Swift Island Historic Arch Bridge Rehabilitation and Widening Feasibility Study

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Henley Street Bridge
Knoxville, TN – Before Construction (courtesy TDOT)

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Henley Street Bridge
Knoxville, TN – During Construction (courtesy TDOT)

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Henley Street Bridge
Knoxville, TN – After Construction (courtesy TDOT)

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NCDOT Pee Dee River Bridge Widening & Rehabilitation

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NCDOT Pee Dee River Bridge Widening & Rehabilitation

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Project Location
between Albemarle and Troy, North Carolina

Predecessor Bridge – Constructed in 1920

“The structure – not 5 years old – was to be submerged by water”

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NCDOT Pee Dee River Bridge Widening & Rehabilitation

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“America’s Great Bridge Test – A Bureau of Public Roads Picture”

“an advisory committee of experts”

“an exhaustive program of tests”

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“Rollers under the tanks made it easy to move them”

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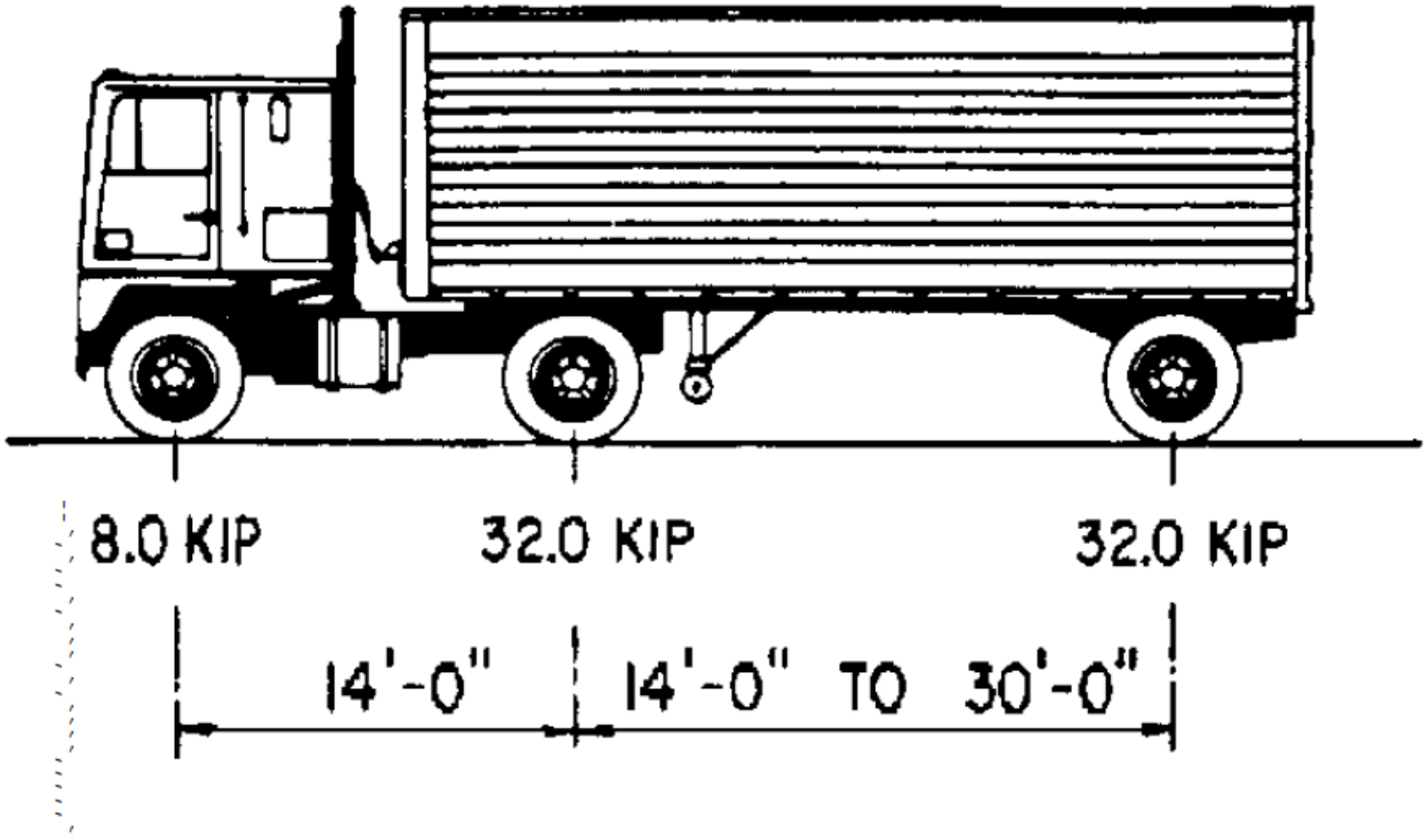
“The heavy tanks were weighed by a unique method”

“The tanks weighed 23½ tons when empty and 164 tons when full of water”



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“In the second phase the floor was cut through so that the action of the free arch could be studied”

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“changes in the shape of the arch rib were measured with a radius meter”

“but the arch did not break”

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“the bridge was turned over to the War Department”

Battle of Swift Island Bridge

“shellfire”

“shellfire”

“—and landmines.”

“—and landmines.”

“—and landmines.”

“Making way for the new bridge over which whir the motors of modern vehicles.”

Swift Island Bridge Widening & Rehabilitation

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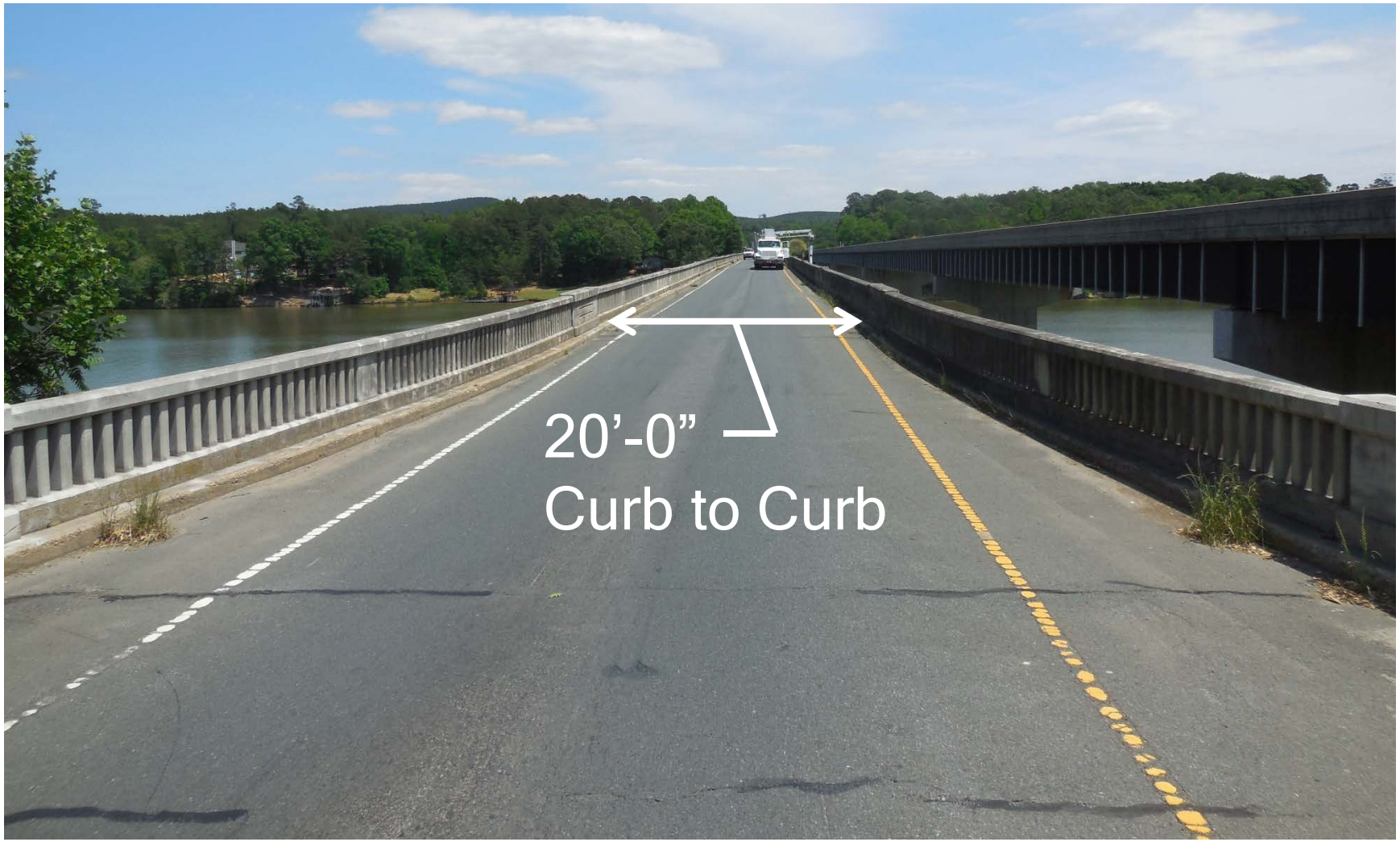
Swift Island Bridge *Widening* & Rehabilitation



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Swift Island Bridge Widening & Rehabilitation

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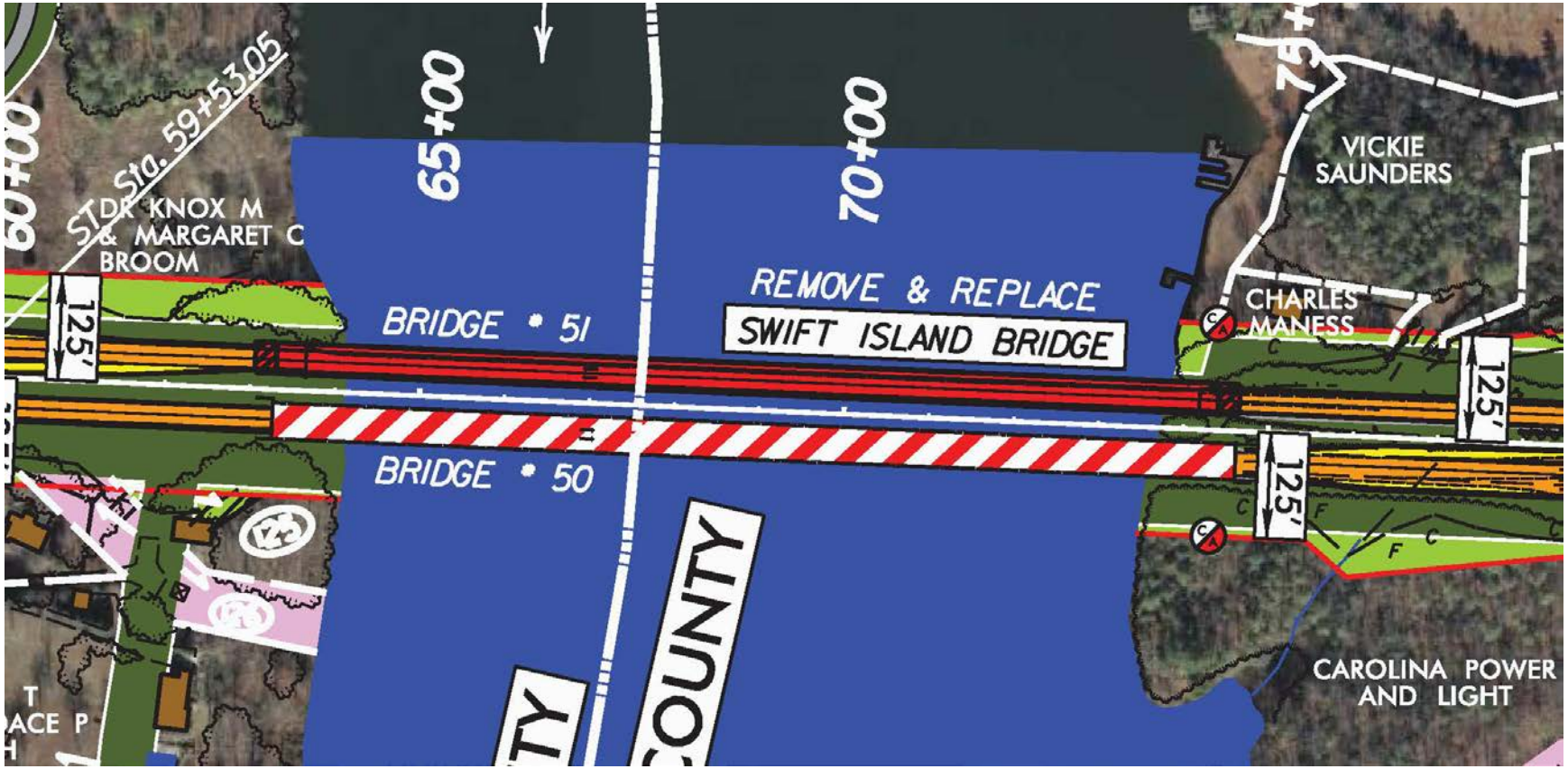
Public Hearing Map Alternate 4
Remove the Arch Bridge and Replace It with a Conventional Bridge



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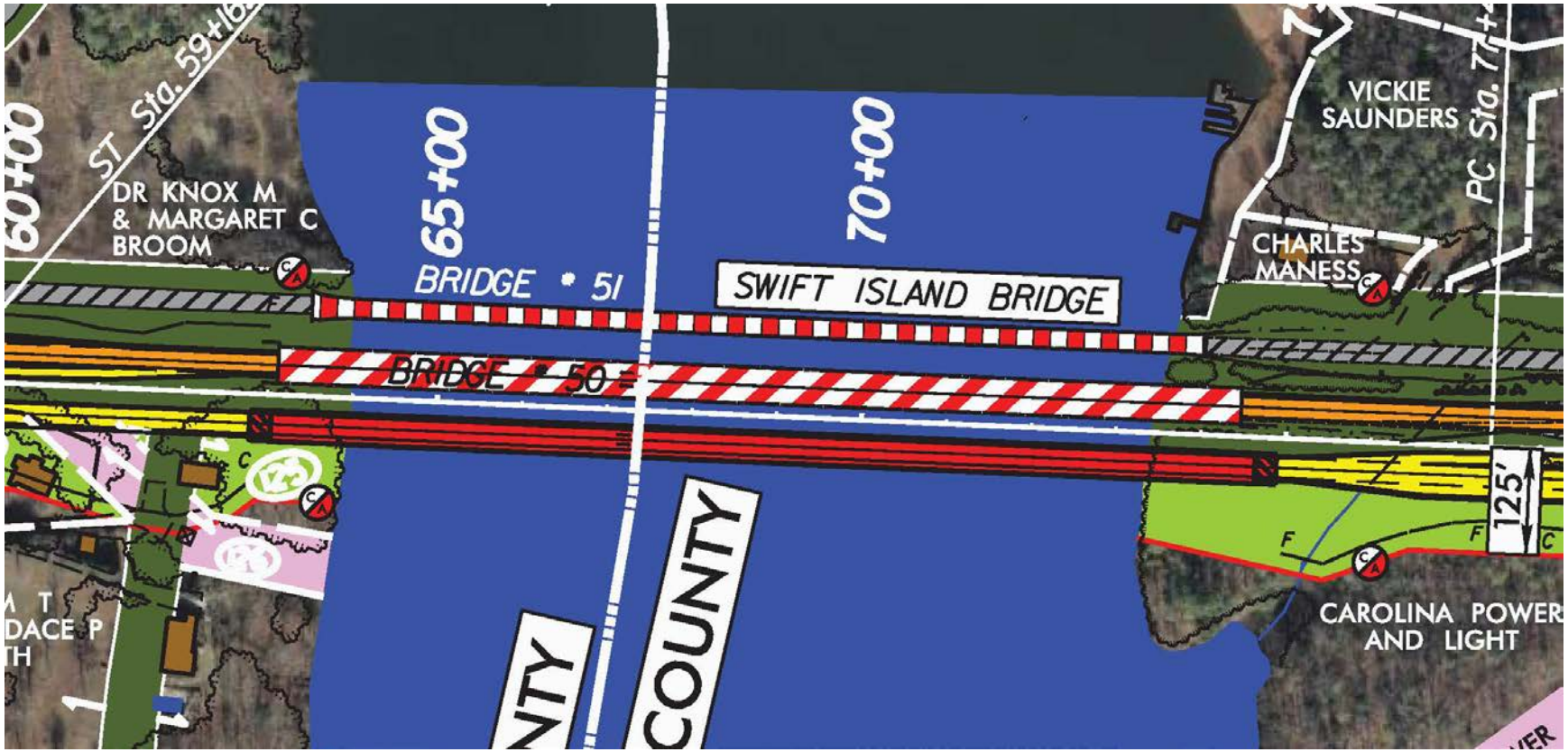
Public Hearing Map Alternate 1
New Bridge to the South – Arch Bridge Preserved as a Bike & Pedestrian Facility



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2016 Feasibility Study

Feasibility Study Team

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INFRASTRUCTURE ENGINEERS, INC.

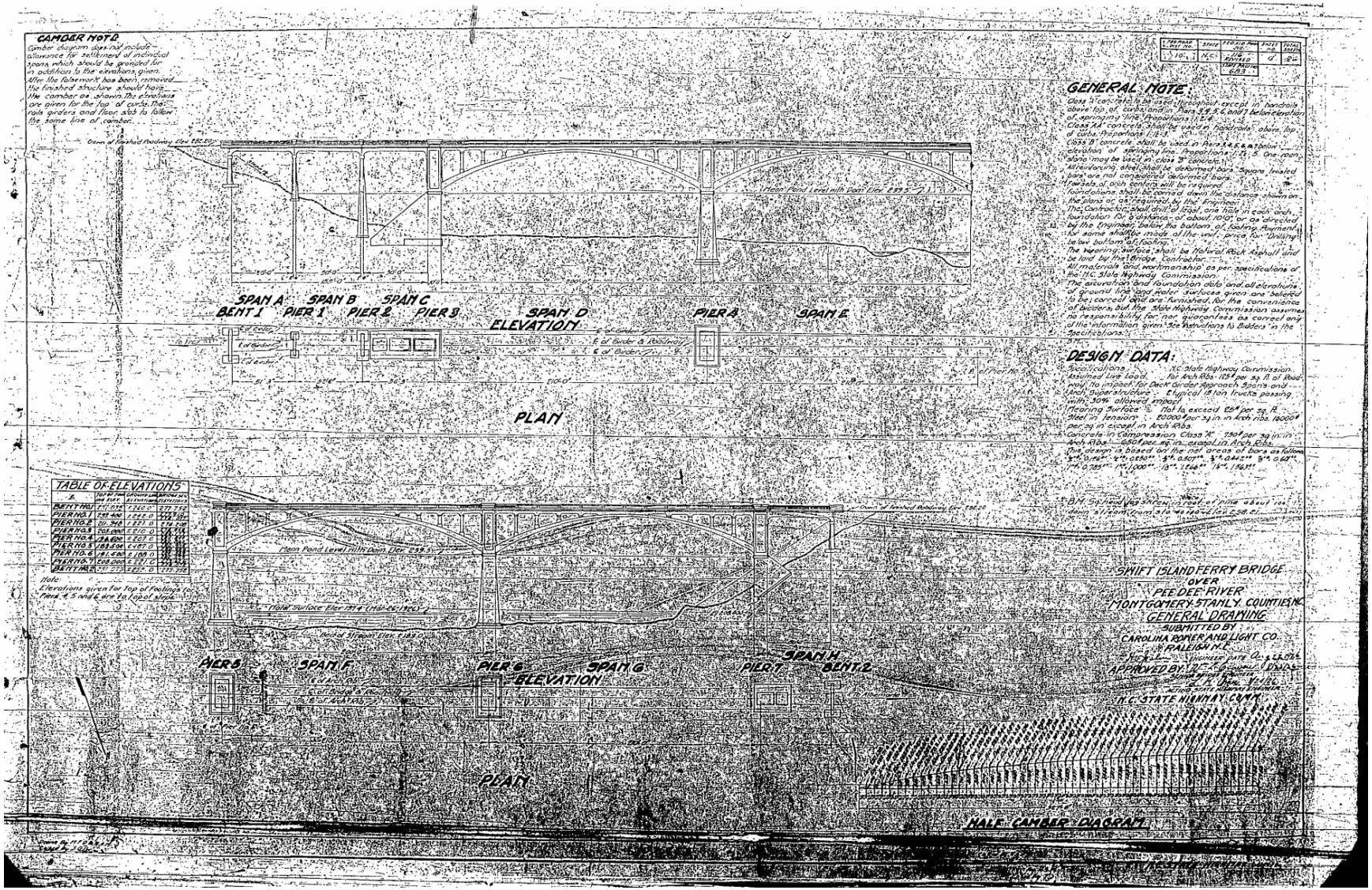
ingenuity & agility

SIVA CORROSION SERVICES, INC.
Materials, Corrosion, and NDT Specialists

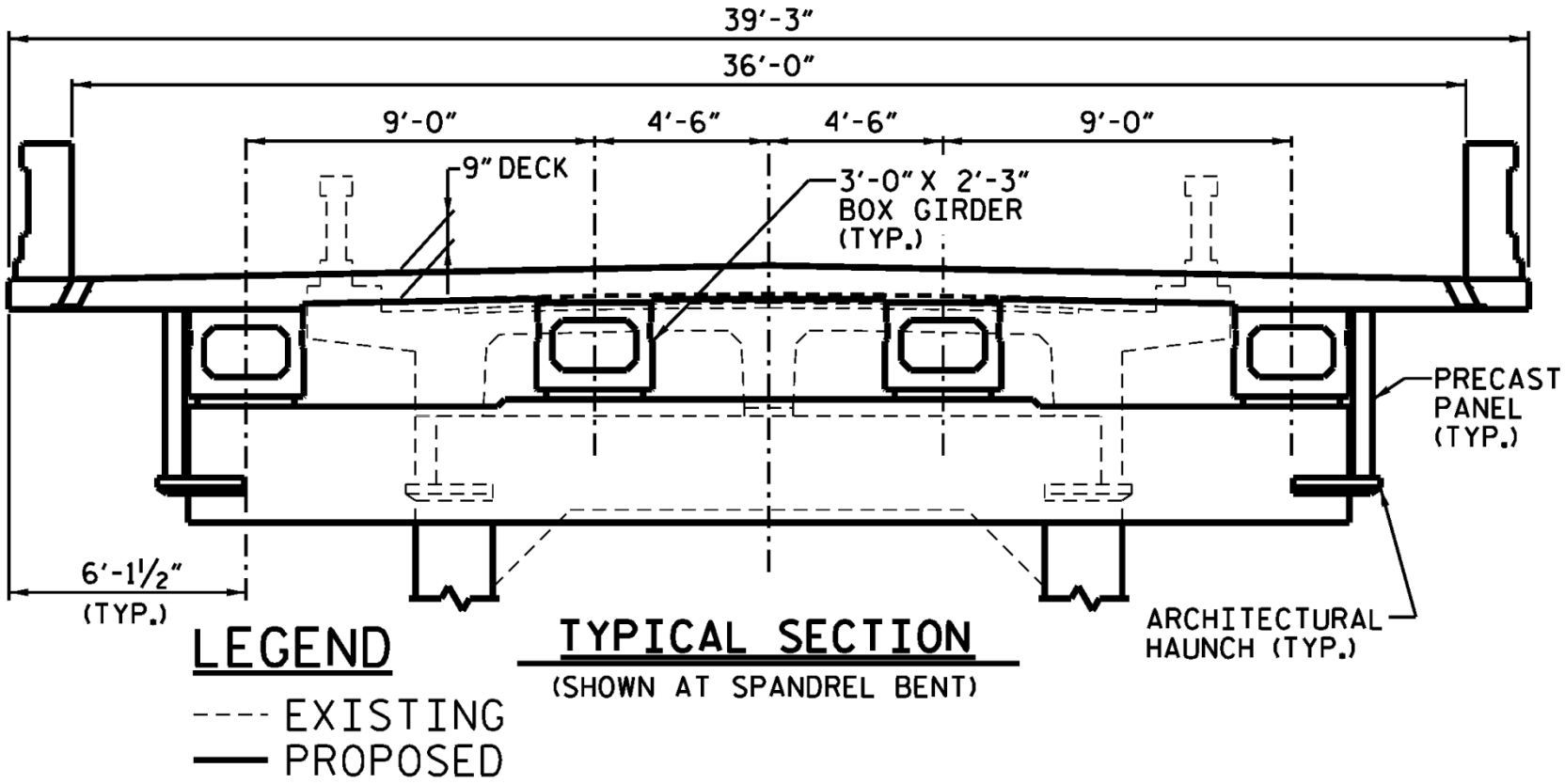
Feasibility Study Scope of Work

- Load rating of the existing bridge
- Load rating of the bridge with a proposed superstructure
- Above water inspection
- Underwater inspection (Infrastructure Engineers)
- Geotechnical investigation (Falcon Engineering)
- Material testing, corrosion protection, and service life analysis (Siva Corrosion Services)
- Consultation for NEPA and historic preservation
- Final feasibility study summary document

Original Arch Bridge Plans



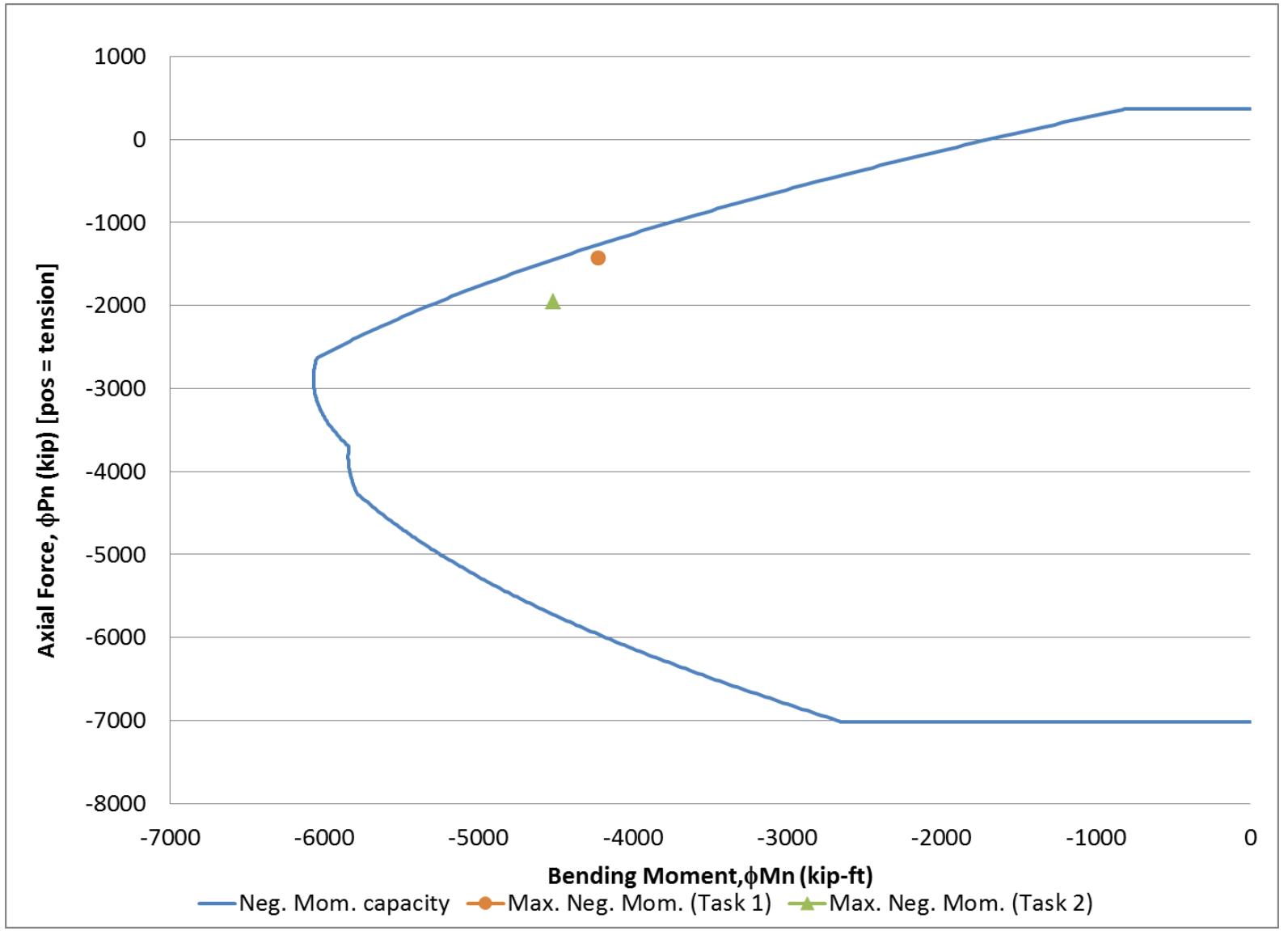
Proposed Typical Section



Analysis Concepts

- The proposed superstructure has a significantly higher inertia over the existing. In combination with relatively soft bearings, this helps relieve demands on the arch ribs.
- The dead load of the proposed superstructure is also significantly higher than the existing. This can be beneficial if the load is applied without inducing flexural demands since the arch rib is a compression member.
- Expansion joints at 1/3 points within each arch span were eliminated, which provided significant benefit for positive bending of the arches in these locations.
- Temperature fall causes significant negative moments at the arch rib springlines.

Arch Rib Interaction Diagram at the Springline



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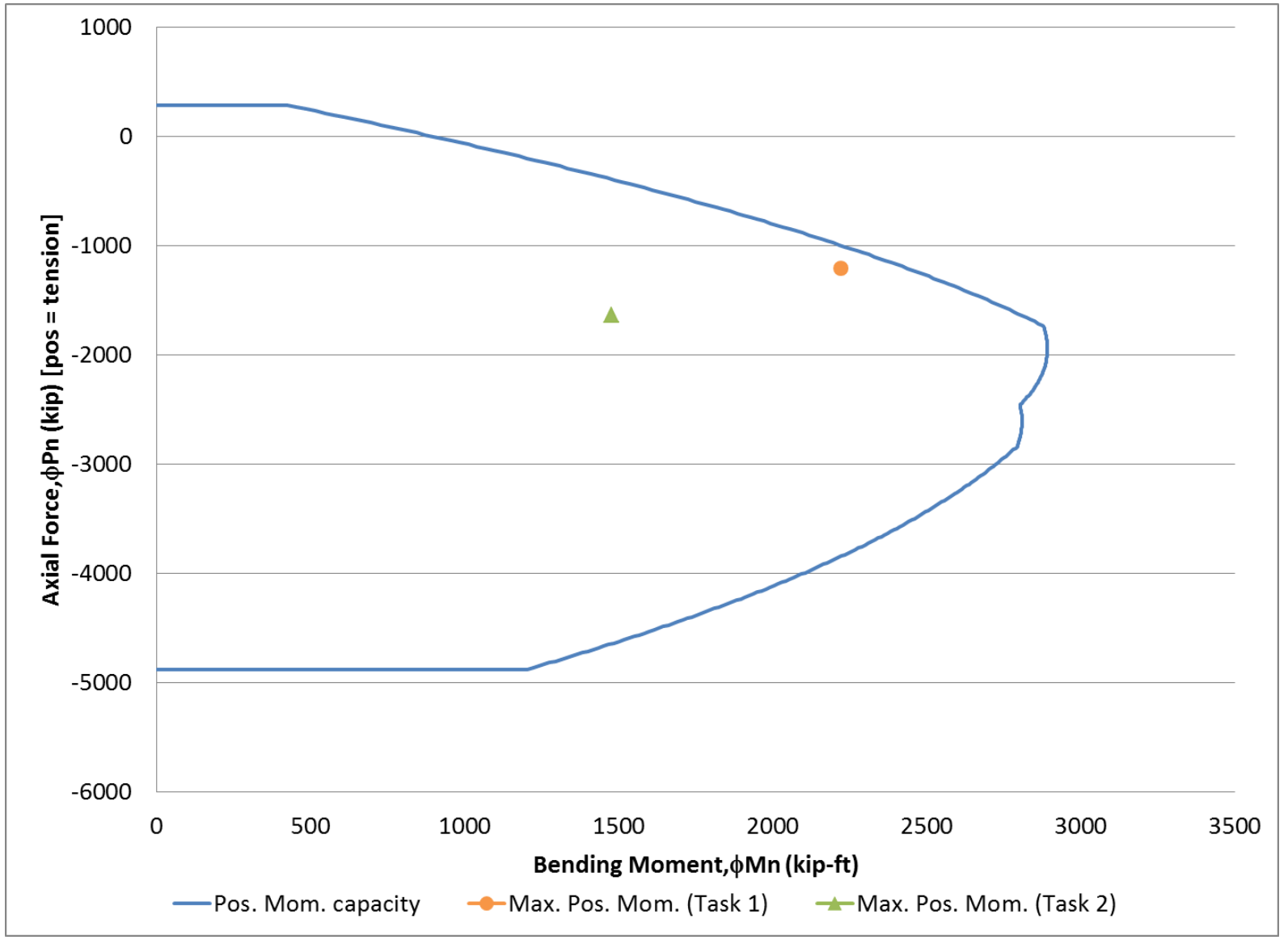
Arch Rib Interaction Diagram at 1/3 Span Exp. Joint



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Inspection Results – Arch Piers

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Progression of Deterioration – Crack

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Progression of Deterioration – Delamination

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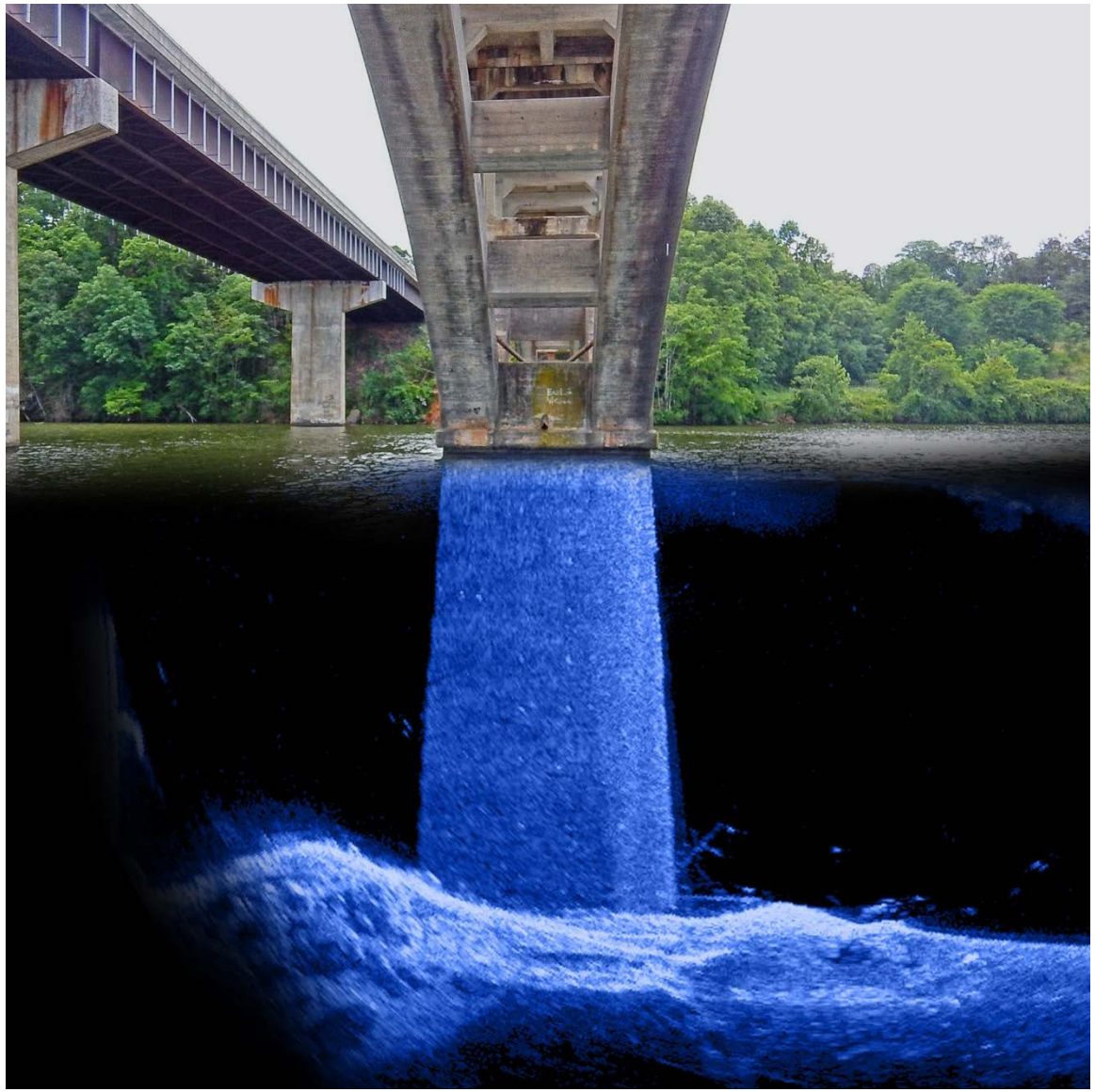
Progression of Deterioration – Spall

Underwater Inspection (photo courtesy IE)



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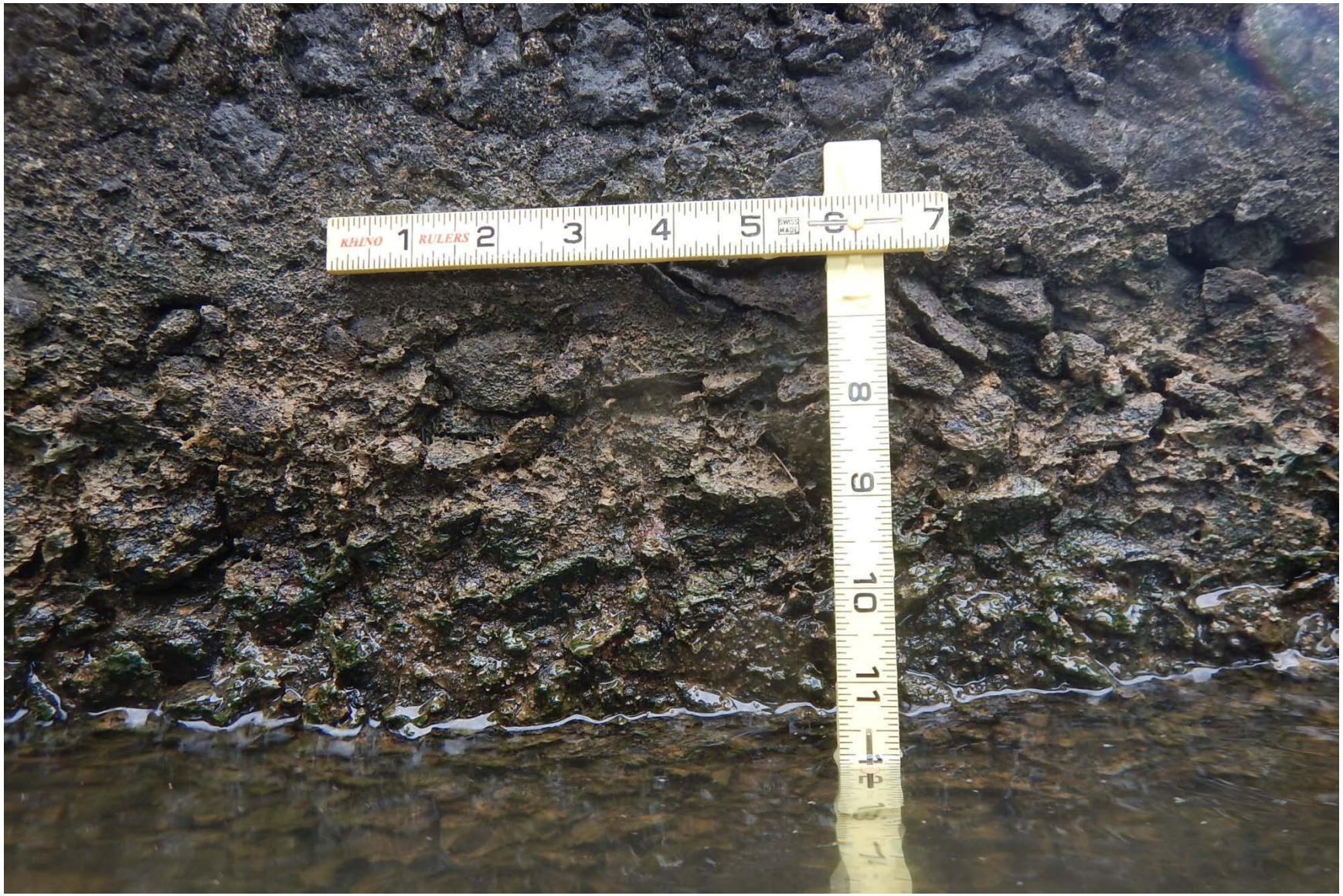

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Inspection Results – Arch Ribs

Deck Expansion Joints at 1/3 of the Arch Span

Scaling at the Top of the Arch Rib near the Springline

Corrosion Protection and Service Life Analysis

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Corrosion Protection and Material Testing

- Strength Cores – 8 total ranging in strength from 3530 psi to 6850 psi.
- Cover survey – 90% of the arch pier reinforcement has cover greater than 1.20”. 90% of the arch rib reinforcement has cover greater than 1.43”.
- Petrographic – 4 cores. “The pier and arch concrete is in excellent condition following 89 years of service.”
- Chloride profile – high chlorides (>500 ppm) at the rebar level in the arch piers near the expansion joints.
- Use discrete anodes in patches and coat all concrete with a breathable sealer.

Proposed Visualization

Conclusions

- This alternative is the Least Environmentally Damaging Practicable Alternative in accordance with NEPA.
- No Adverse Effects upon the historic structure (with conditions) in accordance with Section 106 of the Historic Preservation Act.
- De Minimus impact in accordance with Department of Transportation Act of 1966.
- 75 year service life is projected.
- $4.3 million estimated savings compared to constructing a new bridge south of the existing bridges.

Conclusions

- Eliminate as many joints as reasonably possible. Maintain & replace joints regularly if they can't be eliminated.
- Document every defect with a photo and a sketch during inspection. This benefits quantity calculations for repair material and service life analysis.
- Cracks parallel to a corner indicate corrosion has initiated in the longitudinal reinforcement. Crack injection is not the appropriate repair methodology.
- Concrete Jacket repair at the waterline.
- Replace piers down to the arch rib springline.

Conclusions

- Midas is being utilized for the final three-dimensional modeling of the structure, including the construction sequence.
- Arch rib strengthening is not required.
- 3D laser survey was obtained during final design to verify arch rib and pedestal geometry.
- AECOM and NCDOT were awarded an Engineering Excellence Grand Award from ACEC for this feasibility study.


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