridge is a key consideration. In some locations, the new bridge is positioned approximately five feet from the existing bridge. Additionally, the existing bridge, which is over a century old, carries over 100 passenger trains per day. It is difficult to ascertain the true condition of a bridge that old, with specific regard to those features below the water surface. Such inspections are generally limited to non-destructive testing performed by divers in low visibility water. Furthermore, those elements are below the mudline making it impossible to evaluate without substantial in- water containment systems and access. Constructing the new bridge includes installing large, deep foundations that are immediately adjacent to a 100+ year old bridge, where condition assessment is limited. Construction of the new west bridge will result in all barges being positioned upstream of the existing bridge. Any extreme storm event or accidental loss of anchorage could result in the existing bridge being hit by a stray barge.

In addition, there are two 138 KV electric lines that are attached to each side of the existing bridge and positioned approximately 30 ft. above the tracks. Contact between a crane load line and these electrical lines risks worker fatality, loss of crane control, potential public injury and service loss of the rail. In many places, lifts approaching the OSHA exclusion zones are required. In order to maintain minimally safe distances to the transmission lines, we are limited to less than 6” of planned barge translation (i.e. movement and/or rotation relative to normal).

The proximity to the bridge and transmission lines requires reliable, consistent, precise barge placement and position maintenance. Such precision limits barge positioning technique selection.

Typical barge positioning techniques include spudding, mooring piles, or anchor trees. Mooring piles and anchor trees are unable to provide and maintain reliable positioning precision for the site conditions on this project. Mooring lines stretch, mooring line fatigue, anchor drag, and water level changes will result in unacceptable barge translation. Additionally, the Conowingo Dam, after significant rain events, releases large volumes of debris laden water, that are historically well documented. The inherent limitations of mooring an anchor trees combine with tugboat failure and human error, are events that may result in impact with the existing bridge and/or contact with the 138KV transmission line. Whereas arguments advocating management of such exposures can be made, frequency of exposure, and consequence of failure, when combined, create recurring, unacceptable safety exposures.

Spudding is the single barge position technique that provides the position certainty required for these project conditions. Spudding is effective in sandy or muddy river floors where the spud can penetrate the sand and/or mud in order to establish the “bite” or anchorage necessary. However on this project, the Susquehanna River has a mostly rocky floor which inhibits the ability of spuds to penetrate the river bottom and thereby establish the anchor or “bite” needed to secure a barge position. Without an adequate bite, the spuds would drag across the bottom when pushed by normal currents and wind. The aforementioned Conowingo Dam releases, significant rain events, and high(er) winds will exacerbate this concern and increase the likelihood of contact with either the existing bridge and/or overhead 138KV transmission lines.

I.B Proposed Access

Based on the proposed site conditions, and the precise positioning requirements required to address public and worker safety exposures, the JPA application is amended to show access for in-river work being accomplished by trestles that extend from each shoreline out to the respective edge of the navigation channel as shown on the attached permit plates and plans.

Below is a more detailed description of the proposed access plan. The pier numbers are shown on the attached figure, ascending in order from the Perryville side of the river.

I.B.1 Piers to be Constructed from Ground

Piers 22W to 20W and Piers 22E to 20E at Havre-de-Grace
Piers 01W & 02W and Piers 01E to 03E at Perryville

These 11 piers are positioned outside of the riverbank, so access for construction to each will be from ground level. Zero to eight feet of fill will be placed and graded around the pier sites to create a level work area. Time to grade the entire work area at each approach is estimated to be 30 days.

Portions of the graded work area will extend into designated wetland areas and SAV at three of the four bridge approaches. There are three piers that will be constructed within these areas: Piers 20W and 20E at Havre-de-Grace, and Pier 02W at Perryville. All impacts to wetlands and SAV will be mitigated through compensatory mitigation identified for the project.

I.B.2 Piers to be Constructed from Trestle

Piers 3W to 19W
Piers 3E to 20E

A portion of all four trestles will be positioned within designated wetland and SAV areas. All impacts to wetlands and SAV will be mitigated through compensatory mitigation identified for the project.

Trestle on the project is classified as three distinct types:

Mainline, or that trestle parallel to the bridge,
Fingers, or those shorter sections directly adjacent to the piers,
Arch, a narrower trestle required for to assemble the main tied-arch span.

The mainline deck will be 60-foot wide, most likely comprised of either concrete or timber decking over steel structure founded on six (6) each pipe piles spaced every thirty (30) feet. The fingers will be 40 foot wide and comprised of similar decking over steel structure founded on four (4) each pipe piles.

The trestle will be constructed progressively from the riverside in out towards the in-river construction area. For direct access to the new pier, narrower finger trestles will extend out perpendicular from the main trestle. They will remain in service for at least two years until the respective bridge is complete. To assemble the arch spans on site, a separate trestle will extend from the mainline trestle, oriented parallel to river flow.

To support the construction equipment, it is estimated that 36-inch diameter steel pipe piles are needed to support trestles. It should be noted that construction adjacent to railroads requires larger cranes than typical to highway construction as the aforementioned safety concerns mandate a higher factor-of-safety thereby requiring larger cranes.

On the Havre-de-Grace approach where bedrock is relatively shallow, the pipe piles will be installed by either pre-drilling a hole into the bedrock and then placing the steel pile into the pre-drilled hole, or rotating the piles into the rock with a cutting shoe. Either operation generates relatively low noise levels relative to traditional pile driving and are anticipated to not be subject to TOYR's for anadromous fish. Regarding turbidity, rotation/cutting shoe methods may generate turbidity as the pipe shoe cuts the rock. To mitigate turbidity impacts, turbidity curtains will be installed around any rotation/cutting shoe installation and any pile installation within SAV beds at the Havre-de-Grace approach will be restricted by the TOYR for SAV beds.

On the Perryville approach, bedrock is anywhere from 50-100 feet below river bottom and piles will likely be installed via more traditional pile driving techniques such as impact hammer or vibratory methods or a combination of the two. Traditional pile driving techniques do produce relatively higher noise levels so therefore they will be restricted from being performed during the TOYR's for anadromous fish or northern map turtle. Similar to the Havre-de-Grace approach, no pile installation within SAV beds at the Perryville approach will be allowed during the TOYR for SAV beds. Regarding turbidity, traditional pile driving methods, such as impact driving or vibratory driving produce relatively low levels that are frequently undetectable. Installing and maintaining turbidity curtains under river flows often cause more disturbance than the pile driving process the curtains are intended to mitigate.

Once the respective bridge is complete, the trestle will be removed from topside, in reverse from the sequence in which it was constructed. Piles that are embedded in the soil overburden most likely can be pulled. Some of those piles pre-drilled into rock may require abandonment however, removal may also be possible. The effort required to remove some of these piles may cause settlement of the existing bridge. Each condition will be evaluated and to avoid any impact to the existing bridge, some piles may have to be cut at the mudline abandoned in place.

II. Construction of New Bridge Components

II.A Construction of Land Bridge Piers

There are 11 new piers positioned on land:

Piers 1W & 2W and 1E to 3E at the Perryville approach, and
Piers 20W to 22W and Piers 20E to 22E at Havre-de-Grace.

Once the temporary graded work area is established, a cofferdam system will be constructed around the pier footprint to facilitate construction of the pier foundation. The cofferdam is needed to support the surrounding soils and dewater the excavation. The cofferdam will be comprised of either steel sheet piles or steel posts with timber lagging. It will extend approximately 6 to 10 feet below ground and be installed by driving or vibrating the piles or posts to the design depth. Constructing the cofferdams is estimated to take 60 days per pier. The cofferdams will be in place for less than 1 year.

With the cofferdam in place, soil inside the cofferdam will be excavated down to the bottom of footing elevation. Installing the foundation shafts will begin once the bottom of footing elevation is reached. There will be two 10-foot diameter, steel-cased, reinforced concrete shafts supporting each of these 11 piers.

The shafts will be constructed by lowering the steel casing down to bedrock using either driving, rotating, or vibrating equipment. Once the steel casing is seated on bedrock, the soil and rock material inside the casing will be removed to a point 10 feet below the top of bedrock. Then the reinforcement will be installed, and concrete poured to complete the foundation shaft.

The concrete pier footing will be constructed after the foundation shafts are cured and will be followed up by the first section of the pier stem. At this point, the new pier will extend at least 15 feet above ground, allowing the cofferdam to be removed and the open excavation to be backfilled.

All the work, including excavation for the footing, installation of the steel casing, construction of the concrete shaft, and construction of the final pier footing, will occur from within the confines of the cofferdam. Decanting and sediment control BMPs will be used during dewatering of cofferdams.

II.B Construction of River Bridge Piers

Construction of new bridge piers in the river will occur from the proposed Mainline and Finger trestles. Most of the specific pier work will occur from the finger trestles, with the mainline trestle used mainly to transport materials and equipment to and from the specific work areas.

II.B.1 River Bridge Pier Foundations

New piers positioned within the river will be supported by either two 10-foot diameter or four 8-foot diameter steel-cased, reinforced concrete shafts. The most likely drilled shaft construction process will occur as follows:

1. Set a template. This device is a temporary structure that facilitates precise location of the shaft and further serves to support casing installation equipment.
2. Install the casing. Casing on this project consists of an eight or ten foot diameter steel pipe typically installed via rotation, oscillation, and driving. Rotation and oscillation use cutting teeth at the toe of the casing to “cut’ the soil and or rock to advance the casing. Whereas rotating, and oscillation are the most likely options for casing installation, site conditions may require vibratory or impact driving. Unfortunately, certainty of casing installation method requires experimentation during the test/demonstration shaft program that occurs in advance of installing the final “production” casings for the new bridge.
3. Once the casing is seated, the material within the casing will be removed and excavated down to suitable rock bearing material. Multiple, widely varied techniques exist to excavate inside the casing. Whereas excavation techniques may be narrowed, they cannot be finalized until the aforementioned test/demonstration shaft program occurs. Rock formations on the project likely require combined drilling equipment with impact capacity to break up the rock as it is drilled. Overburden, or the soil which overlays the rock, may require traditional drilling methods. As rock/soil materials (otherwise referred to as “spoils”) are excavated from the shaft, , the spoils are transferred to trucks, barges,

or dumpsters, removed from the site and disposed of in accordance with regulations and permits.

4. Once excavation is complete, the shaft excavation is inspected by various techniques to ensure compliance with the design. After inspection, the reinforcing cage is installed into the excavation. This operation is time critical as the engineering properties of the excavation deteriorate over time requiring the cage be installed and concrete placed as soon as possible once excavation is complete. The timing associated with this operation drives equipment sizing which then affects access requirements.
5. The last step involves concrete placement of the shaft. Concrete is placed from the bottom to the top via a “tremie”, which consists of a pipe extending to the bottom of the shaft, and becoming submerged in the concrete as the shaft is filled. Concrete placement is a critical, time critical, continuous activity that, when interrupted, may result in significant rework, demolition/reinstallation, or abandonment of the shaft. Once again, the criticality of continuous placement dictates the access requirements.
6. Shaft construction will occur in open water, not within a typical cofferdam. Where shafts are drilled in the “wet”, water contaminated with concrete and/or dissolved rock cuttings is collected, then disposed of or treated and discharged in accordance with applicable permits/regulations.

The following mitigation measures are being proposed to minimize the temporary construction impacts associated with the constructing the shaft foundations within the river:

- Amtrak is coordinating with NOAA NMFS and the resource agencies to develop a Zone of Safe Fish Passage (ZSFP) that will allow fish to pass with minimal exposure to temporary construction impacts. No casing install or impact hammer work will occur within the ZSFP during TOYR’s for anadromous fish and northern map turtle. The position of the ZSFP within the river will vary to accommodate construction progress. No matter where it is positioned within the river, the ZSFP will be contiguous, it will include both shallow and deep-water conditions. Bubble curtains and/or other noise attenuating BMP’s will be implemented to further minimize the temporary impacts from construction noise.

- An underwater noise monitoring plan will be implemented to ensure anadromous fish and other aquatic species are not being affected.

  Establish a 200 ft. buffer around SAV beds inside of which no work can occurring during the TOYR’s for SAV beds. Any shaft foundation work outside of the buffer will not be subject to the TOYR’s for SAV beds. We will require turbidity curtains be installed surrounding the perimeter of all shaft construction activities, regardless of timing with respect to TOYR’s.

- Amtrak is currently coordinating with DNR and Towson to determine how to continue construction during the Northern map turtle overwintering TOYR through the installation of an exclusion structure to prevent the Northern map turtle from overwintering near or within potential pier and pile locations.

II.B.2 River Bridge Piers & Superstructure

Once the shafts are complete, pier construction will progress to the shaft cap, pier stem and pier cap. Where possible, cofferdams will be used to keep these work areas available for construction. When water is too deep for a standard cofferdam to be practical, it is anticipated that a suspended "bathtub"-type cofferdam system will be used to facilitate dewatering during construction of pier components above the shaft foundations. The bathtub-type cofferdam will not extend down to river bottom. It will be held in place by a temporary support system anchored to surrounding structures supported on the piles used for the drilled shaft templates.

Sealing the bathtubs will be accomplished by a small placement of hydraulic cement that seals the annulus between the drilled shaft casing and bathtub blockout. As cement is mixing with river water contained inside the bathtub, the water inside the bathtub is ph and turbidity are affected . Such water will be collected and disposed of or treated and discharged in accordance with applicable permits/regulations.

With the shafts complete, the temporary suspended cofferdam can be installed, and the concrete pier footing and first section of pier stem can be built. The first section of the new pier system will extend at least 15 feet above the mean high-water line (MHWL), and the suspended cofferdam can be removed. No backfilling within the river bottom is required because there are no voids with shaft construction.

All of this work will occur far above river bottom and cause no disturbance to the river bottom, thereby precluding the need for turbidity curtains or other earth disturbance mitigation mesures.

II.C Fender System Installation

Access will be via barge and follow the same pathway as for deep water pier foundations. There will be two fenders located at the navigational channel for each bridge. Each fender will consist of concrete filled steel, approximately 35-40 per channel side. Fender railings will be installed. Pile driving will result in disturbed river bottom and generation of some underwater noise. There will be a full channel restriction of marine traffic for an estimated 12-16 months.

II.D Existing Bridge Removal

II.D.1 Removal of Existing Bridge Superstructure

The existing bridge will be removed using top-down progression. Demolition equipment will be mounted on both the existing structure and the temporary trestles. Elements will be cut down to sizes practical for lifting and transport. It is ancitipated that torch-cutting will be required to remove the steel framing and girders. Demolition of superstructure that occurs over SAV areas will be shielded to prevent debris from landing in the SAV areas and eliminate any need to access the SAV area in order to remove fallen debris.

II.D.2 Removal of Existing Bridge Piers

The bridge piers for the existing structure will be removed to approximately 2’ below the mudline. Where the bedrock is 2’ or less below the mudline, the pier structures will be removed to the bedrock elevation. Demolition methods for pier removal shall exclude blasting. Full depth turbidity curtains will be erected around each pier during demolition to contain sediment and debris. The above-water structures will be demolished from the top down using methods such as hammering with an excavator—where the debris will be collected onto a barge—or saw-cutting the structure into movable pieces that can be collected by a crane onto a barge. The underwater structures may be removed using methods, such as hammering with an excavator, where the debris will be mucked out onto a barge and disposed of in accordance with applicable permits and regulations.

Pier demolition and removal to possibly occur for two piers at a time, with one crew positioned at each pier. Removal of the piers will begin nearest to each shore and demolish piers sequentially toward the navigation channel. For existing piers positioned within SAV beds, cofferdams could be installed around the existing pier in order to contain the demolition work and limit impacts to the surrounding SAV beds. The cofferdam installation would be restricted to occur within the TOYR for SAV beds, however demolition work contained within the cofferdam is not subject to the TOYR’s for SAV beds.