US54 Canadian River Bridge Replacement

New Mexico’s First Cast-In-Place Segmental Bridge

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ENGINEERING RCEP

REGISTERED CONTINUING EDUCATION PROGRAM

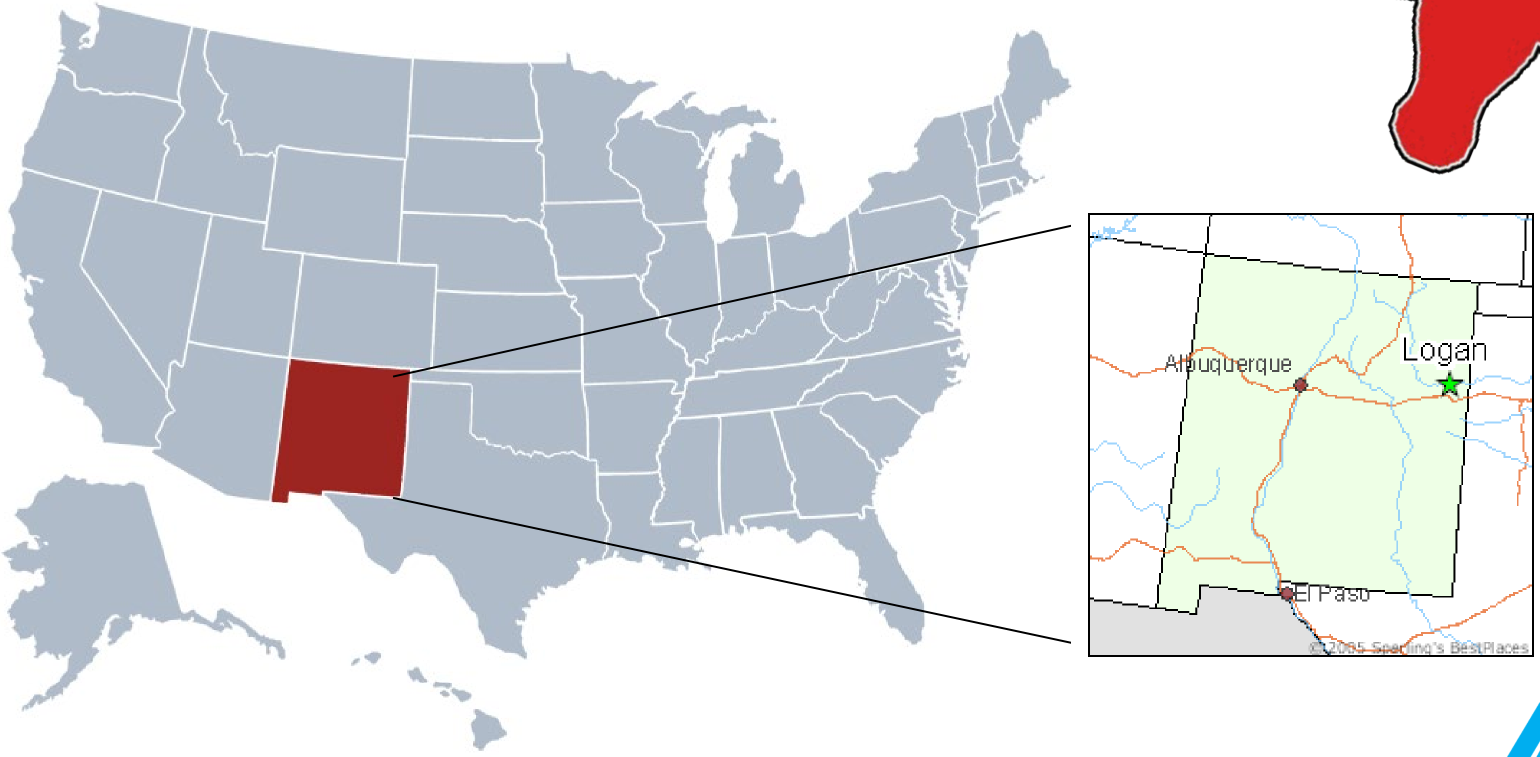
US54 Canadian River Bridge

- **Kim Coleman, PE, Bridge Bureau Engineer**
  - New Mexico Department of Transportation
- **Nyssa Beach, PE, Structural Engineer**
  - Jacobs Engineering

US 54 Canadian River Bridge Replacement

New Mexico’s First Cast-In-Place Segmental Bridge

Where is the project?



(Photo Credit: Ontheworldmap.com)

Why do we need this project?

- Existing steel deck truss bridge was built in 1954, rehab in 1984
- Poor condition
- Narrow
- Load restricted
- Fracture Critical Connections

Emergency inspection during construction shown.
Due to an unauthorized overload vehicle.

(Photo Credit: Wikipedia.com)

What project do we need?

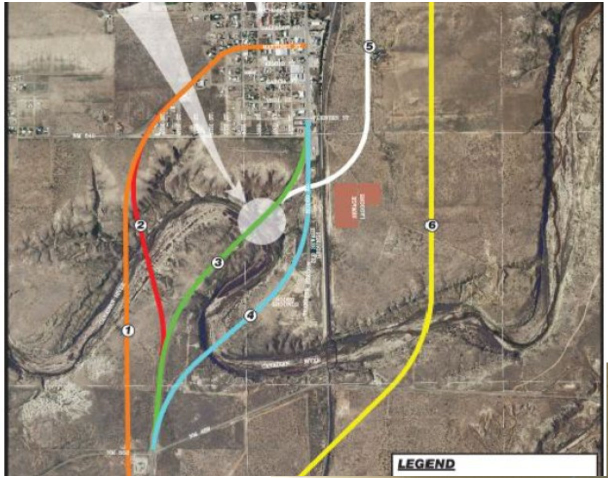
US 54 is the main trucking corridor from Chicago, IL to El Paso, TX

- 50% truck traffic
- 125 mile detour
- Oversize/Overweight
- Commerce from the US54 corridor is critical to the Village of Logan. It was vital to the community that there was no disruption to the traveling public.

→Replace bridge

- Address existing deficiencies
- Improve safety
- Ensure future viability of US 54 Corridor

Logan, NM Public Involvement



- Public Involvement was critical to this rural project
  - The US 54 corridor is essential to the Village of Logan's economy and livelihood and drew considerable input.
  - An alignment that maintained access through Logan but could be built off-line was imperative to maintain and ensure future access through Logan.

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Selected Alternative

- Offset alignment to the east of the existing crossing

Bridge layout

Additional Constraints

- **Avoid the river**
  - Canadian River- "Special Waters"
  - Two State-listed fish species
  - One Federally-listed fish species

- **Avoid the wetlands**
  - Maximize span length
  - Construct primarily from above

Peppered Chub *(Photo Credit: Project Noah)*

Arkansas River Shiner *(Photo Credit: Wikipedia.com)*

Structure Type Selection

	Functional Requirements	Construction Feasibility	Construction Cost	Future Maintenance	Aesthetics
Steel Deck Truss	Viable Str Type 250' to 1500' Fracture critical & redundancy are issues	Constructed from above in pieces in progressive cantilever	$250-$300/SF Estimate $8.74M	Truss requires add'l inspection weathering stl can eliminate painting	Variable truss height, chord members are aesthetically pleasing
Steel Through Truss	Viable Str Type 250' to 1500' Fracture critical & redundancy are issues	Constructed from above in pieces in progressive cantilever	$275-$325/SF Estimate $9.64M	Truss requires add'l inspection weathering stl can eliminate painting	Variable truss height, chord members are aesthetically pleasing
Steel Plate I-Girders	Viable Str Type 60' to 300' span length Conventional structure type	Conventional Limited access from below, deep ravine Launched Constructed from above, launched over site	Conventional $150-$275/SF Estimate $8.27M Launched $200-$300/SF Estimate $9.52M	Weathering stl can eliminate painting, semi-integral abuts assist EJ and routine maintenance	Conventional structure type, constant depth, shallow and slender structure type
Cast-in-Place Segmental	Viable Str Type 250' to 750' span length efficient for longer spans	Cast with form travelers from above in balanced-cantilever	$250-$300/SF Estimate $8.22M	High-strength PT concrete requires low maintenance	Variable depth, trapezoidal box is aesthetically pleasing
Precast Segmental	Viable Str Type 200' to 450' span length efficient for longer spans	Need access in ravine to deliver precast segments Overhead Built from above with gantry / equip	Ground access $200-$250/SF Estimate $7.91M Overhead $200-$250/SF Estimate $9.16M	High-strength PT concrete requires low maintenance	Trapezoidal box with long deck overhang is aesthetically pleasing

Cast-in-Place Segmental

- Efficient for long spans and horizontal curve geometry
- Constructed primarily from above, no impact sensitive wetlands
- Construction cost lower than alternatives, especially considering rural constraints.
- Low Maintenance in the future
- Aesthetically pleasing, simplistic curving profile against the desert landscape

Cast-In-Place Segmental Design

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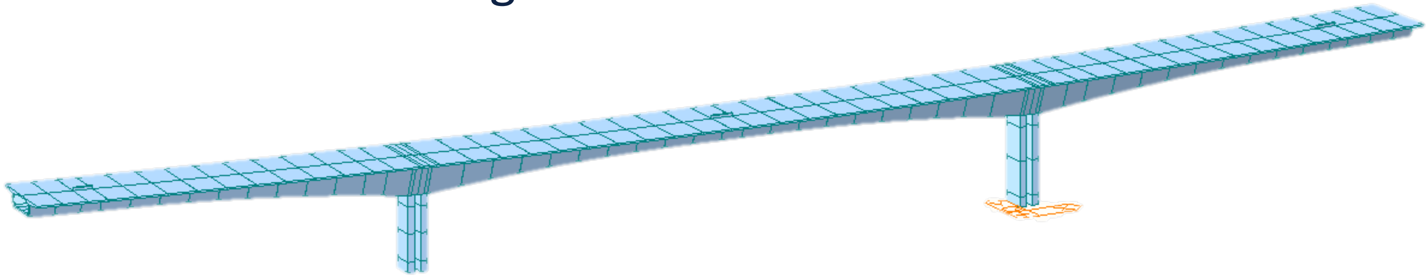
Jacobs Design Software – Midas Civil 3D



Pros:
- Staged Construction Modeling
- Input of segments and post-tensioning with variable geometry

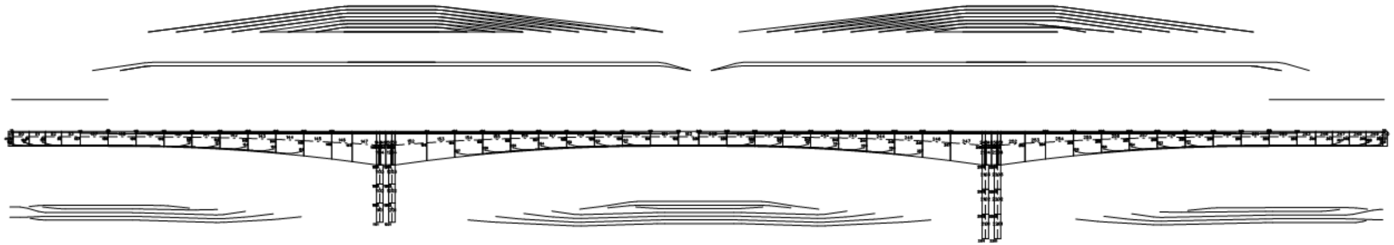
Challenges:
- Load Rating incorporating construction stage loading
    - Continued issues with load rating equation in module
- Interaction between superstructure and columns design

1.2.2 Calculation of RF

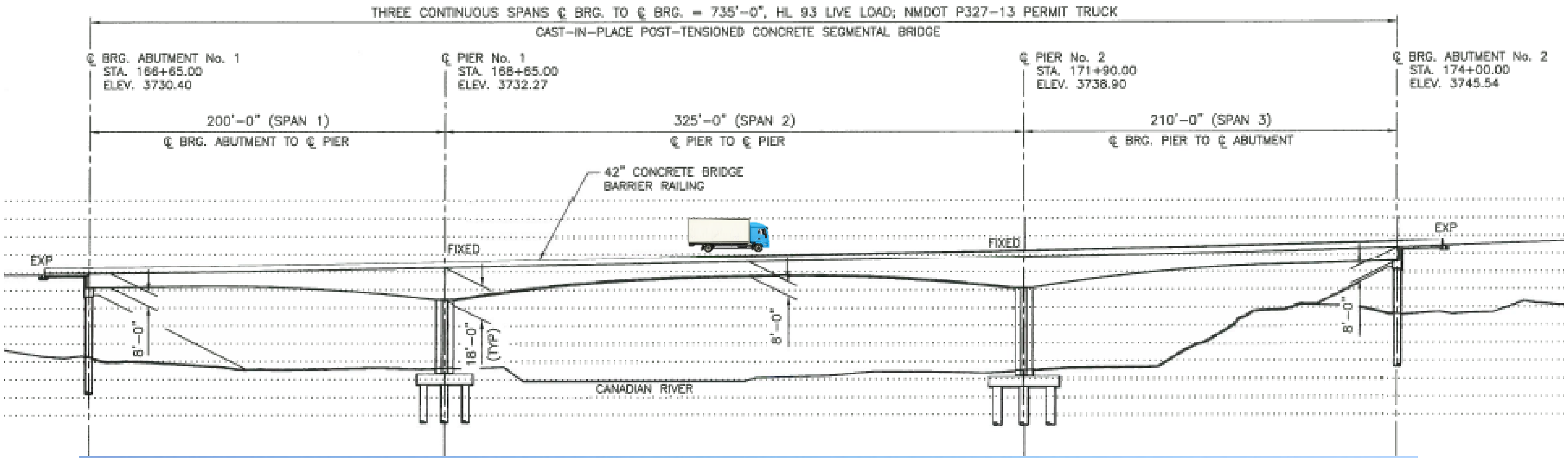
Midas Civil's PSC Bridge Load Rating function uses the below equation [3.2] upon the request of the California Department of Transportation (Caltrans).

$$RF = \frac{C-(\gamma_{DC})(DC)-(\gamma_{DW})(DW)-(\gamma_{T})(T)-(\gamma_{SEC})(SEC)-(\gamma_{P})(P)-(\gamma_{USER})(USER)-(\gamma_{AV})(AV)}{(\gamma_{PV})(PV)} \quad (3.2)$$

McNary Bergeron Longitudinal Construction Analysis – BD2



US 54 Bridge Span Layout



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US 54 Bridge Section

Dep
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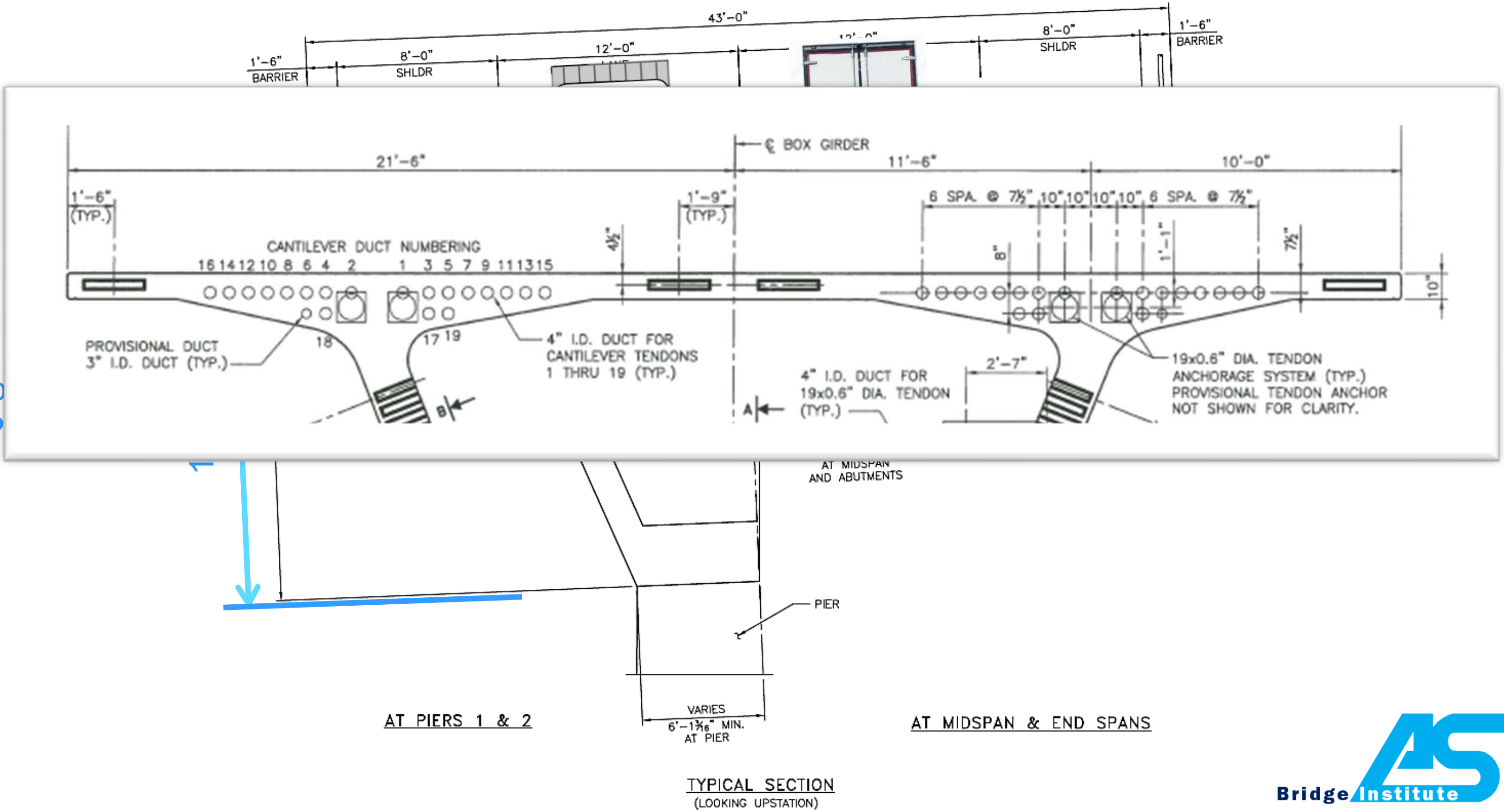
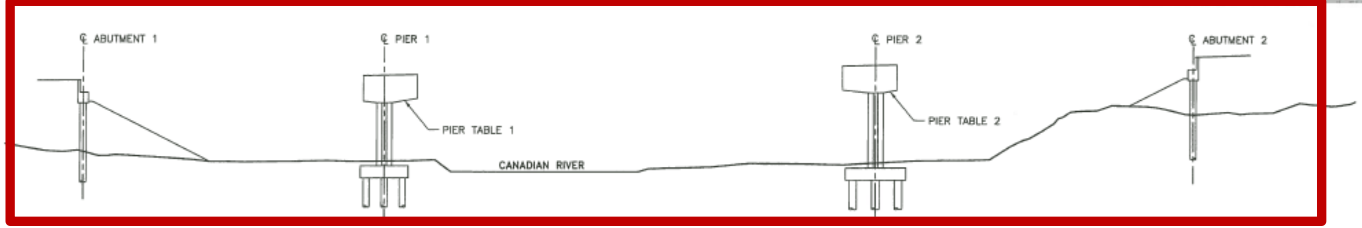


Bridge Institute ASBI

CONTROL No.	SHEET No.
4100401	5-79

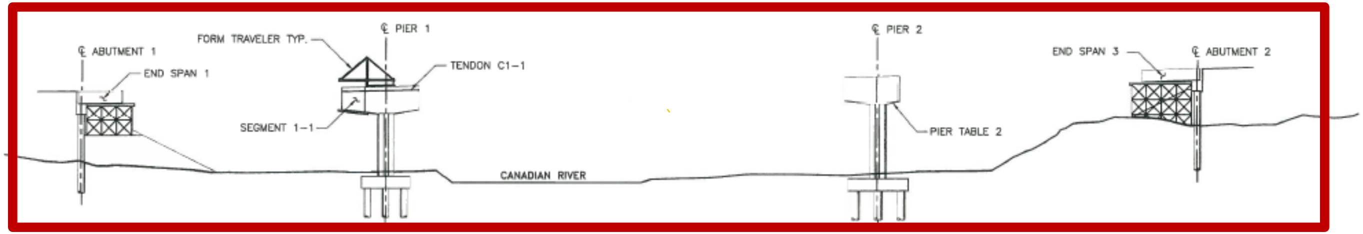


1. CONSTRUCT FOUNDATION, PIER COLUMN AND PIER TABLE AT PIERS 1 AND 2.

NOTE: CONTRACTOR IS RESPONSIBLE FOR MEANS AND METHODS, AND DESIGN OF TEMPORARY FALSEWORK TO CONSTRUCT AND POUR THE PIER TABLE. SUBMIT TEMPORARY FALSEWORK TO NMDOT.(*)

2. CONSTRUCT FOUNDATIONS AT ABUTMENTS 1 AND 2.

NOTE: ABUTMENT AND PIER CONSTRUCTION CAN BE DONE INDEPENDENT OF EACH OTHER AND ORDER CAN BE ADJUSTED TO MEET THE CONTRACTOR'S PROPOSED SCHEDULE AND SEQUENCE.



3. ERECT FORM TRAVELER ON THE PIER TABLE.

4. SET FORMS TO MEET SEGMENT GEOMETRY AND PLACE REINFORCING AND POST–TENSIONING FOR SEGMENT 1–1.

5. CAST SEGMENT 1–1.

6. ONCE CONCRETE STRENGTH REACHES 3500 PSI, STRESS TRANSVERSE TENDONS AND CANTILEVER TENDON C1–1.

NOTE: ORDER OF BALANCED–CANTILEVER PIER CONSTRUCTION AND END SPANS CAN BE DONE INDEPENDENT OF EACH OTHER, AND CAN BE ADJUSTED TO MEET THE CONTRACTOR'S PROPOSED SCHEDULE AND SEQUENCE.

7. CAST END SPANS 1 AND 3 IN–PLACE ON FALSEWORK.

NOTE: CONTRACTOR IS RESPONSIBLE FOR MEANS AND METHODS, AND DESIGN OF TEMPORARY FALSEWORK TO CONSTRUCT AND POUR END SPANS.

CONTRACTOR IS RESPONSIBLE FOR THE STABILITY OF THE STRUCTURE AND TEMPORARY WORKS DURING CONSTRUCTION.

NOTES:

A. THE INFORMATION SHOWN FOR THE CONSTRUCTION SEQUENCE ILLUSTRATES THE ASSUMPTIONS MADE BY THE ENGINEER DURING DESIGN OF THE STRUCTURE. THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE FINAL CONSTRUCTION SEQUENCE WHICH SUITS THE DESIRED MEANS AND METHODS. DETAILS OF THE FINAL CONSTRUCTION SEQUENCE SHALL BE SUBMITTED TO NMDOT FOR REVIEW AND APPROVAL.(*) SEE PROJECT SPECIFICATIONS FOR LIMITATIONS AND ADDITIONAL INFORMATION.

B. THE STRUCTURE HAS BEEN DESIGNED FOR CONSTRUCTION LOADS USING THE ASSUMED CONSTRUCTION SEQUENCE IN ACCORDANCE WITH THE AASHTO LRFD AND AASHTO SEGMENTAL GUIDE SPECIFICATIONS. THE CONTRACTOR IS RESPONSIBLE FOR CHECKING THE STRUCTURE LOADING FOR THE ACTUAL CONSTRUCTION SEQUENCE AND LOADING. SUBMIT A CHECK OF THE ACTUAL SEQUENCE AND LOADING TO NMDOT FOR REVIEW AND APPROVAL.(*)

C. TRAVELER WEIGHT OF 150 KIPS WAS ASSUMED FOR THE DESIGN. ACTUAL TRAVELER WEIGHT AND CONSTRUCTION LOADING IS TO BE EVALUATED AND SUBMITTED BY THE CONTRACTOR FOR APPROVAL BY NMDOT.(*)

(*) SUBMITTALS MUST BE PREPARED BY A PROFESSIONAL ENGINEER LICENSED IN NEW MEXICO WITH 5 YEARS OF SEGMENTAL DESIGN AND CONSTRUCTION EXPERIENCE.

JEFFREY S. MEHLE — NEW MEXICO — 13780 — REGISTERED PROFESSIONAL ENGINEER — 1/12/2017

REVISIONS			
NO.	DESCRIPTION	DATE	BY

NEW MEXICO DEPARTMENT OF TRANSPORTATION

US 54 OVER CANADIAN RIVER

BRIDGE NO. 9747

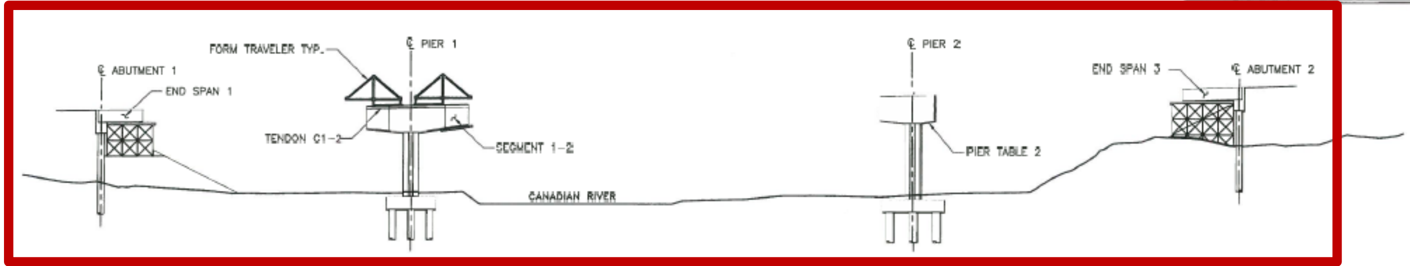
CONSTRUCTION SEQUENCE 1 OF 4

DESIGNED BY: JSM DRAWN BY: AJP CHECKED BY: NJB PLOT DATE: 01/12/17

APPROVED FOR CONSTRUCTION: Kimberly Coleman DATE: 1/13/2017

STA. 166+65.00 SHEET NO. 5-79

CONTROL No.	SHEET No.
4100401	5-80

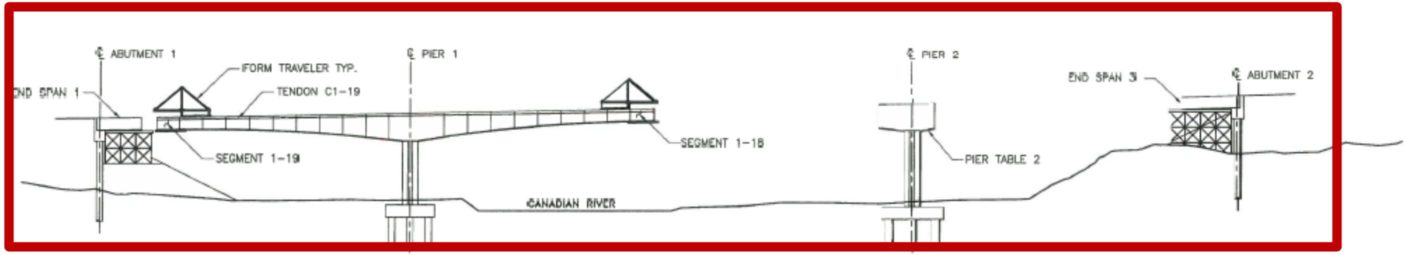


8. ONCE TENDON C1-1 IS STRESSED ADVANCE FORM TRAVELER ONTO SEGMENT 1-1 TO PROVIDE ROOM ON THE PIER TABLE TO ERECT THE SECOND FORM TRAVELER.

9. SET FORMS TO MEET SEGMENT GEOMETRY AND PLACE REINFORCING AND POST-TENSIONING FOR SEGMENT 1-2.

10. CAST SEGMENT 1-2.

11. ONCE CONCRETE STRENGTH REACHES 3500 PSI, STRESS TRANSVERSE TENDONS AND CANTILEVER TENDON C1-2.



12. CONTINUE SEQUENCE OF CASTING THROUGH SEGMENT 1-19, ALTERNATING CASTING ON EACH CANTILEVER END TO MINIMIZE CANTILEVER LOADING TO NO MORE THAN ½ SEGMENT OUT-OF-BALANCE.

TYPICAL ERECTION SEQUENCE ASSUMED IS:

	DOWNSTATION CANTILEVER	UPSTATION CANTILEVER
STEP 1	ADVANCE TRAVELER, TO CAST NEXT DOWNSTATION SEGMENT	FINAL SETUP FOR CASTING NEXT UPSTATION SEGMENT
STEP 2		CAST UPSTATION SEGMENT
STEP 3	INSTALL AND STRESS POST-TENSIONING	
STEP 4	FINAL SETUP FOR CASTING NEXT DOWNSTATION SEGMENT	ADVANCE TRAVELER, TO CAST NEXT UPSTATION SEGMENT
STEP 5	CAST DOWNSTATION SEGMENT	
STEP 6	INSTALL AND STRESS POST-TENSIONING	

JEFFREY S. MEHLE
NEW MEXICO
17290
REGISTERED PROFESSIONAL ENGINEER
1/12/2017

BRIDGE

REVISIONS

NO.	DESCRIPTION	DATE	BY

NEW MEXICO DEPARTMENT OF TRANSPORTATION

US 54
OVER CANADIAN RIVER
BRIDGE NO. 9747

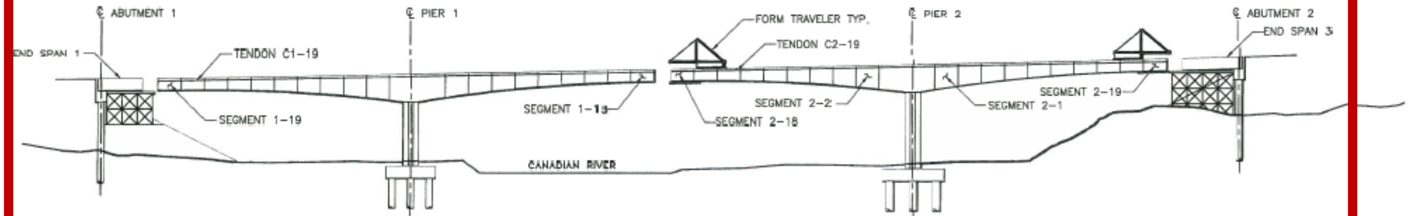
CONSTRUCTION SEQUENCE 2 OF 4

STA. 166+65.00 SHEET NO. 5-80

DESIGNED BY: JSM DRAWN BY: AJP CHECKED BY: NJB PLOT DATE: 01/12/17

APPROVED FOR CONSTRUCTION: Kimberly Coleman DATE: 1/13/2017

SHEET No. 5-81

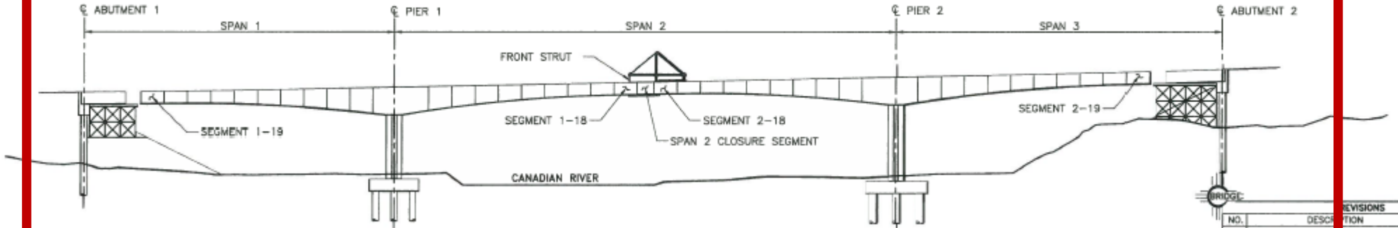


13. AFTER TENDON C1-19 IS STRESSED, REMOVE FORM TRAVELERS. REMOVE THE FORM TRAVELER ON SEGMENT 1-19 FIRST.

14. REPEAT PROCESS FOR CASTING CANTILEVER 2. CONTINUE SEQUENCE FOR SEGMENT 2-1 THROUGH SEGMENT 2-19, ALTERNATING CASTING ON EACH CANTILEVER END TO MINIMIZE CANTILEVER LOADING TO NO MORE THAN ½ SEGMENT OUT-OF-BALANCE.

TYPICAL ERECTION SEQUENCE ASSUMED IS:

	DOWNSTATION CANTILEVER	UPSTATION CANTILEVER
STEP 1	ADVANCE TRAVELER, TO CAST NEXT DOWNSTATION SEGMENT	FINAL SETUP FOR CASTING NEXT UPSTATION SEGMENT
STEP 2		CAST UPSTATION SEGMENT
STEP 3	INSTALL AND STRESS POST-TENSIONING	
STEP 4	FINAL SETUP FOR CASTING NEXT DOWNSTATION SEGMENT	ADVANCE TRAVELER, TO CAST NEXT UPSTATION SEGMENT
STEP 5	CAST DOWNSTATION SEGMENT	
STEP 6	INSTALL AND STRESS POST-TENSIONING	



15. AFTER TENDON C2-19 IS STRESSED, REMOVE FORM TRAVELER FROM SEGMENT 2-19.

16. LAUNCH TRAVELER SOUTH TO POUR SPAN 2 CLOSURE SEGMENT. TRANSFER HALF OF THE TRAVELER WEIGHT TO CANTILEVER 1 THROUGH FRONT STRUT.

17. IF REQUIRED, ALIGN CANTILEVERS FOR SPAN 2. ALIGNMENT FORCE AND ASSOCIATED DISPLACEMENTS MUST BE SUBMITTED AND APPROVED BY NMDOT PRIOR TO ALIGNING.(*)

18. SET FORMS AND PLACE REINFORCING AND POST-TENSIONING FOR THE SPAN 2 CLOSURE SEGMENT.

19. CAST CLOSURE SEGMENT IN SPAN 2.

20. ONCE CONCRETE STRENGTH REACHES 3500 PSI, STRESS TRANSVERSE TENDONS IN CLOSURE SEGMENT AND TWO PAIRS AND BOTTOM SLAB CONTINUITY TENDONS IN SPAN 2. ONCE THE CONCRETE STRENGTH REACHES 5,500 PSI REMAINING BOTTOM SLAB CONTINUITY TENDONS IN SPAN 2 CAN BE STRESSED. STRESS TENDON B2-7 FIRST.

(*) SUBMITTALS MUST BE PREPARED BY A PROFESSIONAL ENGINEER LICENSED IN NEW MEXICO WITH 5 YEARS OF SEGMENTAL DESIGN AND CONSTRUCTION EXPERIENCE.

NO.	DESCRIPTION	DATE	BY

NEW MEXICO DEPARTMENT OF TRANSPORTATION

US 54 OVER CANADIAN RIVER

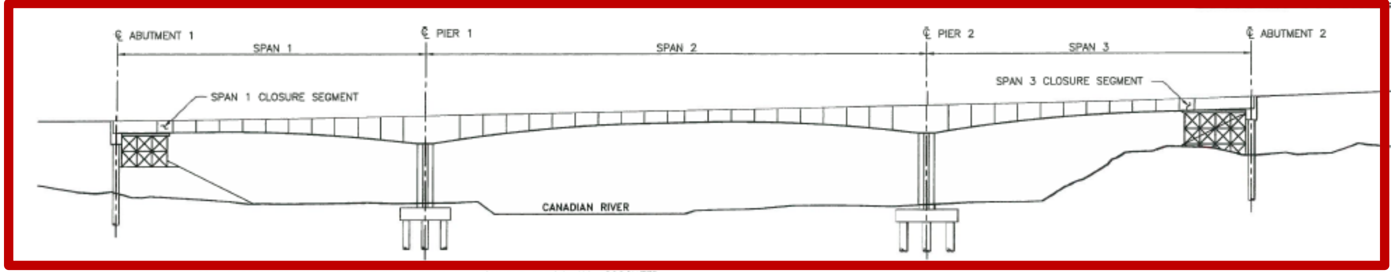
BRIDGE NO. 9747

CONSTRUCTION SEQUENCE 3 OF 4

DESIGNED BY: JSM DRAWN BY: AJP CHECKED BY: NJB PLOT DATE: 01/12/17

APPROVED FOR CONSTRUCTION: Kimberly Coleman DATE: 1/13/2017

STA. 168+65.00 SHEET NO. 5-81



22. IF REQUIRED, ALIGN CANTILEVER IN SPAN 1. ALIGNMENT FORCE AND ASSOCIATED DISPLACEMENTS MUST BE SUBMITTED AND APPROVED BY NMDOT PRIOR TO ALIGNING.(*)

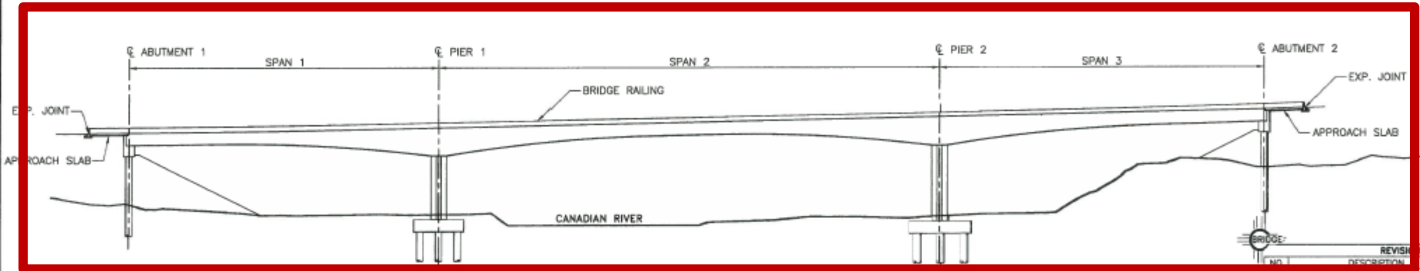
23. SET FORMS AND PLACE REINFORCING AND POST-TENSIONING FOR THE SPAN 1 CLOSURE SEGMENT.

24. CAST CLOSURE SEGMENT IN SPAN 1.

25. ONCE CONCRETE STRENGTH REACHES 3500 PSI, STRESS TRANSVERSE TENDONS IN CLOSURE SEGMENT AND TWO PAIRS OF BOTTOM SLAB CONTINUITY TENDONS IN SPAN 1. ONCE THE CONCRETE REACHES 5,500 PSI REMAINING BOTTOM SLAB CONTINUITY TENDONS CAN BE STRESSED. STRESS TENDON B1-6 FIRST.

26. REMOVE END SPAN 1 FALSEWORK.

27. REPEAT PROCESS FOR SPAN 3.



28. INSTALL EXPANSION JOINTS AT ABUTMENTS 1 AND 2.

29. CAST BRIDGE RAILING PER NMDOT STANDARD DRAWING 514-03-1/6 THRU 6/6.

30. APPLY POLYESTER CONCRETE OVERLAY AS A LEVELING COURSE AND JOINT SEALER.

(*) SUBMITTALS MUST BE PREPARED BY A PROFESSIONAL ENGINEER LICENSED IN NEW MEXICO WITH 5 YEARS OF SEGMENTAL DESIGN AND CONSTRUCTION EXPERIENCE.

JEFFREY S. MEHLE — NEW MEXICO — 13250 — REGISTERED PROFESSIONAL ENGINEER

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NO.	DESCRIPTION	DATE	BY

NEW MEXICO DEPARTMENT OF TRANSPORTATION

US 54
OVER CANADIAN RIVER
BRIDGE NO. 9747

CONSTRUCTION SEQUENCE 4 OF 4

DESIGNED BY: JSN DRAWN BY: AJP CHECKED BY: NJB PLOT DATE: 01/12/17

APPROVED FOR CONSTRUCTION: Kimberly Coleman DATE: 1/13/2017

STA. 166+65.00 SHEET NO. 5-82

Construction Engineering Support

US54 Canadian River Bridge
Concrete Repair Plan
Hannah Jo Beach, Age 6

- Comprehensive Concrete Repair Plan
- Post-Tensioning and Grouting Support
- Geometry Control QA
- Top of Deck LiDAR Scan and Heat Map

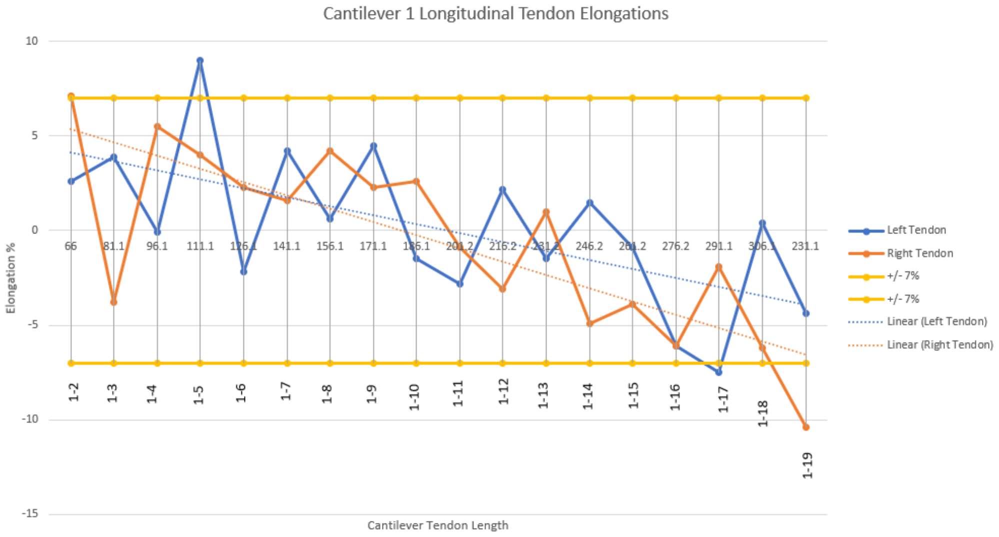
Comprehensive Concrete Repair Plan

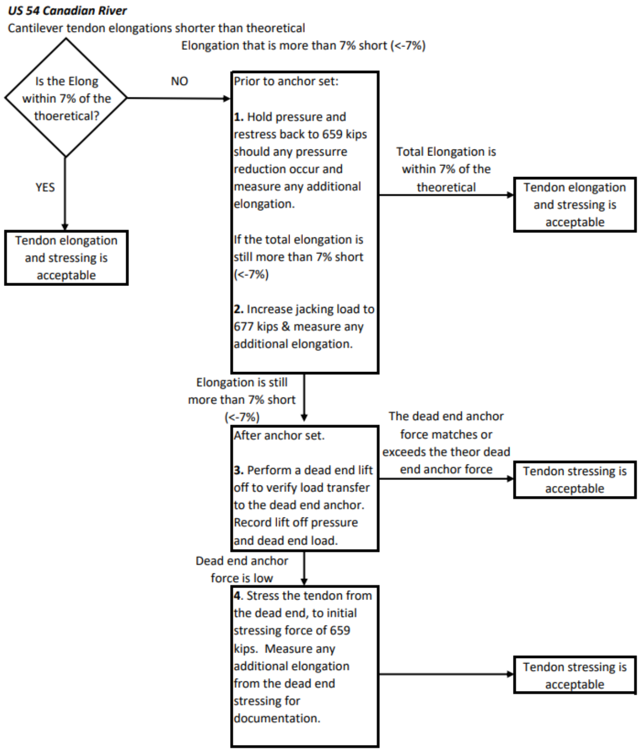
Figure 5: Photograph of Segment 2-1 overlaid with Impact Echo results. Yellow circles indicate questionable conditions, and red circles indicate poor conditions. The points that do not have circles are sound conditions. The horizontal measurements are measured from the south joint, which is the left side of the photograph.

- Project Concrete Repair Plan identified approved products for repair and acceptable limits for on-site repair without further engineering review.

- More significant concrete repairs involved project team coordination and, when necessary, advanced investigation such as NDT.

Post-Tensioning and Grouting Support





5:

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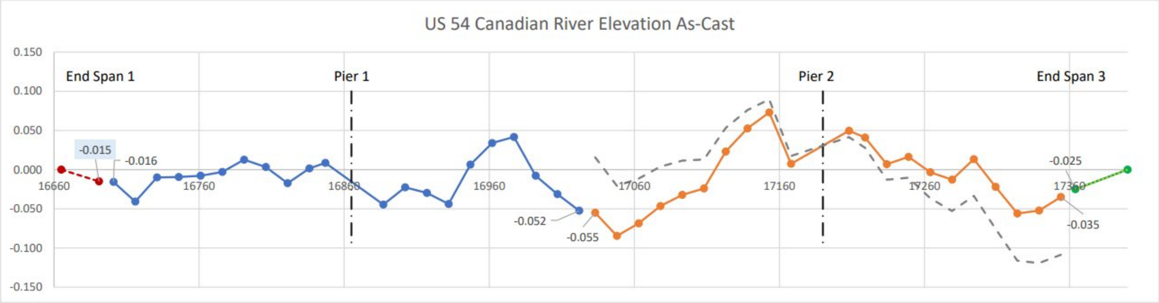
Geometry Control QA

- McNary Bergeron performed Geometry Control for Segmental Construction.
- Jacobs provided Geometry Control QA and Geometry Control Survey QA.



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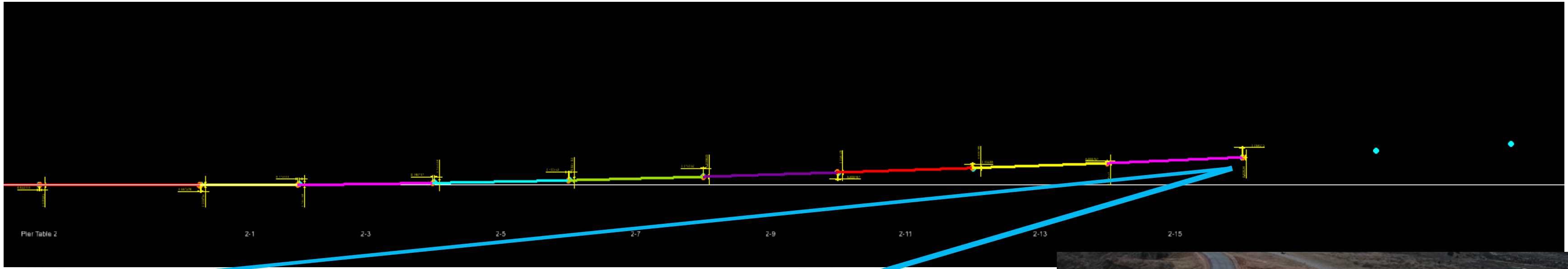
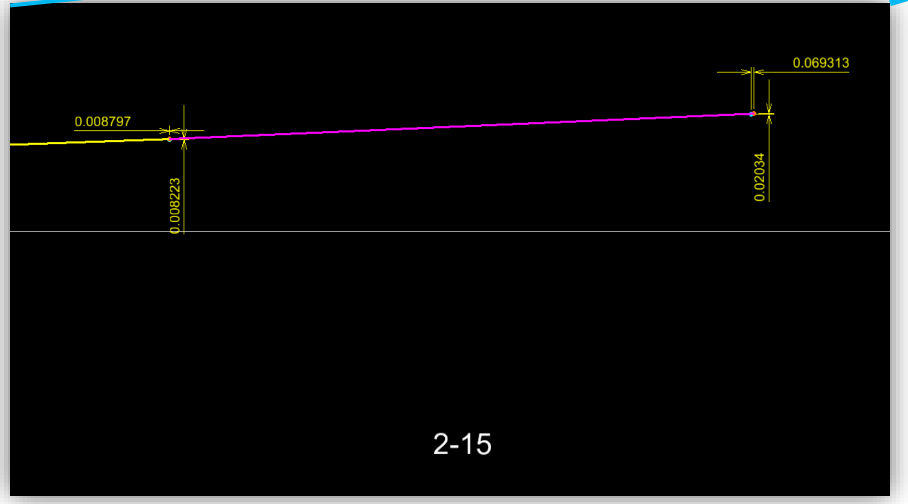
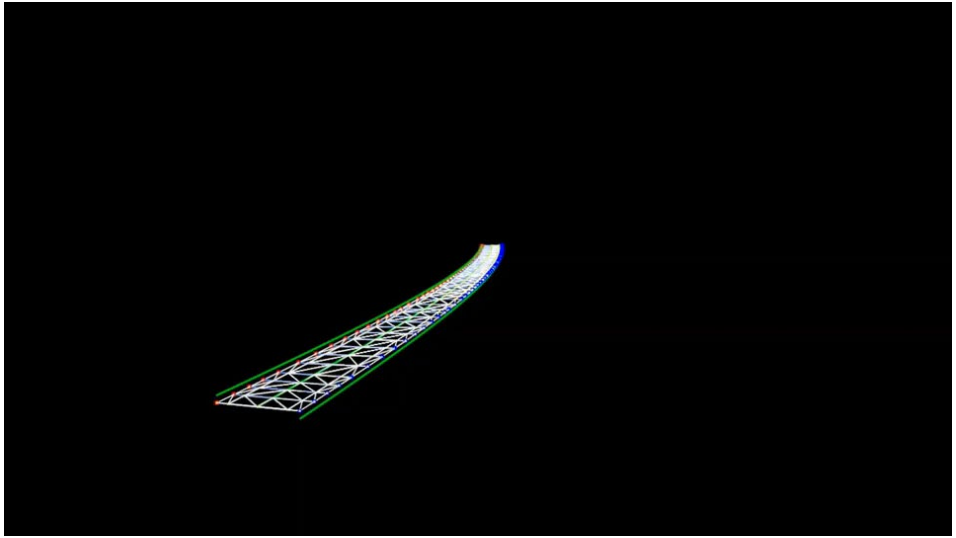
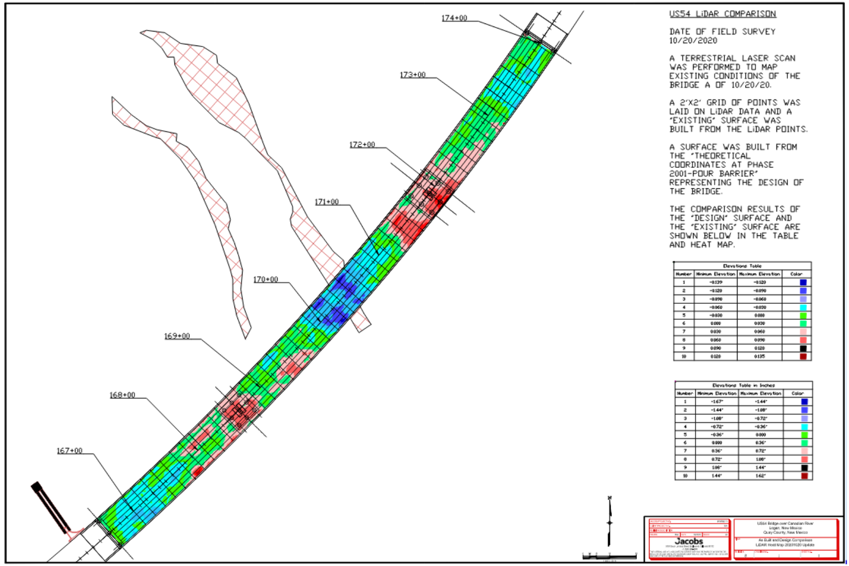
Horizontal Geometry Control QA





Top of Deck LiDAR Scan and Heat Map





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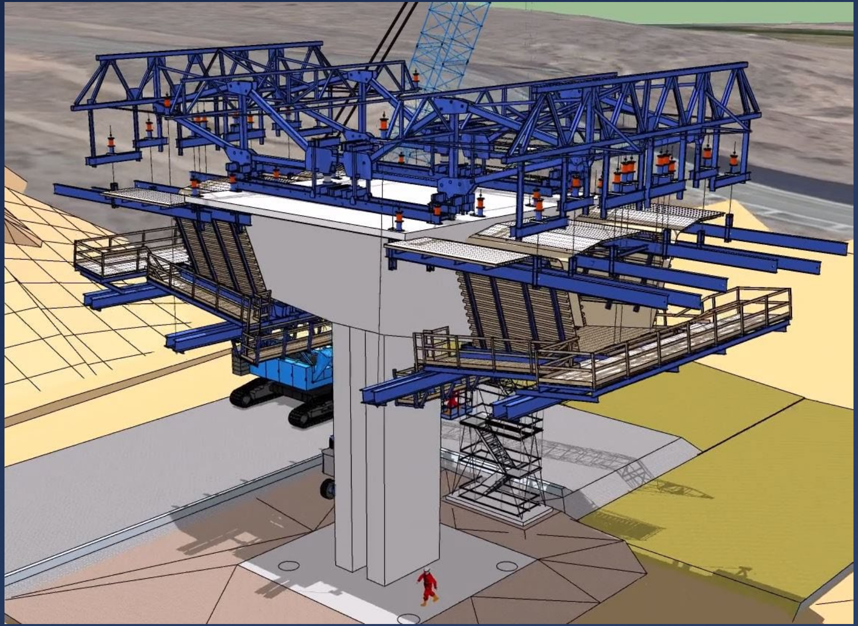
Construction Challenges: Local Workforce Training



Malcolm Segment Rebar Mockup and Form Traveler Sketch-Up Models

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Construction Challenges: Weather

Tuesday

Wednesday

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ASBI

Construction Challenges: Ready-Mix Concrete Supply

- Pacheco Construction & Trucking
- Dry-Batch Facility
- NMDOT Approved Supplier in Tucumcari

Batch Plant Relocated to Logan

US54 Construction Photos

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Pier Table and Form Travelers at Cantilever 1

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Cantilever 1

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Construction of Pier Table 2 during the casting of Cantilever 1

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Cantilever 2

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Span 2 Closure

Span 2 Closure

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Canadian
River

Collaboration and Teamwork

Design

NMDOT ● Jacobs ● FHWA

Construction

- Jacobs: NMDOT's Engineer, Phase III Services
- NMDOT and FHWA: Project Oversight
- Fisher Sand and Gravel: Prime Contractor
- Malcolm International: Bridge Subcontractor
- McNary Bergeron: Malcolm's Engineer

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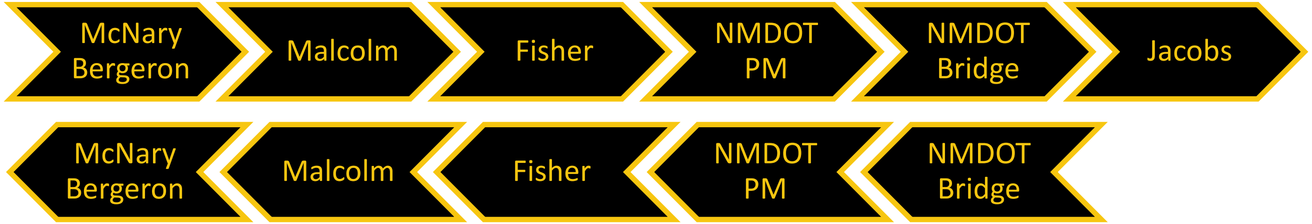
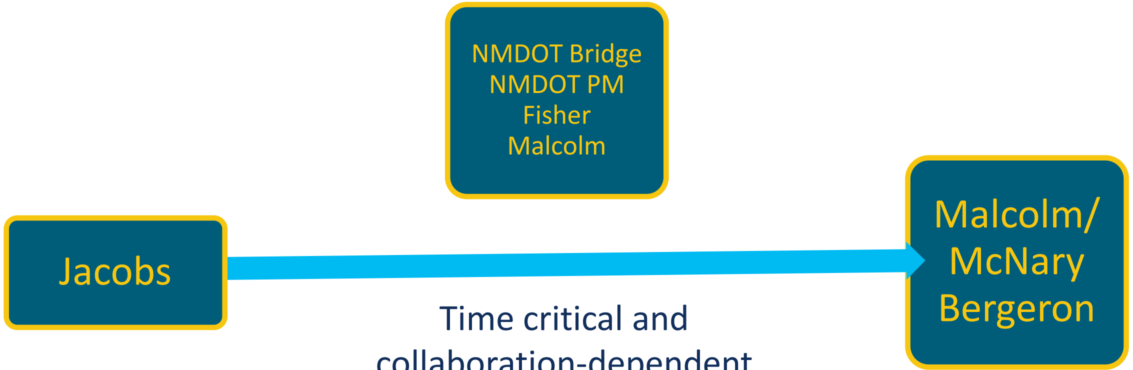
Collaboration and Teamwork

Official Line of Communication for the project. Critical for ensuring that full team is informed, and decisions are documented





Time critical and collaboration-dependent items required variation (with approval) for efficiency.

"This is YOUR Bridge"
Logan School District Presentation

Teaming with ASBI

June 12, 2019: ASBI provided on-site grouting training in Logan NM with NMDOT engineers and inspectors

Special thanks to:

Gregg Freeby

Greg Hunsicker

Brian Merrill

Ingrid Ramsey

American Segmental Bridge Institute

Existing US54 Steel Deck Truss Bridge Demo

Challenges Include:

- Lead Paint Mitigation
- Protection of Sensitive Environmental Wetlands
- <u>Safety</u>

American Segmental Bridge Institute

Thank you for your time!

QUESTIONS?

This concludes the educational content of this activity

Kimberly.Coleman@state.nm.us

Nyssa.Beach@jacobs.com

New Mexico DEPARTMENT OF TRANSPORTATION
MOBILITY FOR EVERYONE

Jacobs

Challenging today.
Reinventing tomorrow.

American Segmental Bridge Institute ASBI