Innovative Steel Erection Procedure for a Curved Girder Viaduct Over Water and Soft Soils

Jersey City and Kearny
Hudson County, New Jersey

Presented to the

Association for Bridge Construction and Design

Susquehanna Chapter

September 6, 2017

By
Michael Marks, PE
EIC Group LLC, Fairfield, New Jersey

Originally Presented at the
International Bridge Conference
National Harbor, Maryland
June 2017

Project Location

Route 7 Wittpenn Bridge over the Hackensack River

Project Location

Route 7 Wittpenn Bridge over the Hackensack River

Project Description

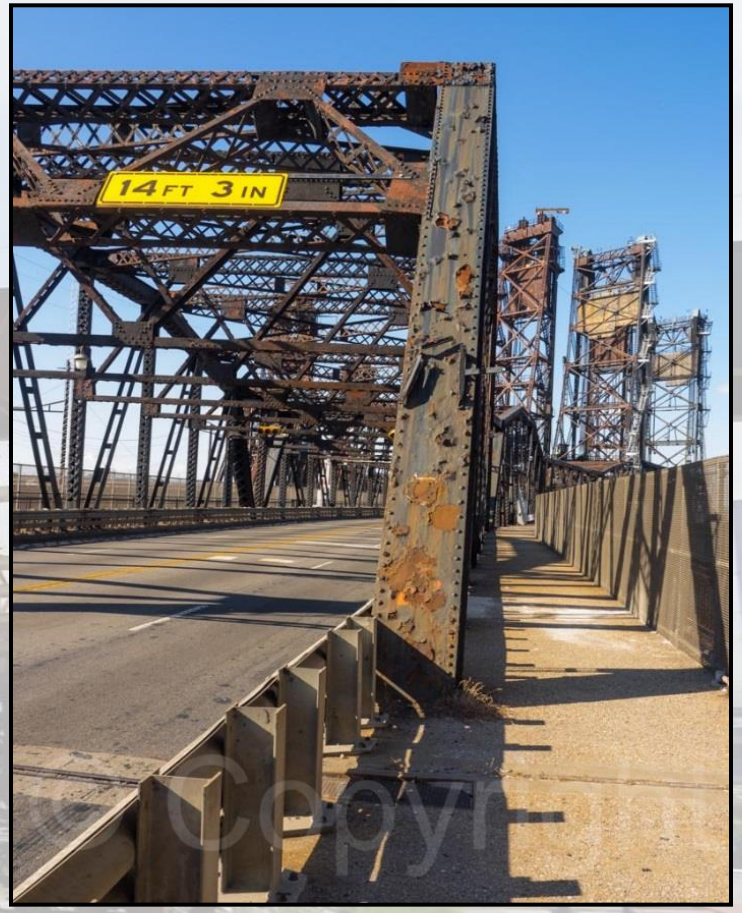
- Existing Structure
  - Originally built in 1930
  - Approximately 2200’ long
  - Carried two (2) lanes of traffic in each direction linking Kearny and Jersey City, NJ
  - Named for H. Otto Wittpenn, a former mayor of Jersey City.

Project Description

- Existing Bridge
  - Fourteen (14) Deck plate girder approach spans
  - Two (2) fixed Camelback through trusses and a Pratt through truss
  - Vertical lift span consisting of a 210’ skewed Parker Truss, located over the shipping channel.
  - Shares foundations with railroad bridge

Project Description

- Existing Bridge
  - The structure is structurally as well as functionally obsolete due its insufficient clearance and narrow 10’ lanes.



EIC Group LLC

STRUCTURAL SERVICES

union paving & Construction Co., Inc.

Project Description

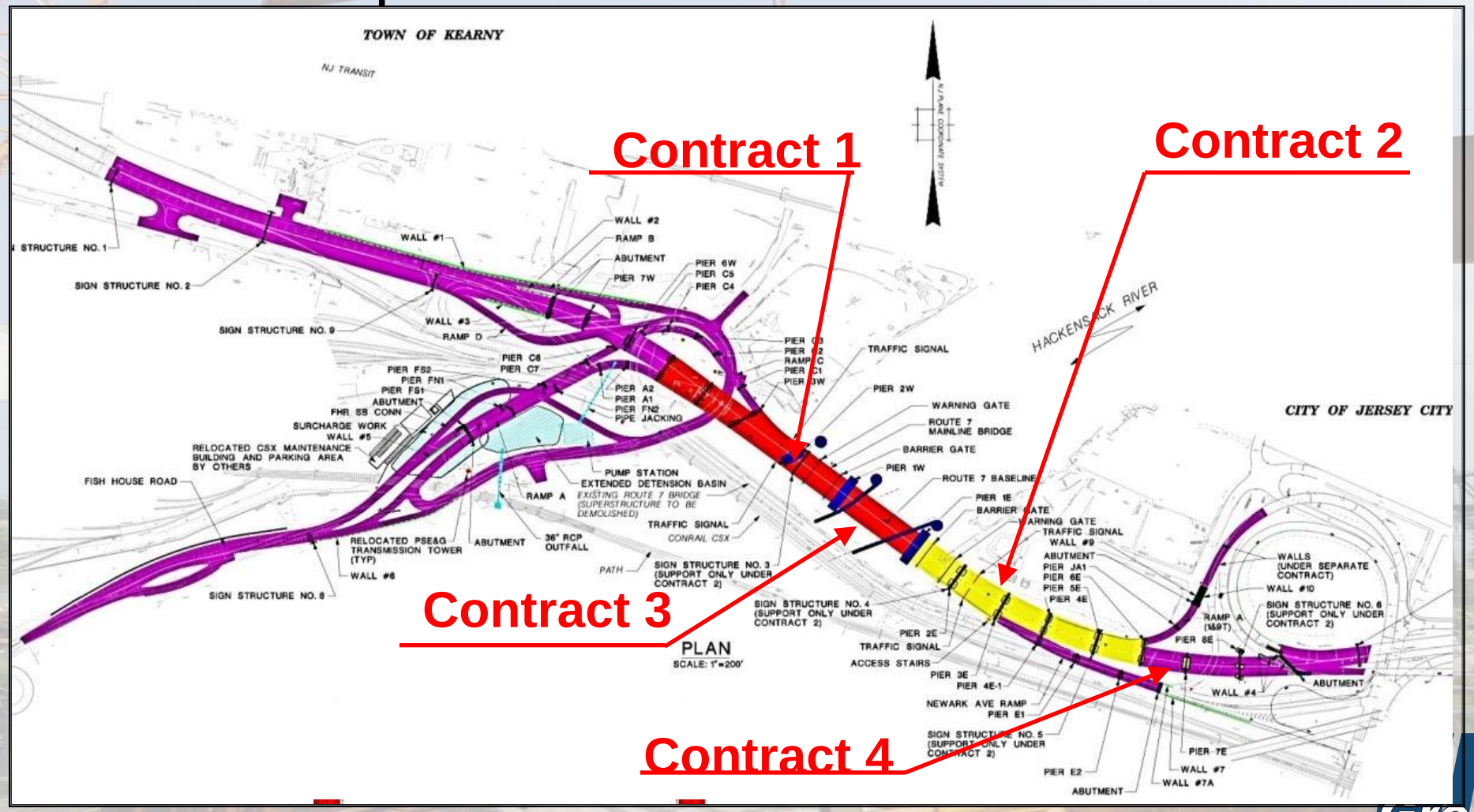
- Proposed Structure
  - To be located just to the north of the existing.
  - Will consist of steel multiple plate girder approach spans supporting a concrete deck with an overall length of 3300’.
  - Main span to be a 325’ long box girder lift structure.
  - Wider bridge will carry three (3) 12’ lanes, and an 8’ to 10’ right shoulders.

Project Description

- Proposed Structure
  - The bridge is being constructed in four (4) major contracts:
    - Contract 1: The river piers and fender system. Completed December 2014.
    - Contract 2: Eastern approach span superstructures for Units 4, 5 and 6 and associated piers. Completed in January 2016.
    - Contract 3: Western approach spans and vertical lift span. Currently under construction.
    - Contract 4: Tie-in spans and roadways to Route 7 at the limits of the project. Estimated to be awarded Summer 2017.

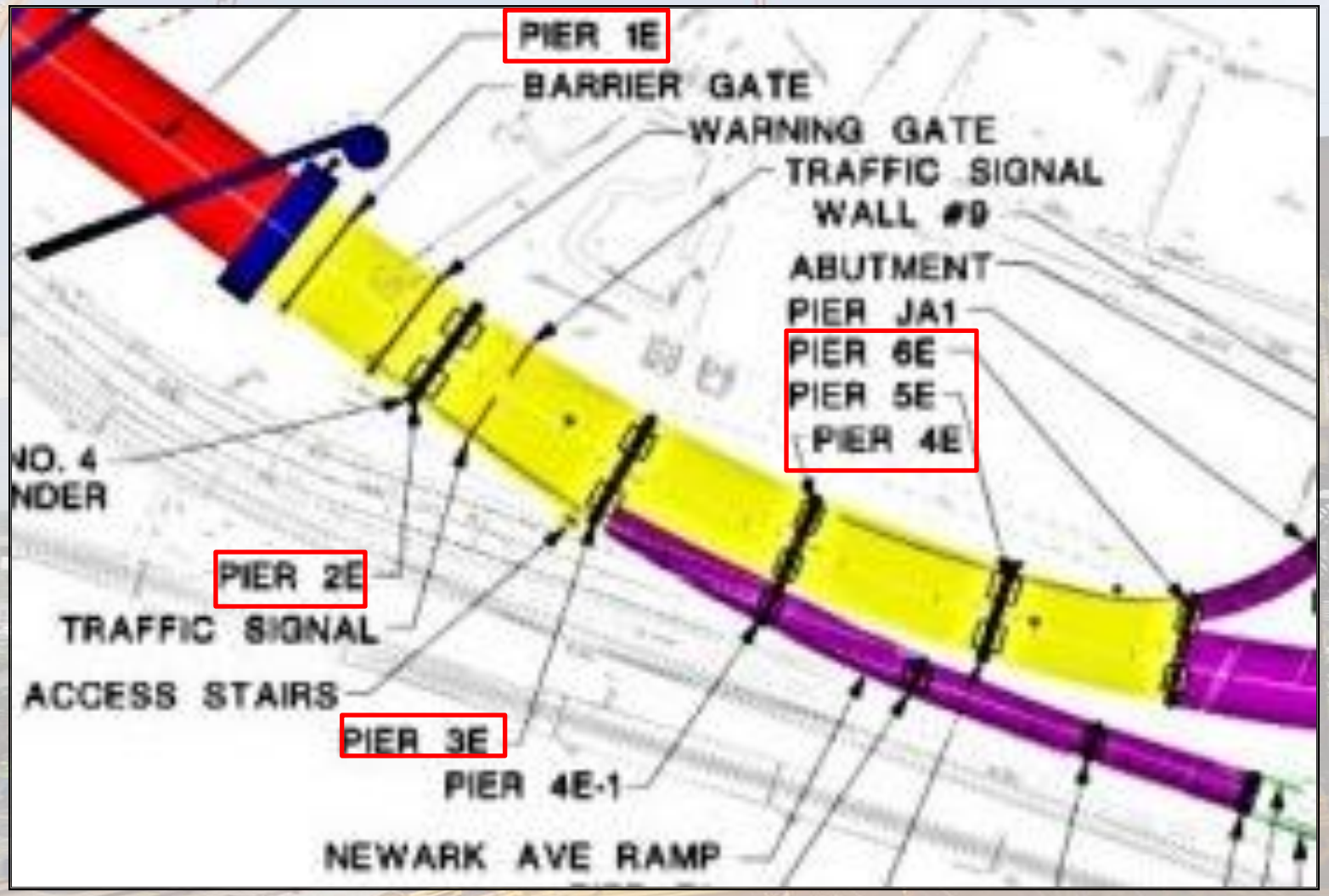
Project Description

- Proposed Structure



Project Description

- Proposed Structure – Contract 2

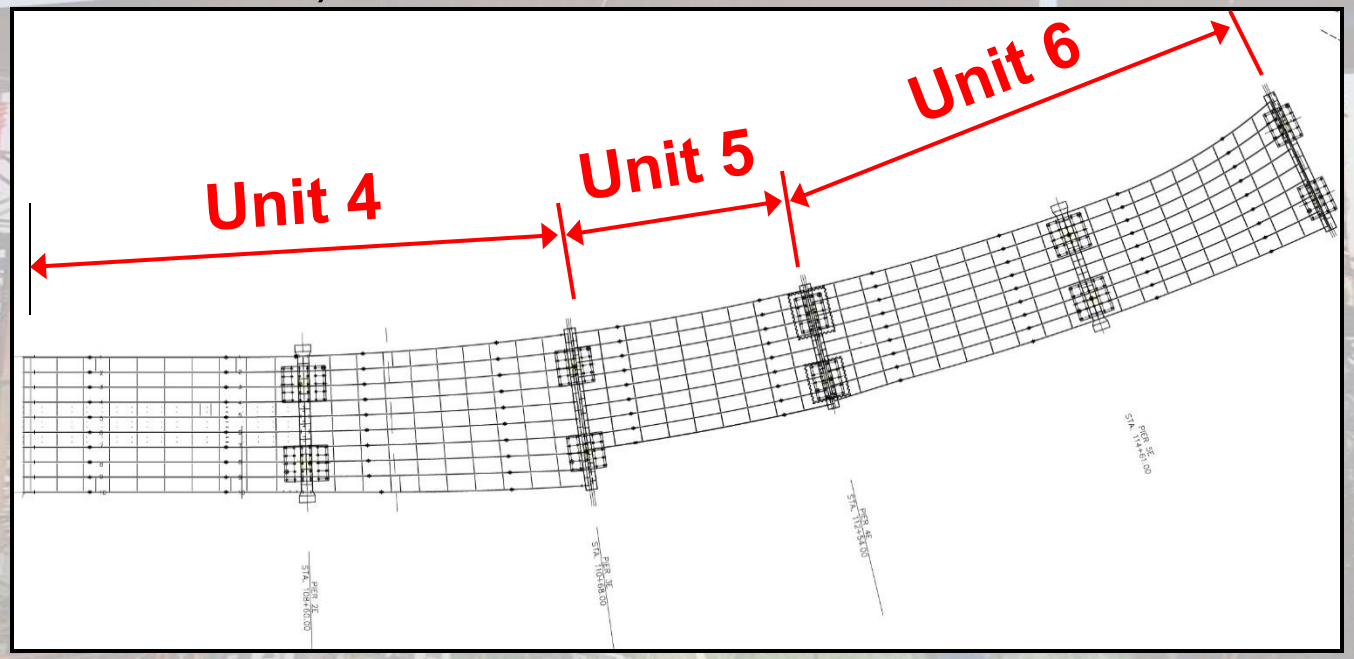


Project Description

- Contract 2
  - July 2012 - Union Paving & Construction Company, Mountainside, NJ was the low bidder at $33,200,000 and became the General Contractor for the Contract 2 project.
  - Structural Services Inc., Bethlehem, PA, was awarded the subcontract to perform the steel erection.
  - EIC Group LLC, Fairfield, NJ was retained by Structural Services to perform the erection engineering and related geotechnical design.

Project Description

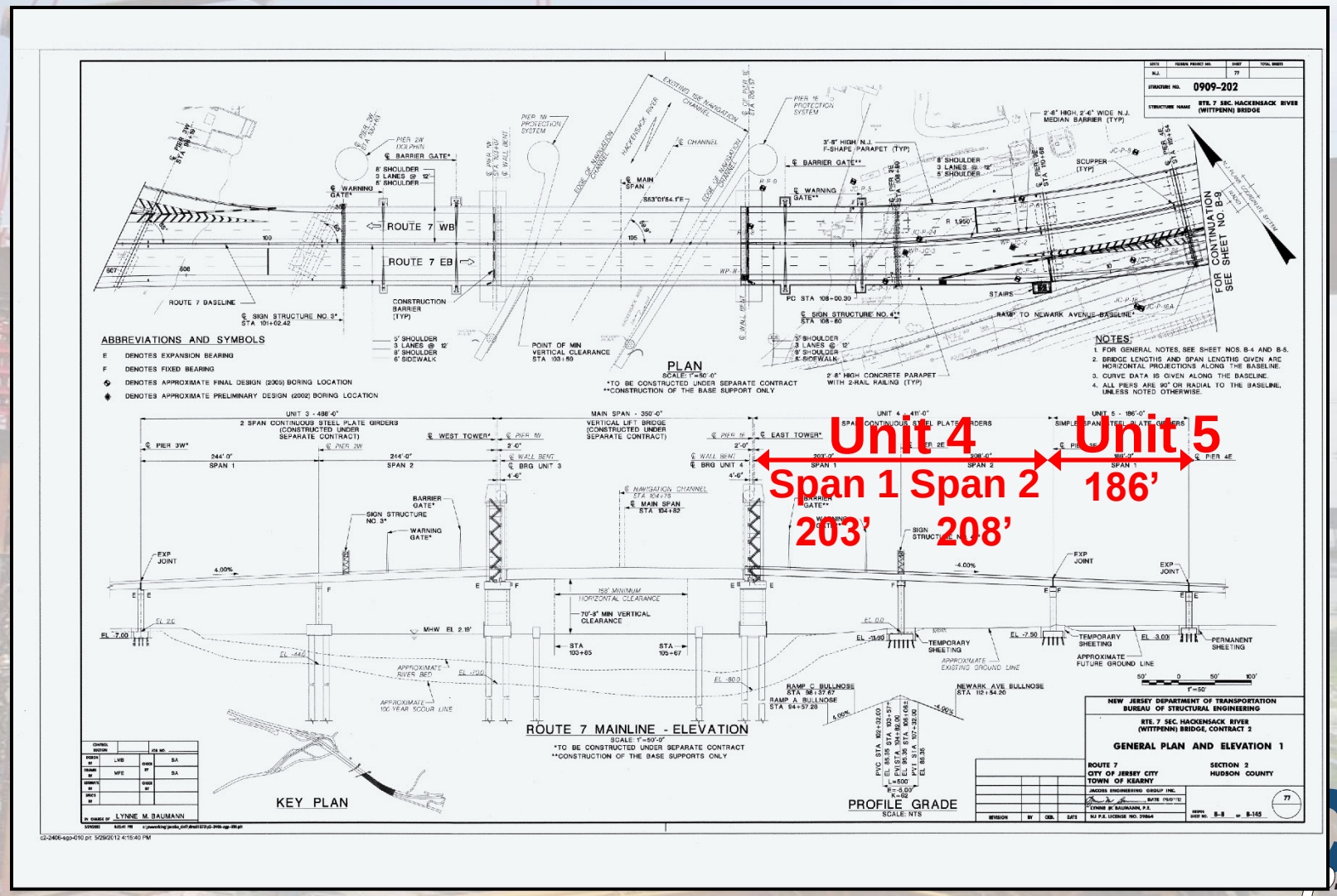
- Contract 2
  - Consists of three (3) structural units:
    - Unit 4, 5 and 6



Contract 2 Superstructure Framing Plan

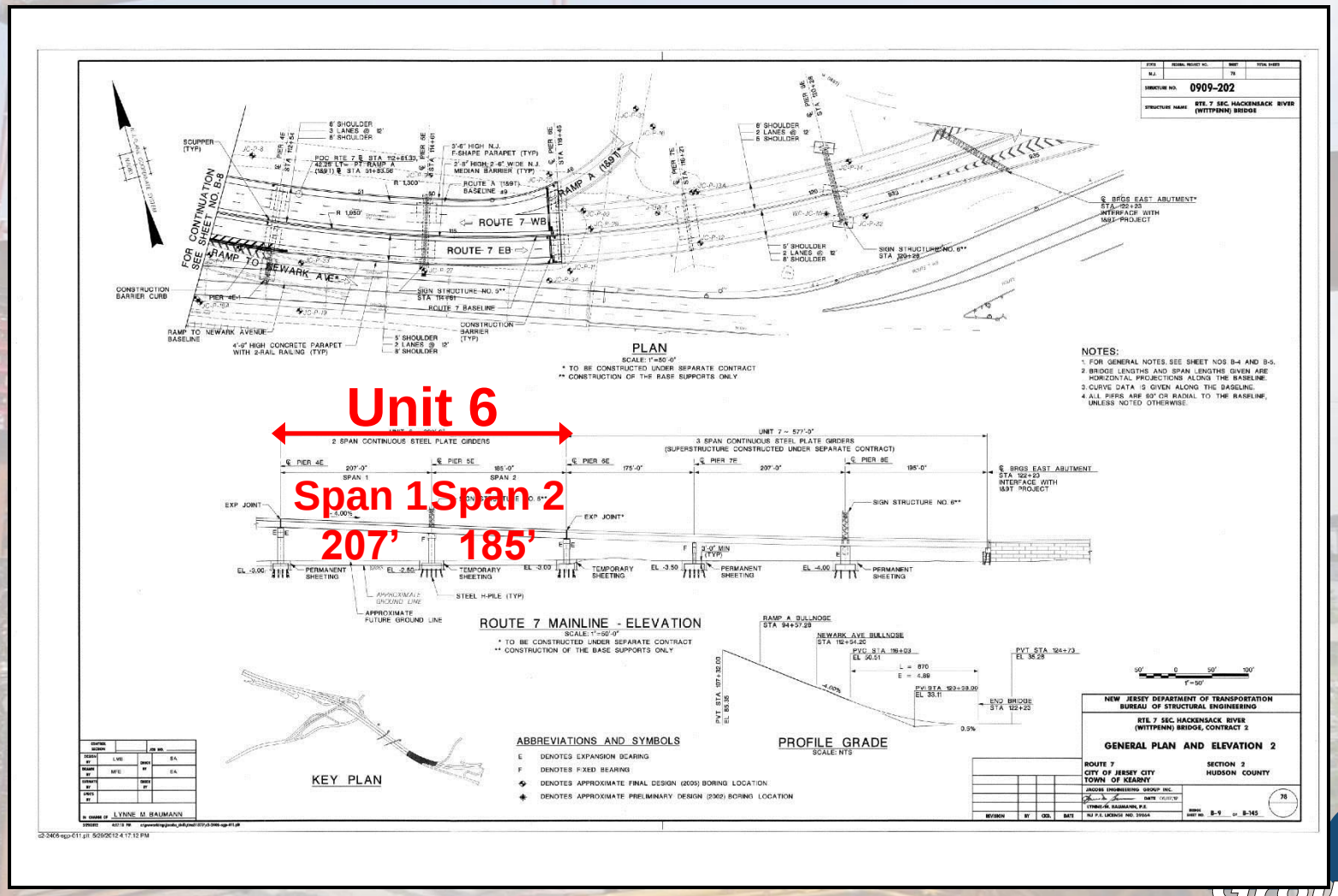
Project Description

- Contract 2



Project Description

- Contract 2



STRUCTURAL SERVICES

union paving & Construction Co., Inc.

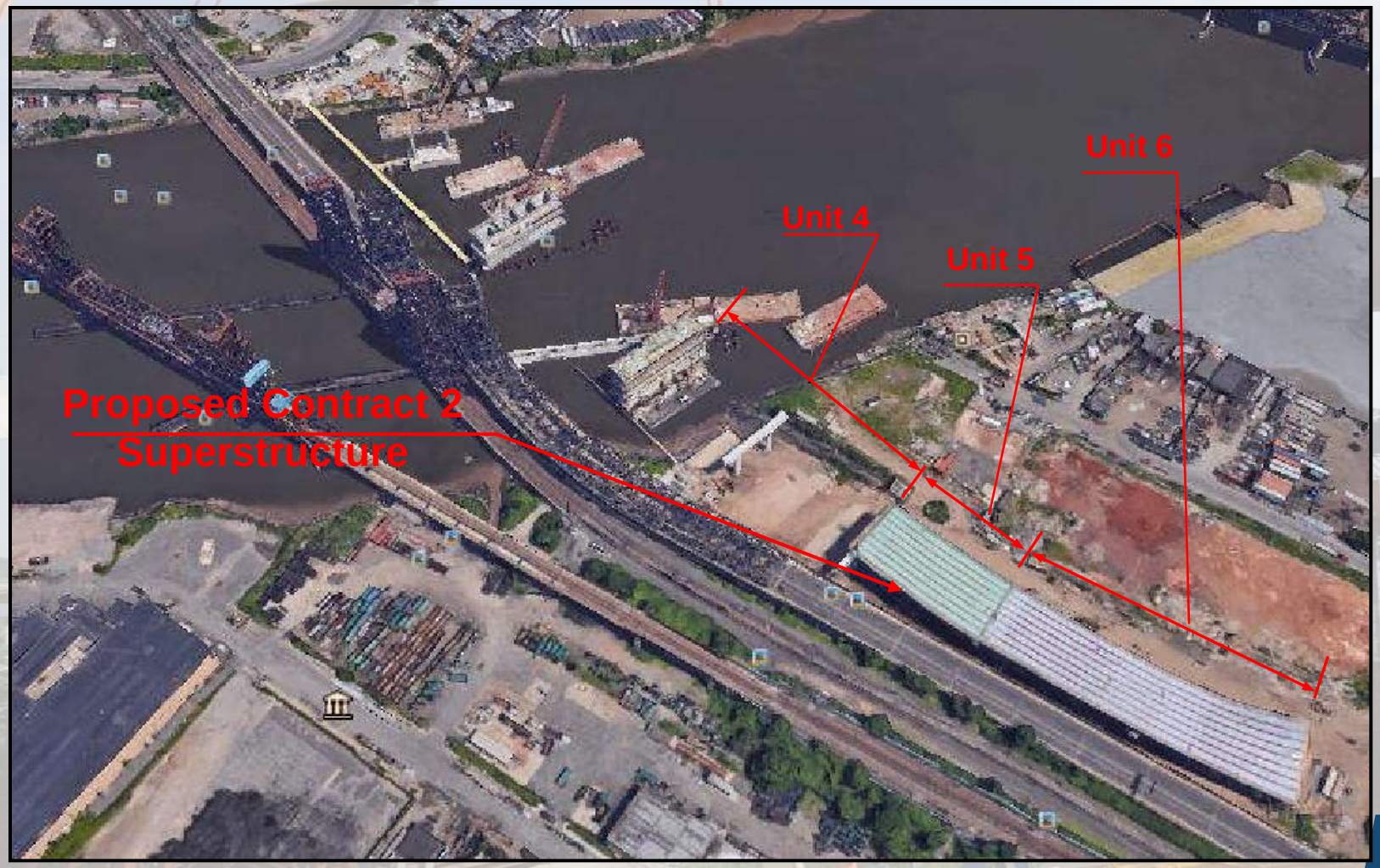
Project Description

- Contract 2

Existing Site -2010

Project Description

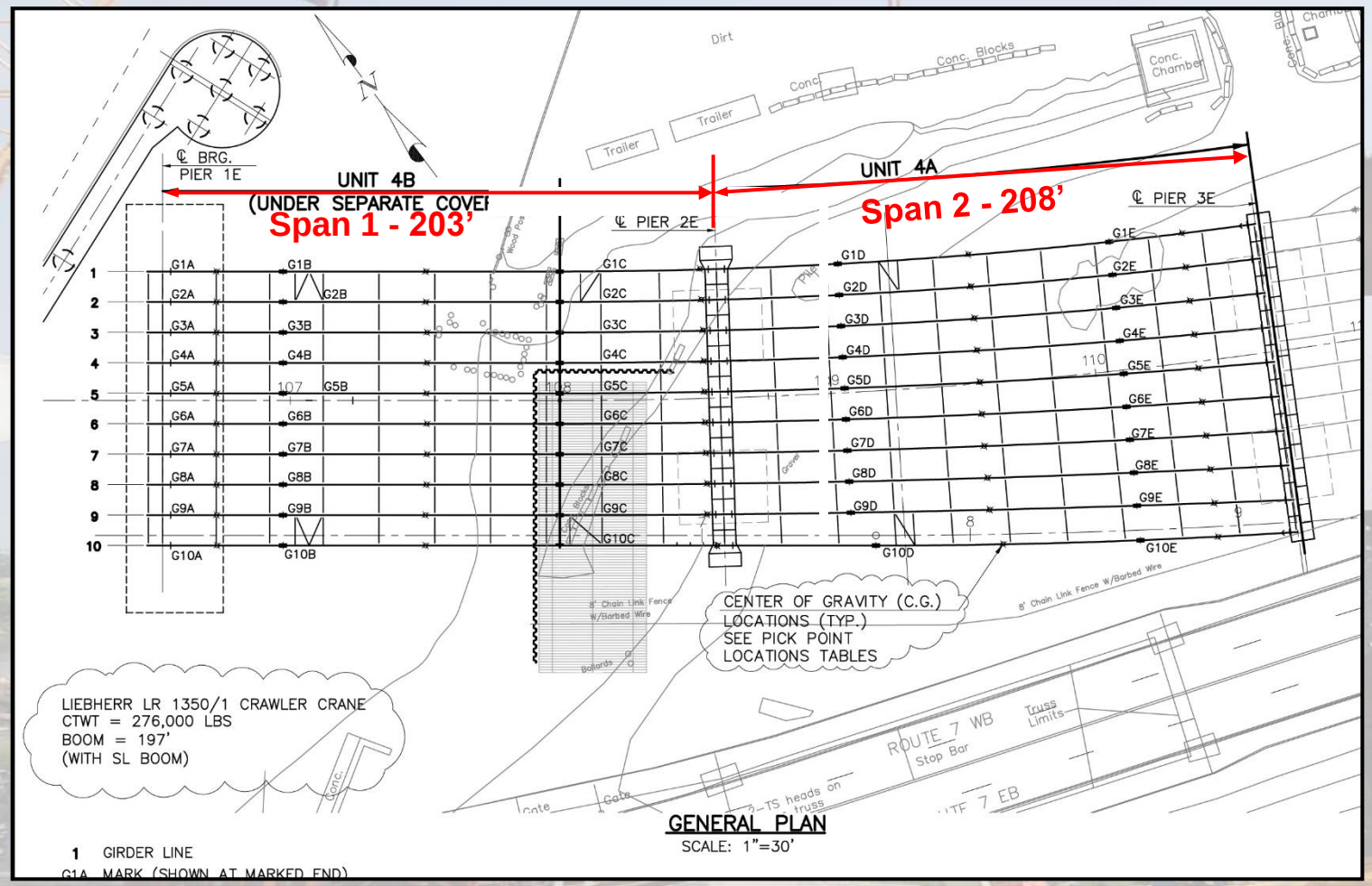
- Contract 2



Location of Units 4, 5 and 6

Project Description

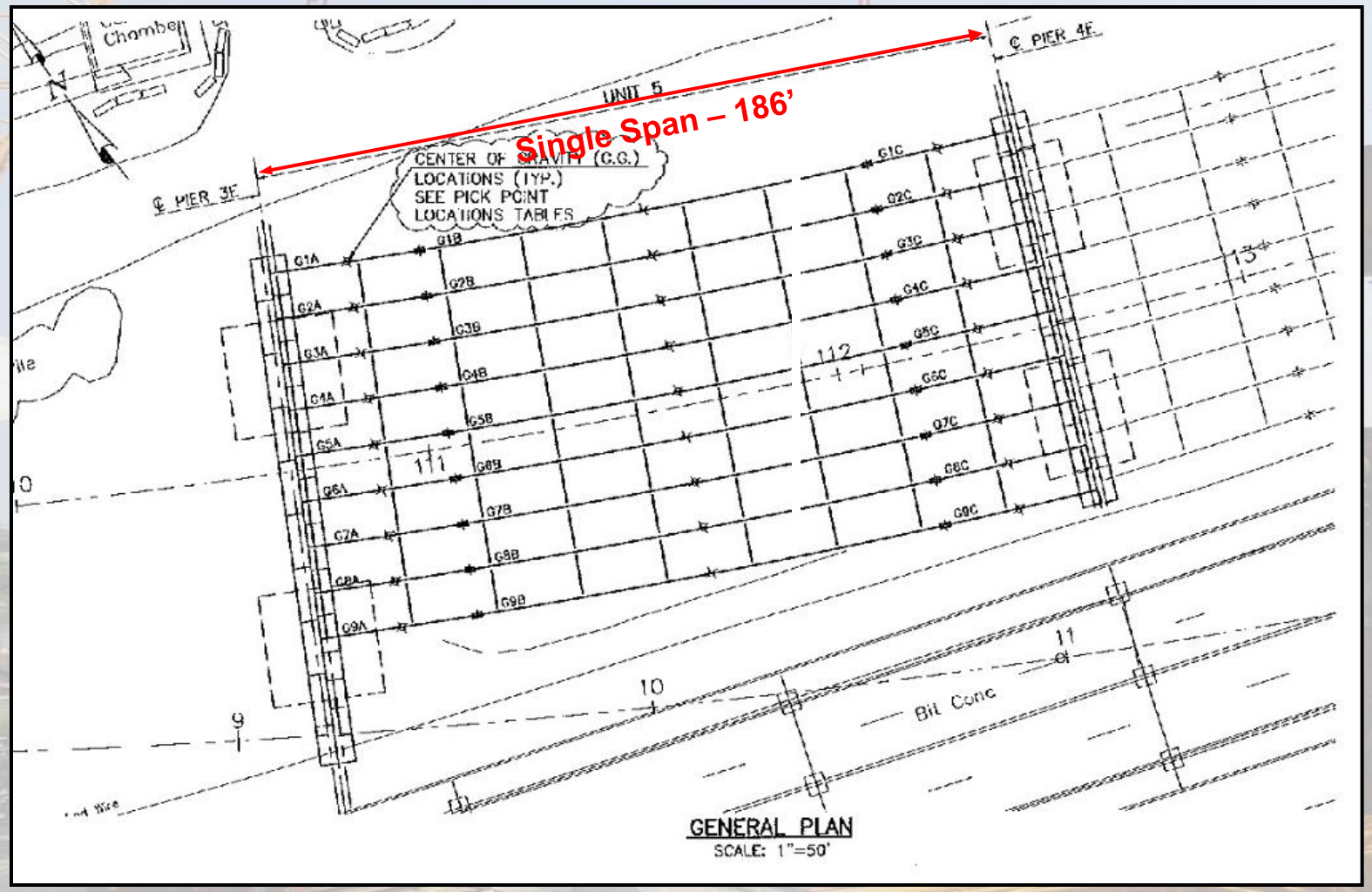
- Unit 4



- Begins at Pier 1E and consists of two spans approximately 203' and 208' continuous over Pier 2E to Pier 3E.
- Span 1 is located over the water and is primarily straight with a radius beginning approximately 63' west of Pier 2E.
- All girders in Span 2 are on a radius with varying spacing slightly flaring out at Pier 3E to account for Newark Ave Ramp.

Project Description

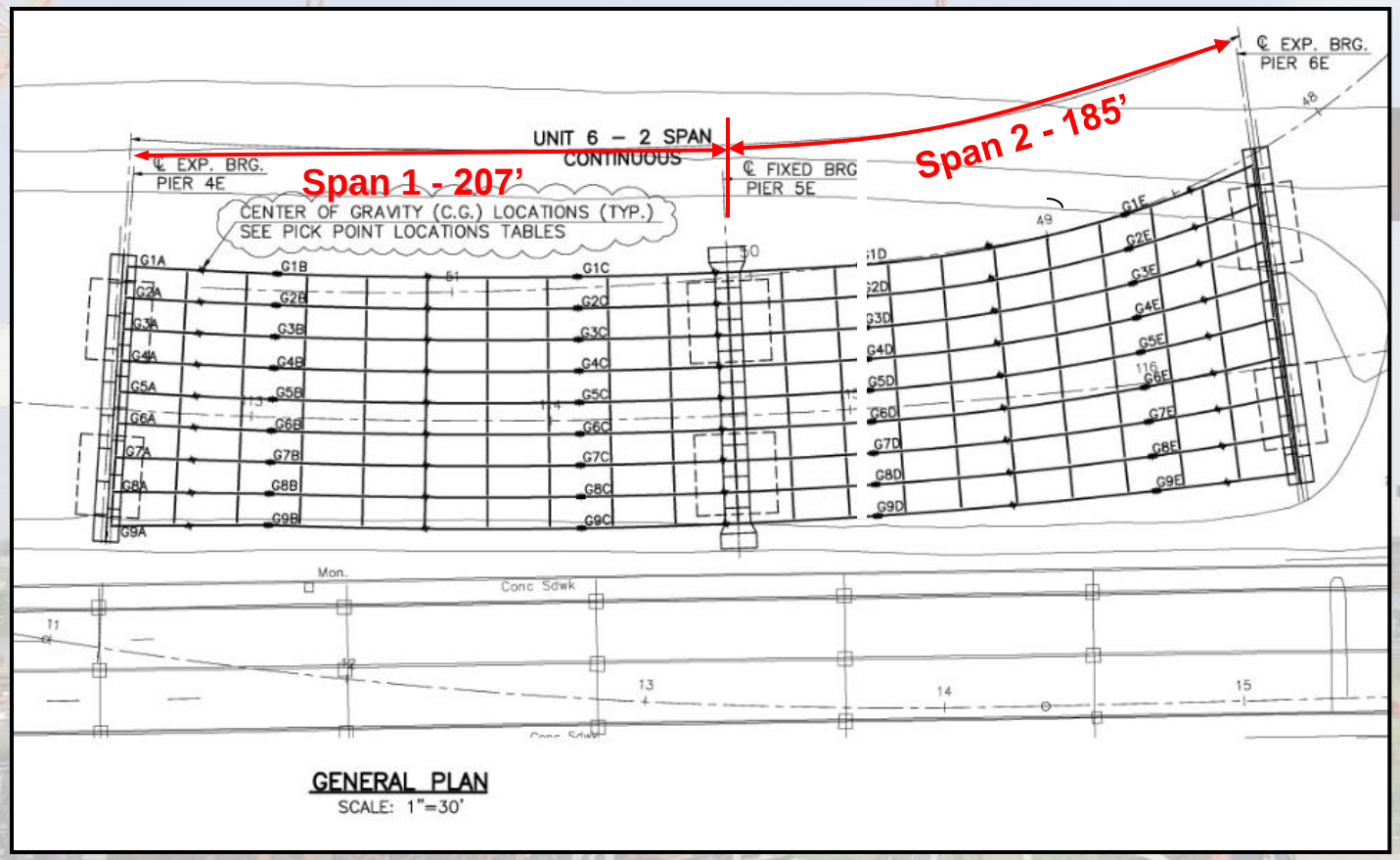
- Unit 5



- Single curved span approximately 186' in length.
- The girders are uniformly spaced at 11'-1" spanning between Piers 3E and 4E.

Project Description

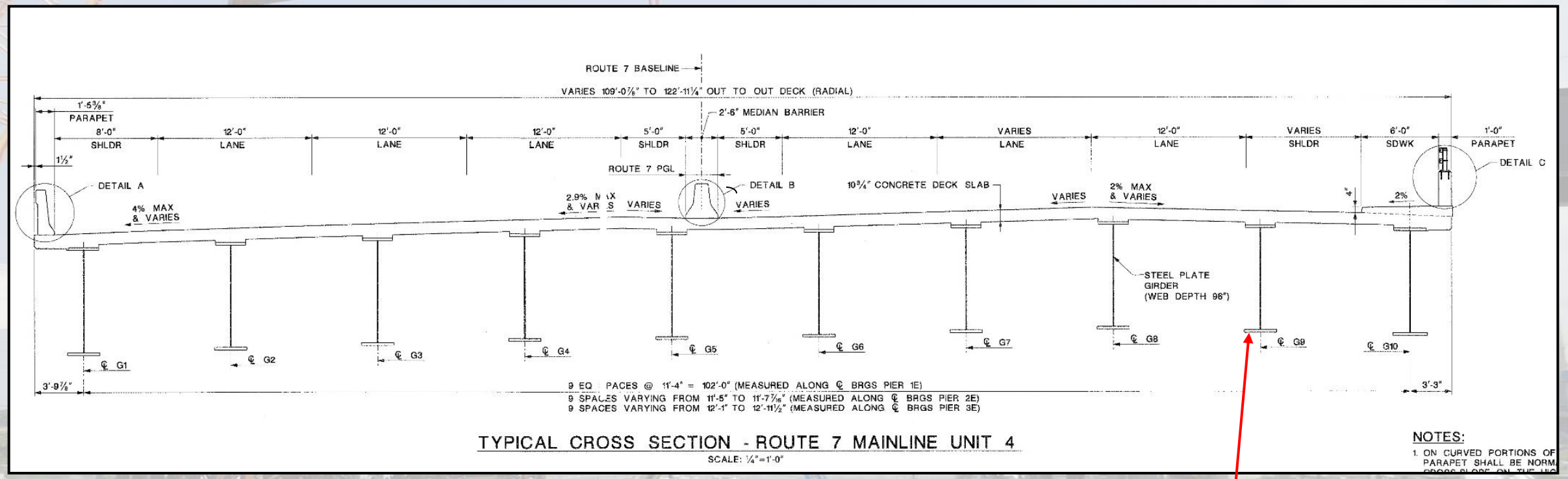
- Unit 6

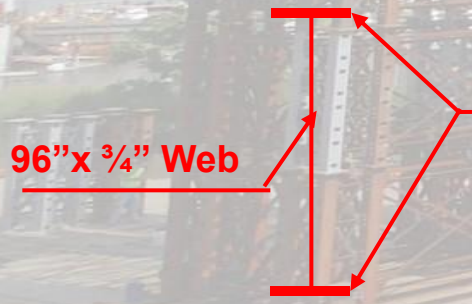


- Begins at Pier 4E and consists of two (2) spans approximately 207' and 185' continuous over Pier 5E to Pier 6E.
- Girders in Span 1 are all radial and have uniform spacing.
- Span 2 - girders are also on a curve with the radius decreasing and sharpening significantly at the east end near Pier 6E to account for Ramp A to Route 1&9.
- Girder spacing increases approximately 2'-6" at the east bearings.

Project Description

- General Bridge Cross Section





96"x ¾" Web

26" or 28" Flange x 1 ½" to 2 ½"

Typical Steel Girder Spaced @ 11' Avg.

Erection Plan

- General Plan
  - Plan was to erect the superstructure from east to west resulting in an order of erection of Unit 6, 5 and finally 4.
  - This order was primarily due the increased pre-erection set up of Unit 4 over water.
  - In addition, Pier 1E, part of the Contract 1 project, was not fully completed at the start of Contract 2.
  - Erecting from east to west would allow for the completion of Pier1E, additional time to construct the crane pad and procure the barges required.

Erection Plan

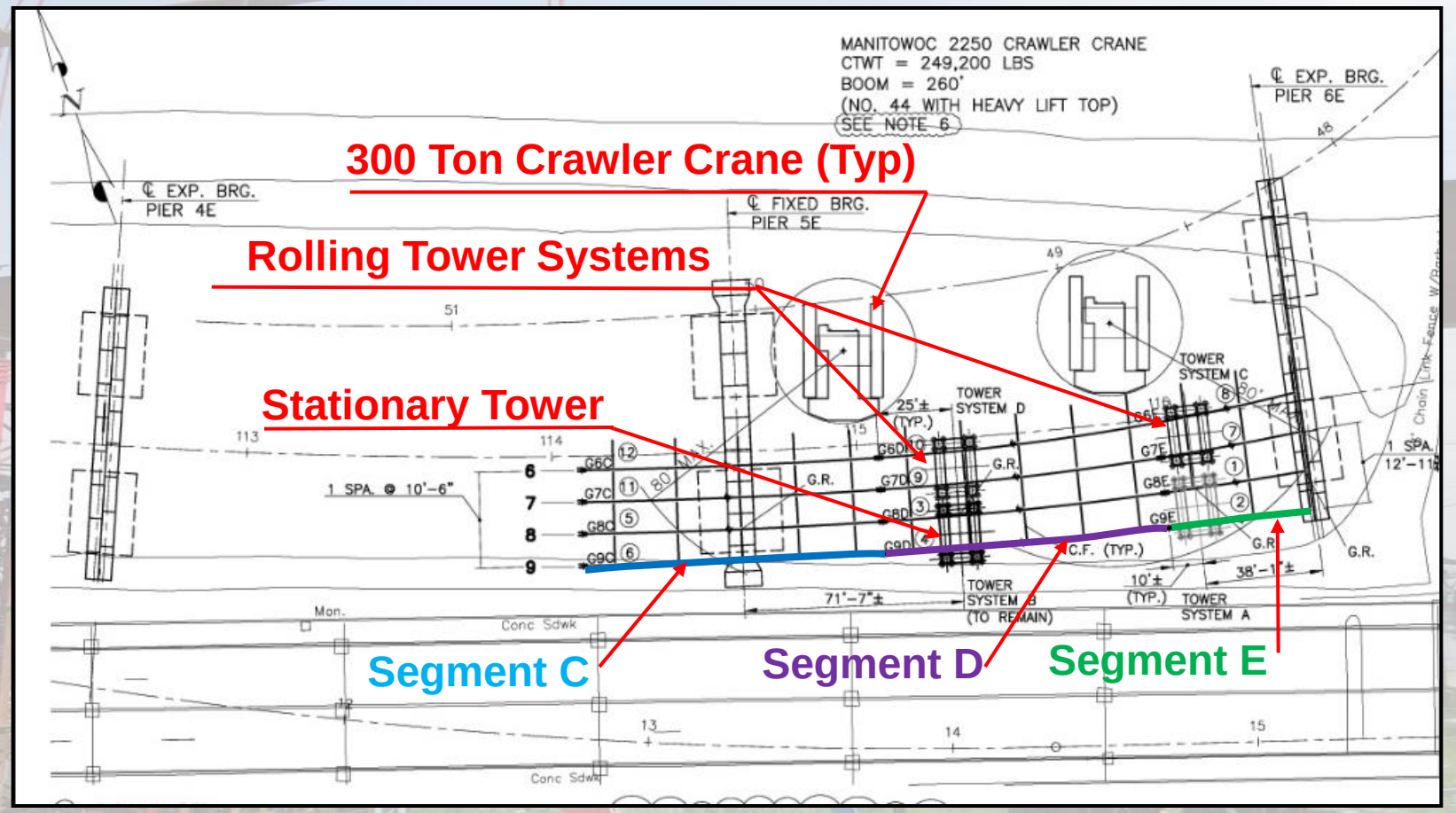
- Each unit had its own unique logistical and design challenges to overcome.
  - Unit 6 had significant curvature and temporary tower requirements.
  - Unit 5, a long single curved span, consisted of three individual segments and combined with difficult site logistics, necessitated the use of two major tower systems and a third stabilizing tower.
  - Unit 4, which was over water resulting in:
    - Crane access constraints
    - The need for rolling tower systems,
    - Construction of a crane pad due to soft soils present
    - Innovative girder hanger system to support a girder segment from the fully erected girders already in place.

Erection Plan

- Unit 6 Erection
  - Erect East to West, South to North.
  - Erect as singles due to crane access and capacity
  - Erect first inner girder, then fascia
  - Tower system required for stability
  - Utilized patented tower units and rolling system for time savings.

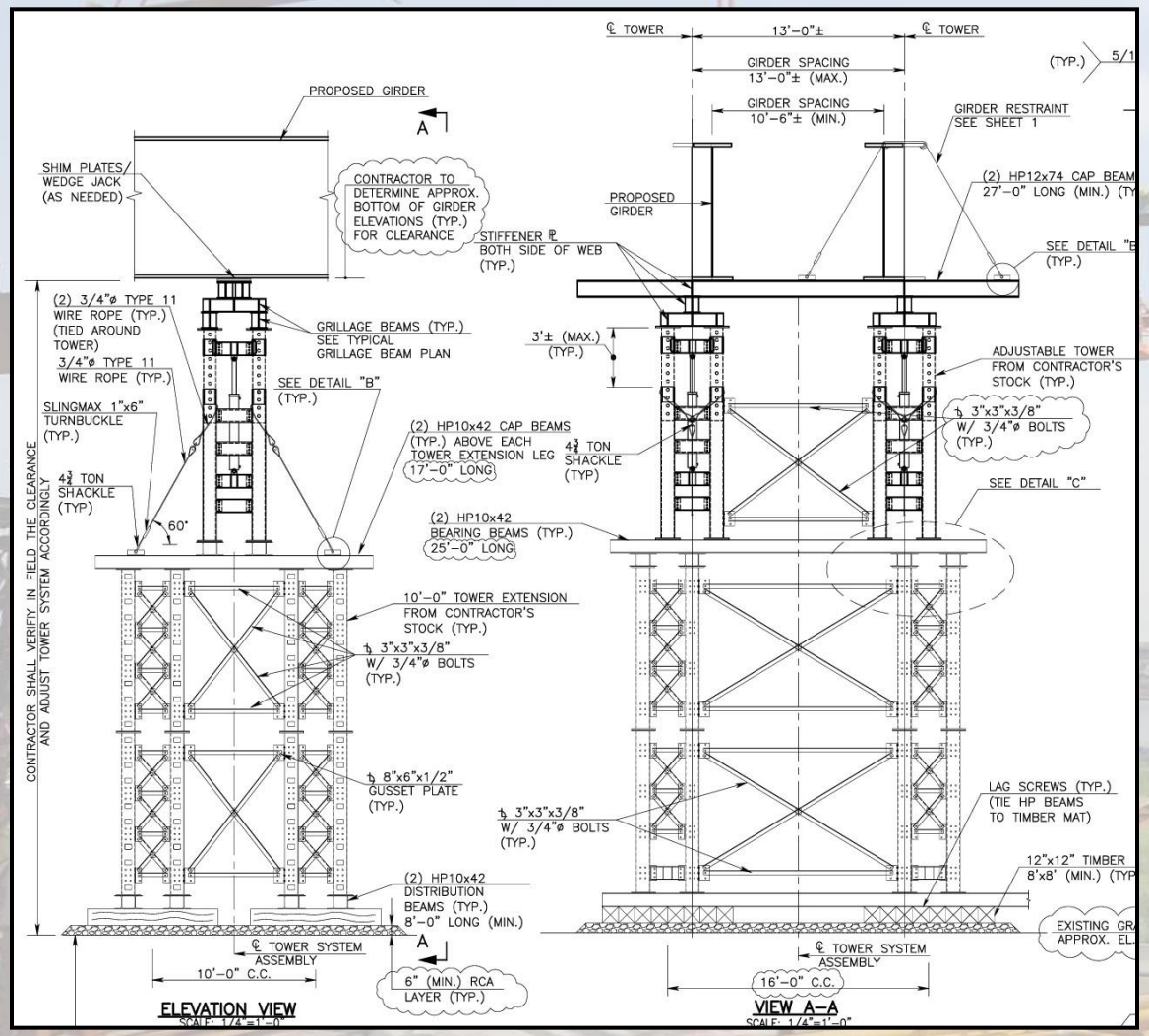
Erection Plan

- Unit 6 Girder Erection – Step 1



Erection Plan

- Tower System



- Patented by Structural Services
- Adjustable telescoping legs using hydraulic cylinders
- Minimizes set up time
- Able to obtain more accurate elevations

Erection Plan

- Tower System

Erection Plan

- Tower System

Erection Plan

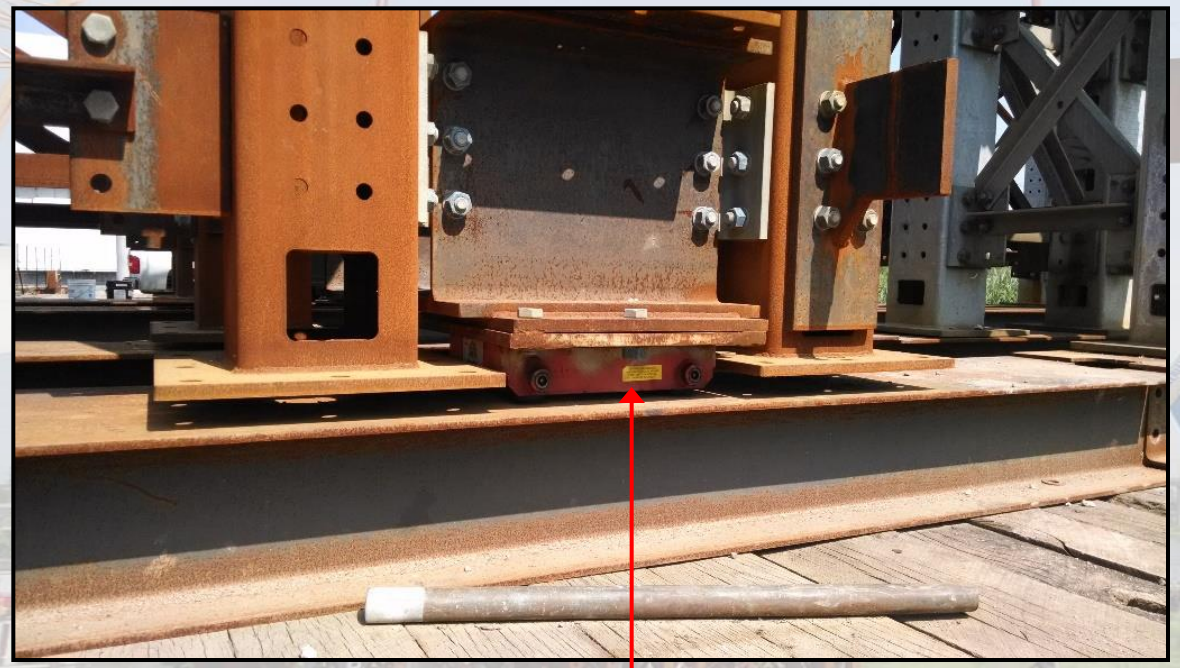
- Tower Rolling System

Jacking and Roller Beam

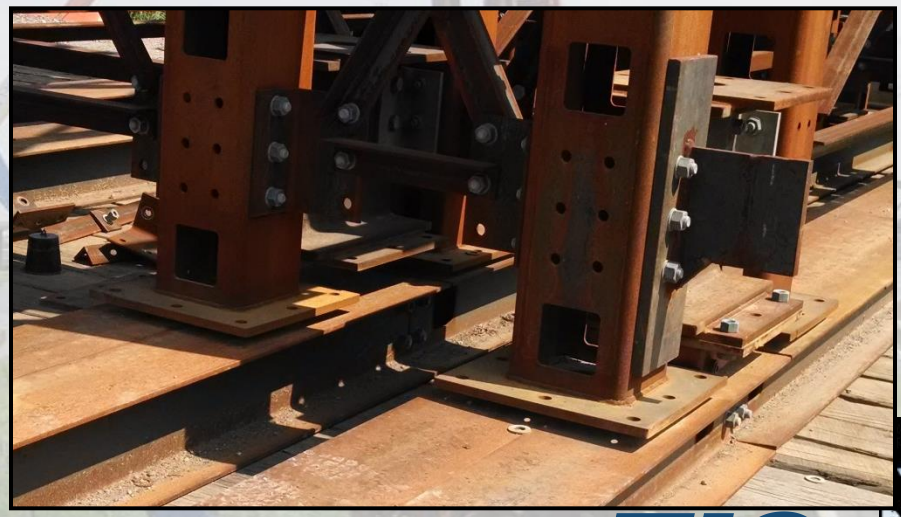
Distribution and Rolling Beam

Erection Plan

- Tower Rolling System



Hilman Roller

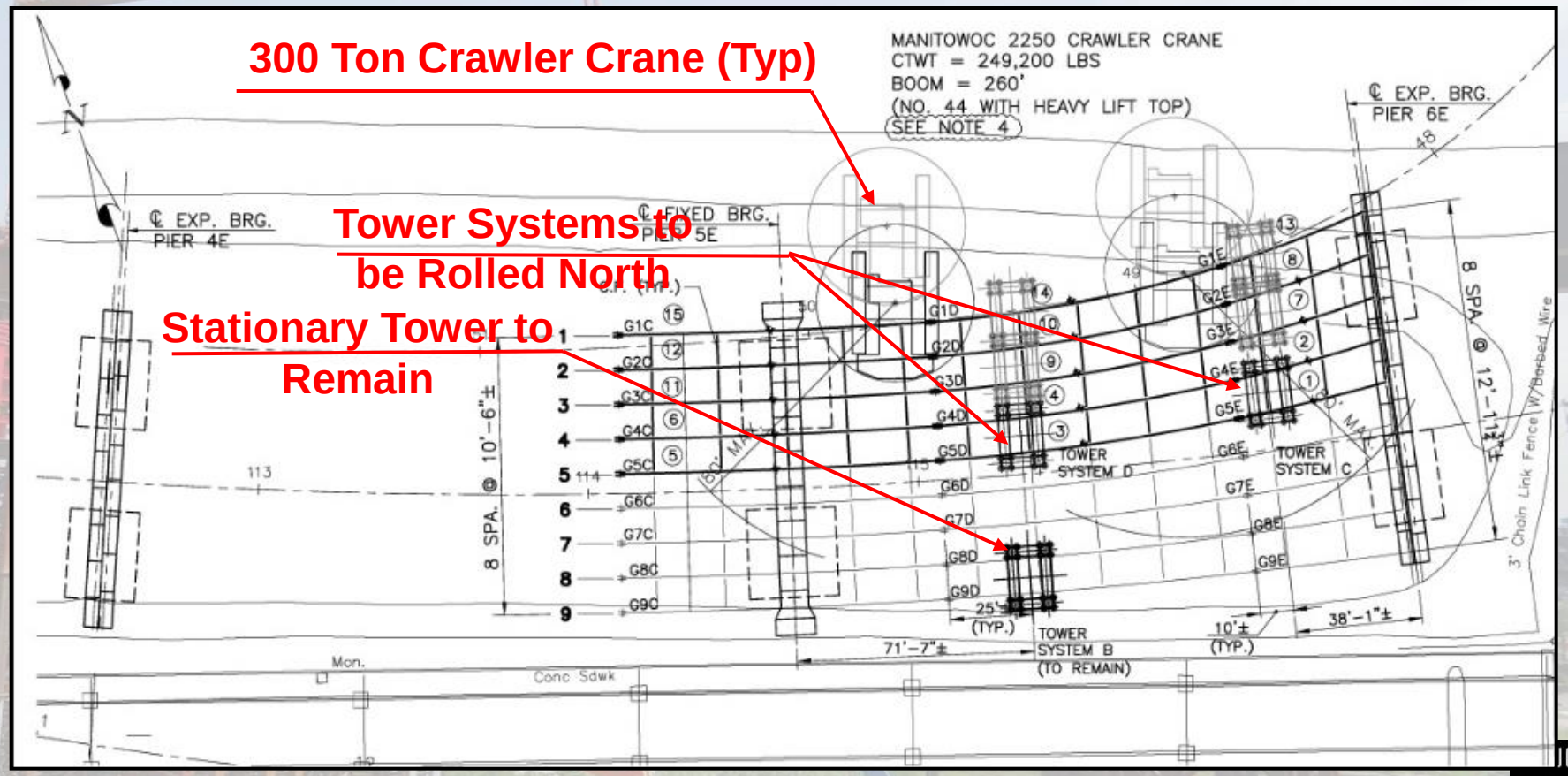


Erection Plan

- Tower Rolling System

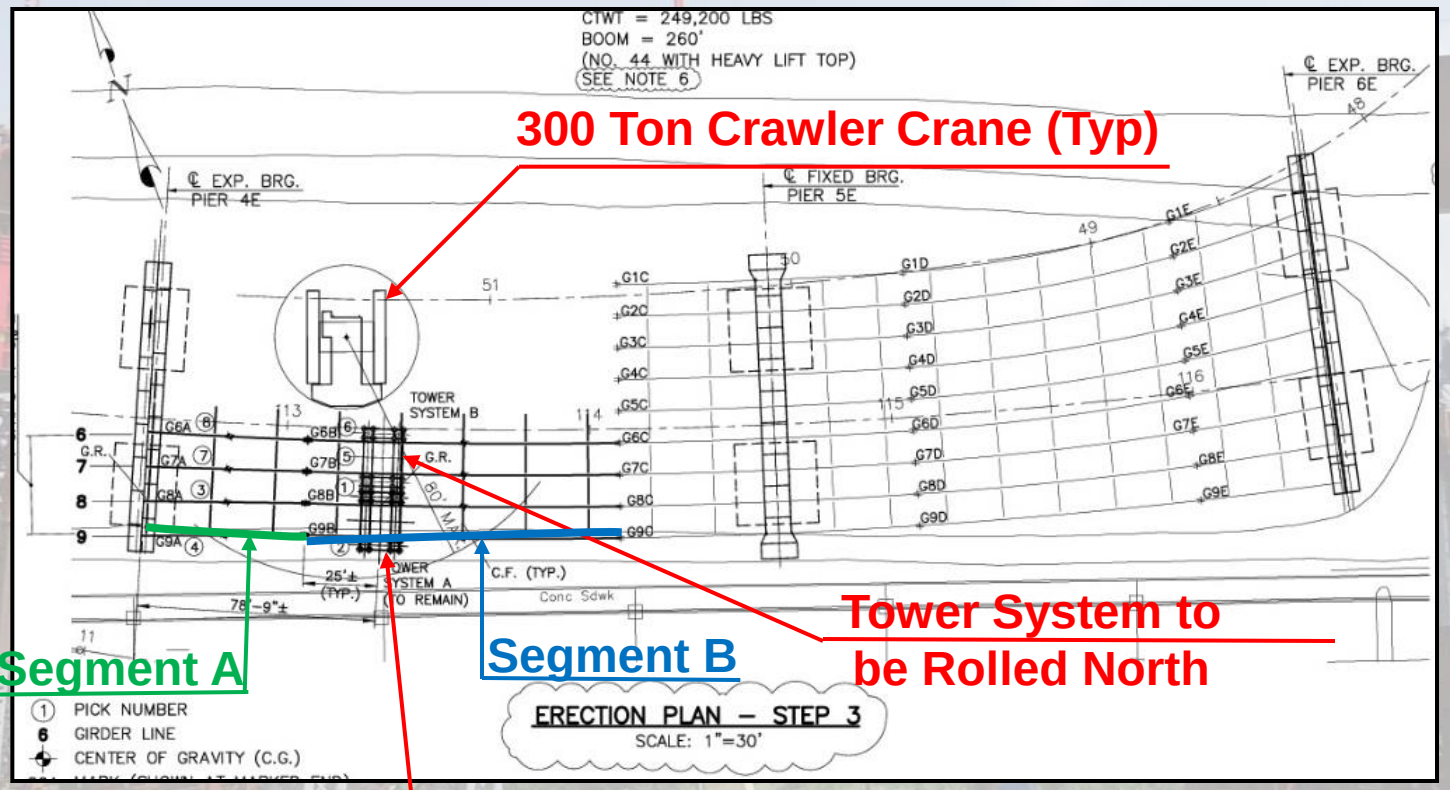
Erection Plan

- Unit 6 Girder Erection – Step 2



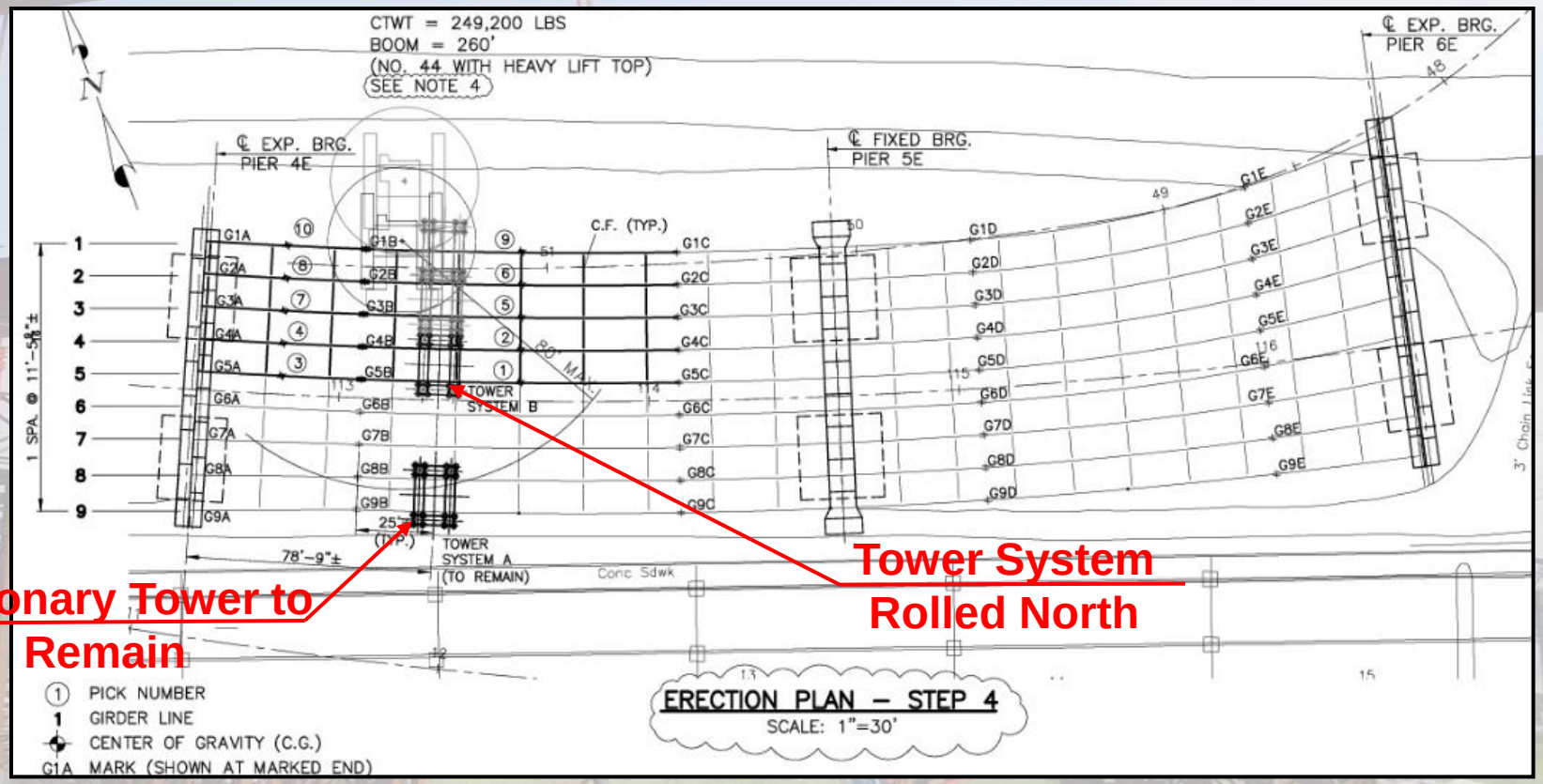
Erection Plan

- Unit 6 Girder Erection – Step 3



Erection Plan

- Unit 6 Girder Erection – Step 4



Erection Plan

- Unit 6 Erection

Erection Plan

- Unit 6 Erection

Erection Plan

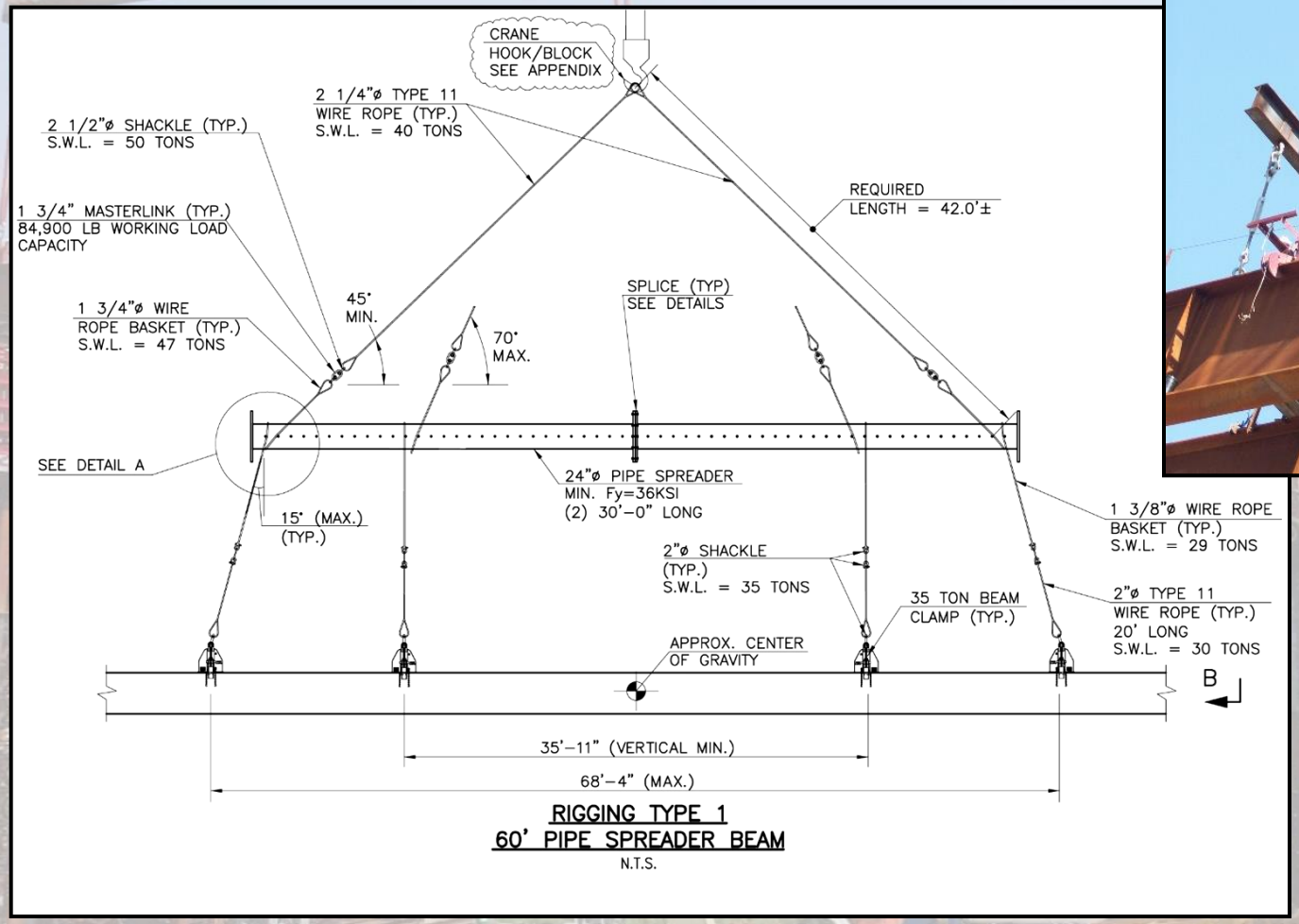
- Unit 6 Erection

Erection Plan

- Adjustable Spreader Beam

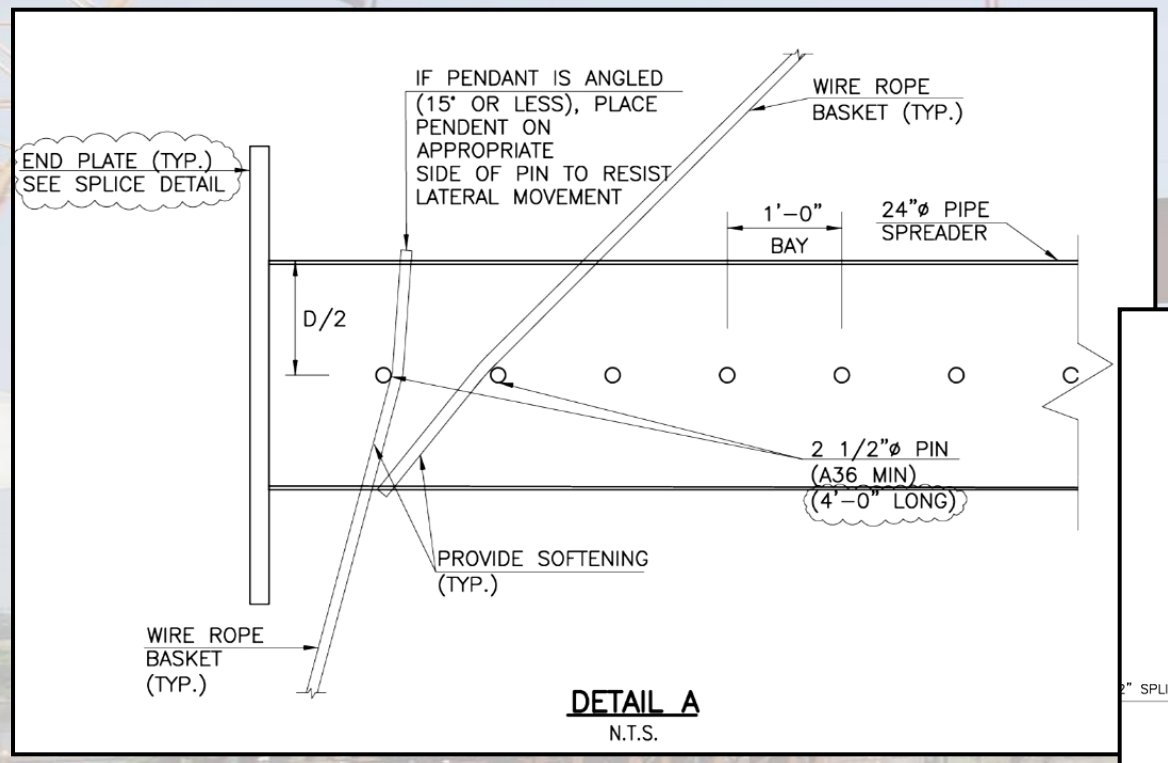
Erection Plan

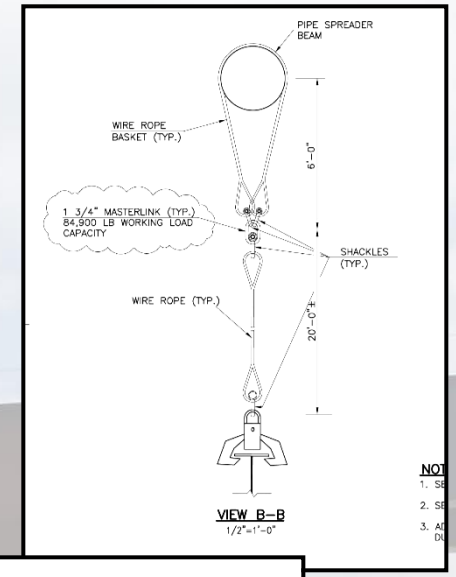
- Adjustable Spreader Beam

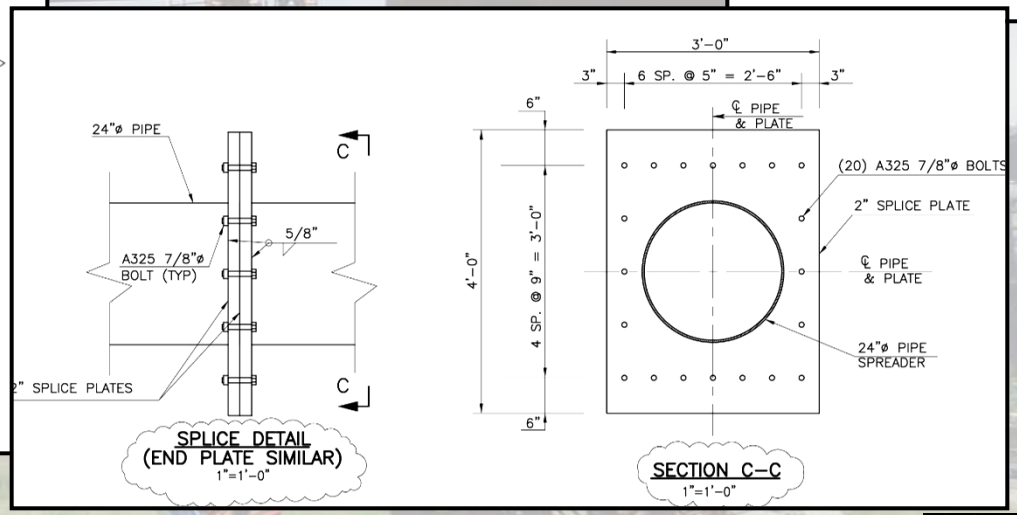


Erection Plan

- Adjustable Spreader Beam







Erection Plan

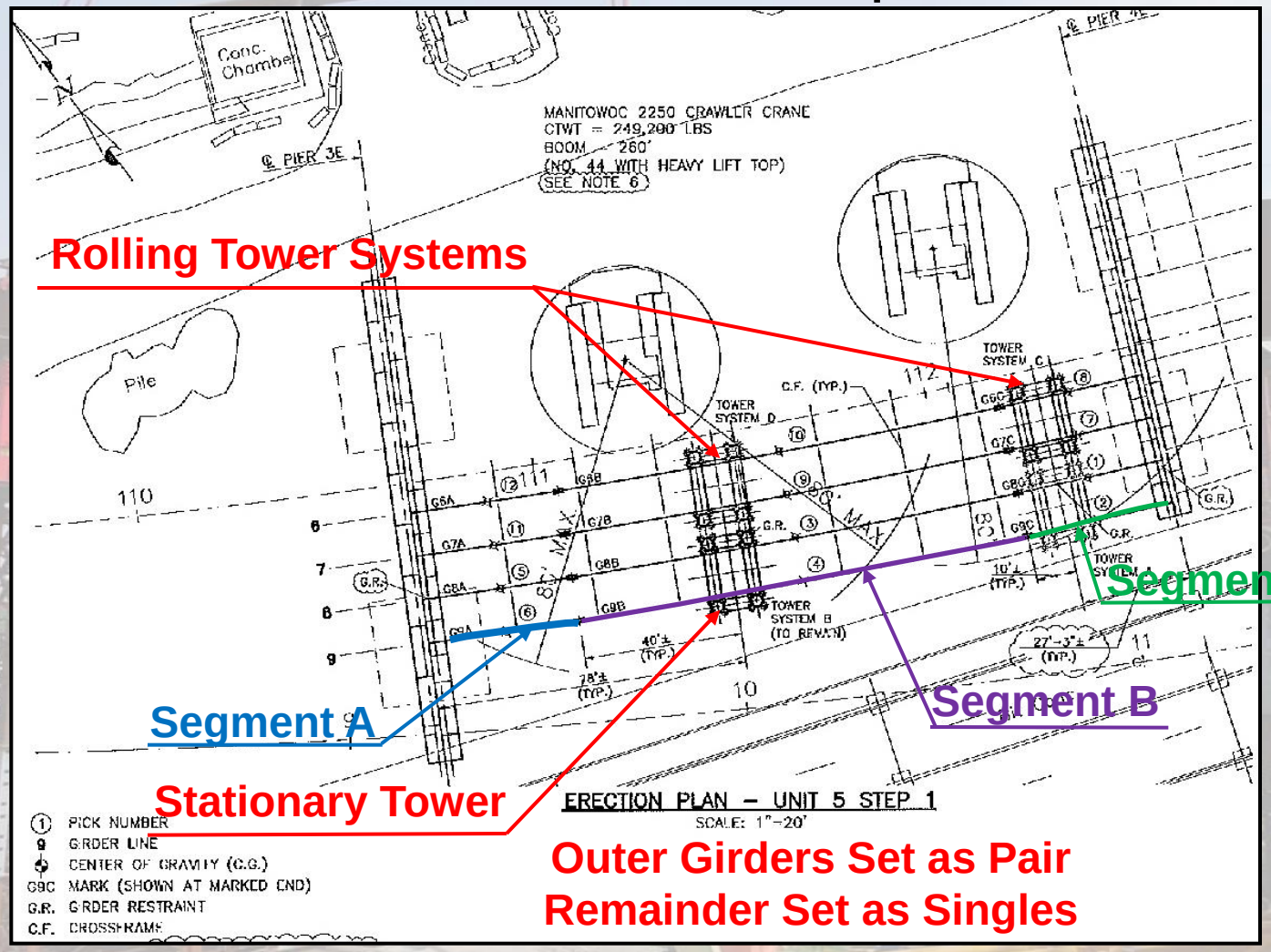
- Adjustable Spreader Beam

Erection Plan

- Unit 5 Erection
  - Single span, curved girders
  - Erect first two girder lines as a pair, singles thereafter.
  - Required three (3) towers including single stability tower.
  - Utilized patented tower units and rolling system for time savings.

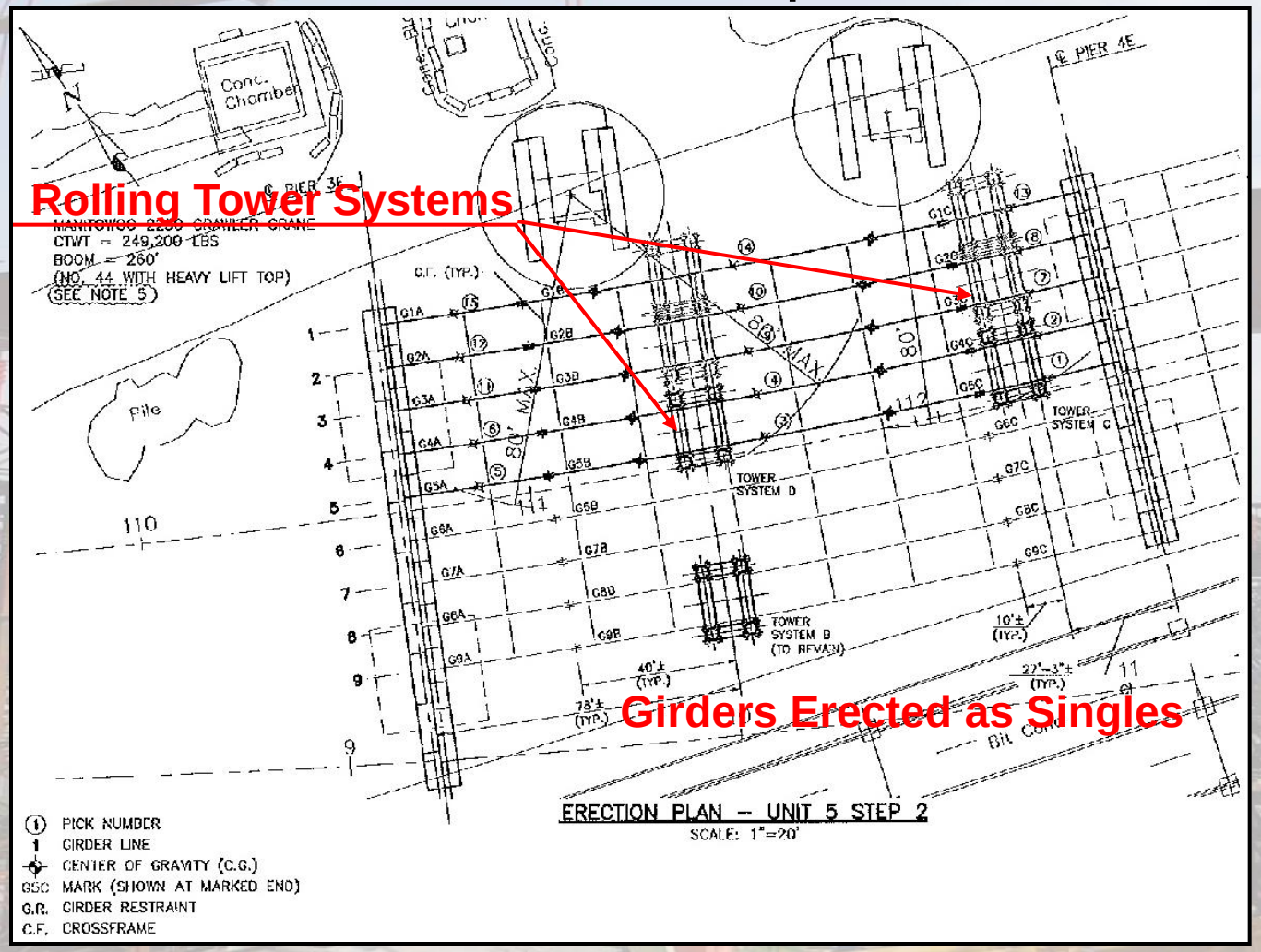
Erection Plan

- Unit 5 Girder Erection – Step 1



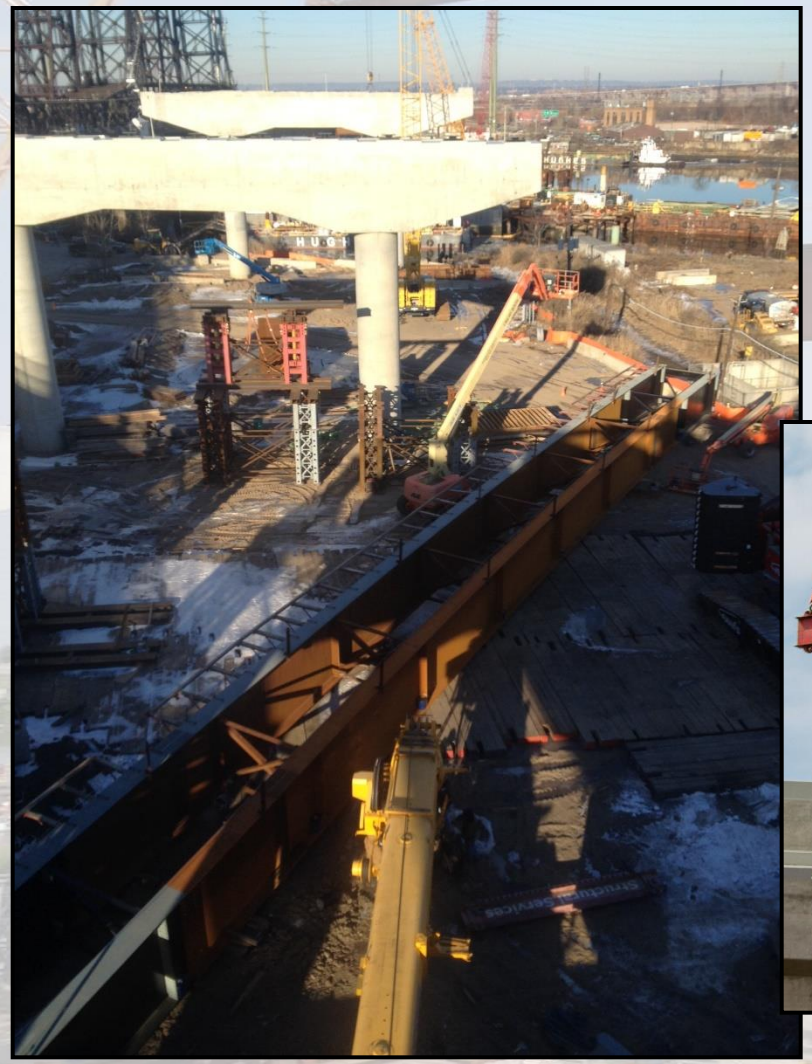
Erection Plan

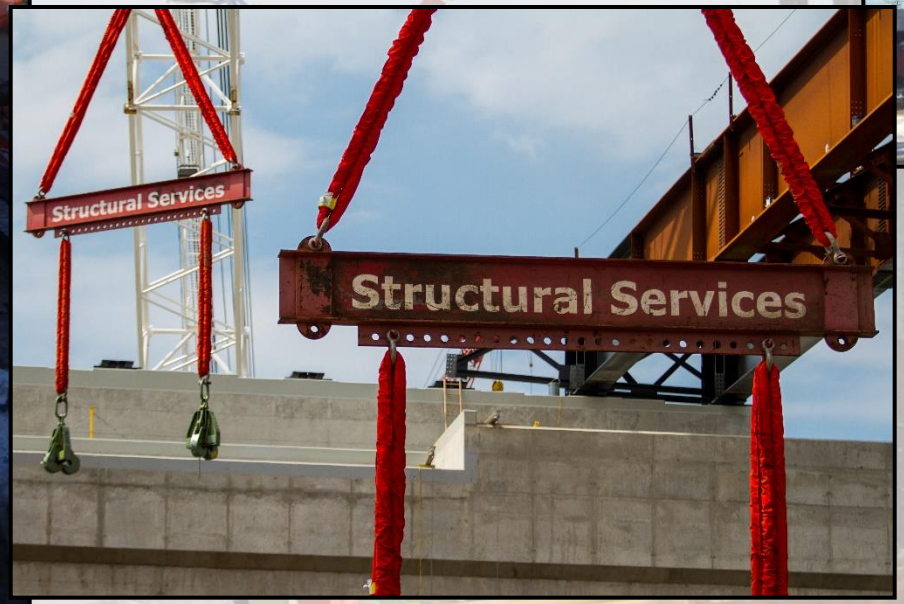
- Unit 5 Girder Erection Step 2



Erection Plan

- Unit 5 Girder Erection





Erection Plan

- Unit 5 Girder Erection

Erection Plan

- Unit 5 Girder Erection

Erection Plan

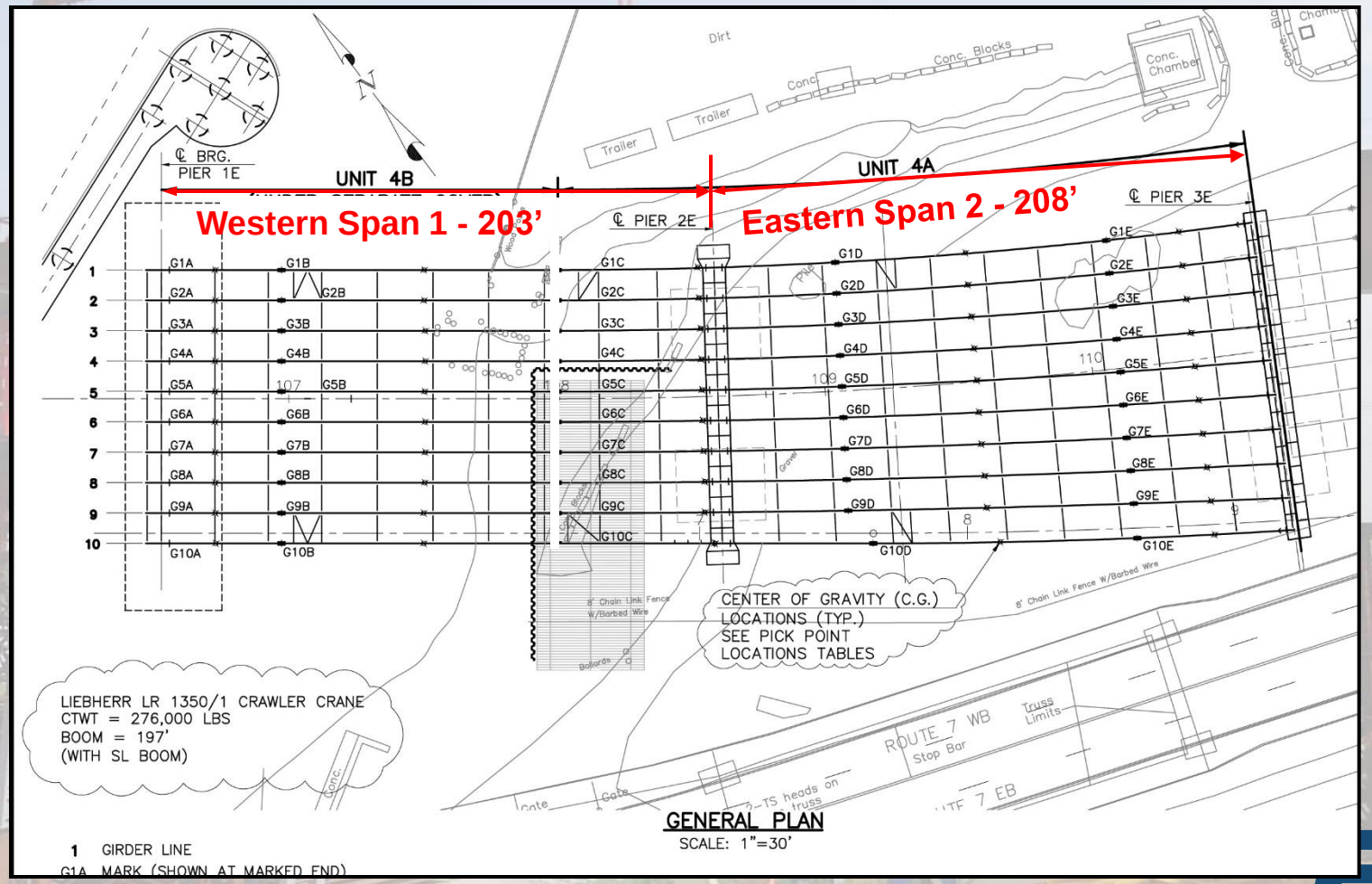
- Unit 4 Erection
  - The western portion of the unit was mostly over very shallow water resulting in limitations on potential barge locations.
  - Both spans were above soft soils creating crane placement and support concerns.
  - The elevation of the east span was approximately 65ft above ground resulting in tall tower configurations.
  - Limited clearances on the ground resulting in assembly area and crane placement challenges.
  - Due to the resulting limitations on crane locations and pick points, beam stability concerns during setting had to be accommodated.

Erection Plan

- Unit 4 Erection
  - Most difficult unit to erect.
  - Significant challenges to be overcome.

Erection Plan

- Unit 4 Erection



Erection Plan

- Unit 4 Erection

Erection Plan

- Unit 4 Erection
- Ground support issues had to be addressed.
- The ground contained organic material and could not be considered adequate to provide support for towers and cranes.
- Union Paving installed approximately 10’ of compacted fill to stabilize the ground for towers and cranes.

Erection Plan

- Unit 4 Erection
- To erect over the water for the western span, crane access had to be provided by the river bank.
- The bank was sloped and consisted of very soft soils.
- To overcome this, a steel sheet pile bulkhead system was designed by EIC to retain the new fill material.
- Anchored by a concrete dead man and a waler system.
- Design included the appropriate track pressures from the crawler crane.

EIC Group LLC

STRUCTURAL SERVICES

union paving & Construction Co., Inc.

Erection Plan

- Unit 4 Erection Concept- Eastern Span 2
  - A single crawler crane used to erect single pieces supported by two (2) tower systems similar to Unit 6.
  - Excessive elevation of the proposed superstructure required a multi-tier tower system with an overall height of over 60’.
  - The drainage ditch, overhead electric lines and underground utilities on the north side made crane placement impossible, crane had to be located between the new and existing structures.
  - Erection had to proceed north to south, opposite of the previous units.

Erection Plan

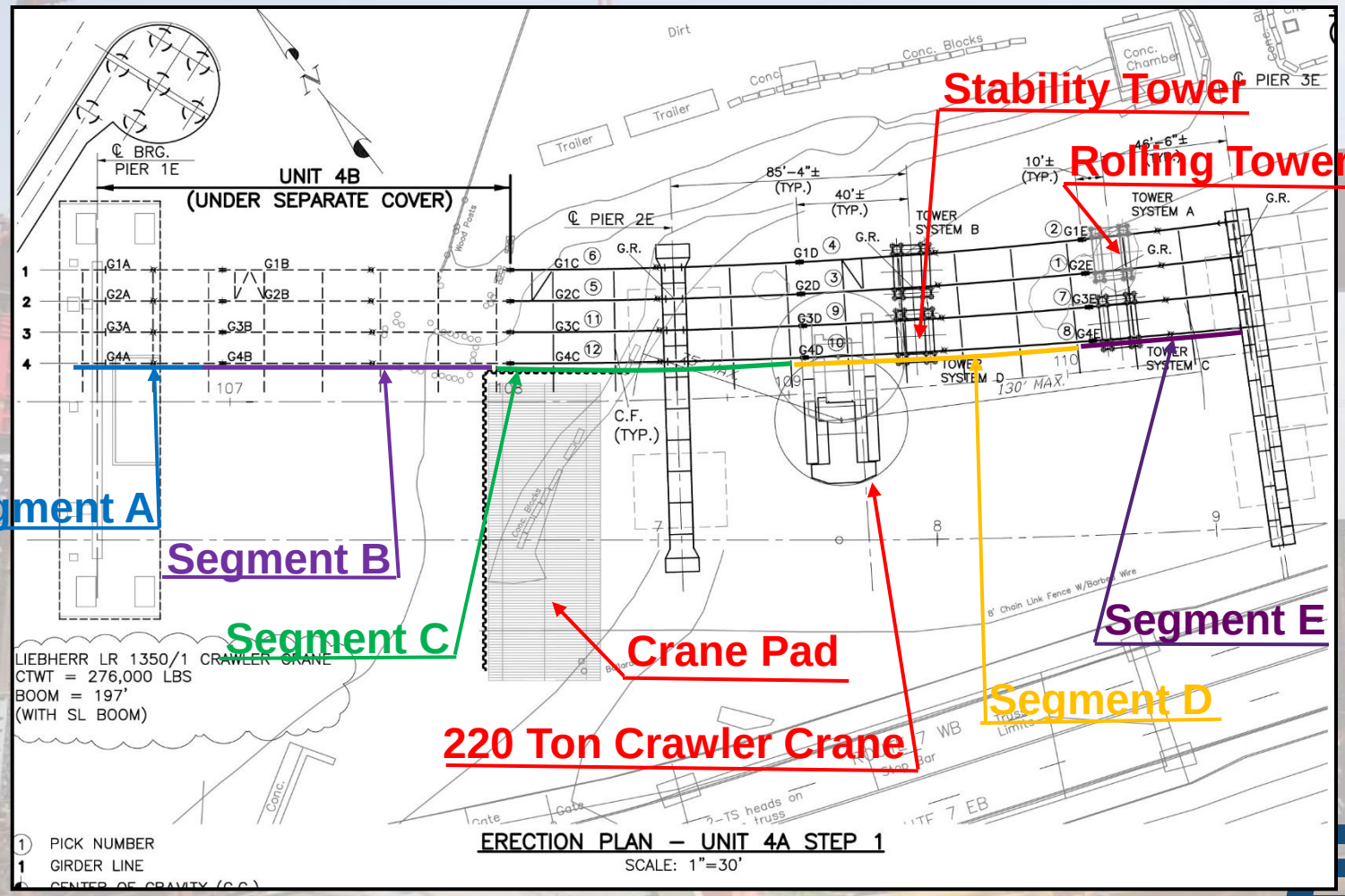
- Unit 4 Erection Concept- Western Span 1
  - The crane placement and assembly area for the western span presented extreme challenges.
  - Due to the water, it was not possible to construct towers for support of the individual segments as was done on the prior units.
  - The shallow water depth between Pier 1E and the shore eliminated the possibility of a barge crane in this area.
  - However, a land crane set on the new pad that was constructed on the bank did not have the reach or capacity to erect the combined spliced girder segment.

Erection Plan

- Unit 4 Span 1 Erection Solutions
  - Lift first four (4) girder lines (G1 to G4) in pairs with two cranes. Utilize a land crane on the bank and the 527 Barge Crane supplied by Weeks Marine, Cranford, NJ located on the western side of Pier 1E.
  - Assemble the pairs on land then using the land crane, lift and roll the assembled pair and set the western end on barge just to the east of Pier 1E.
  - Beginning with Girder Line G5, erect girders with the land crane in individual segments utilizing a custom designed hanger system installed on the previous erected girder lines.

Erection Plan

- Unit 4 Girder Erection – Step 1



Erection Plan

- Unit 4 Girder Erection – Step 1

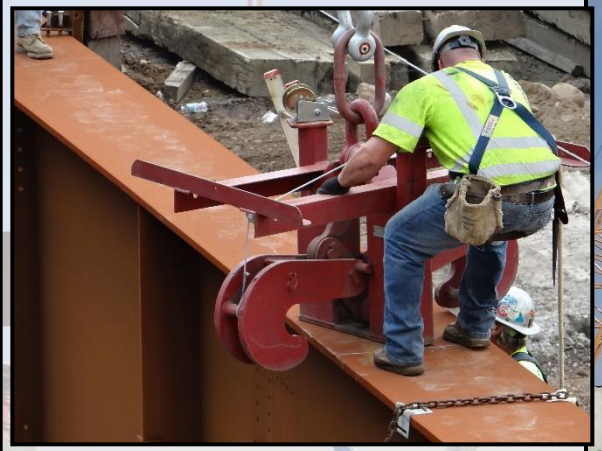
EIC Group LLC

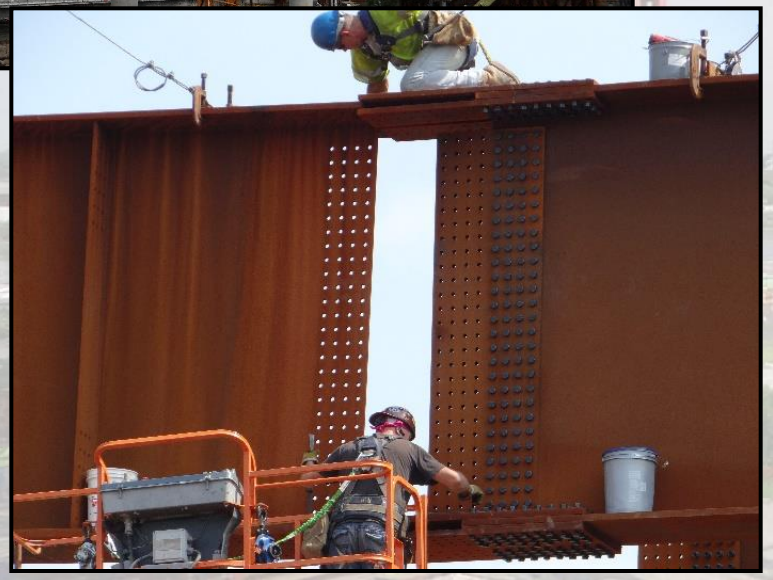
STRUCTURAL SERVICES

union paving & Construction Co., Inc.

Erection Plan

- Unit 4 Girder Erection – Step 1



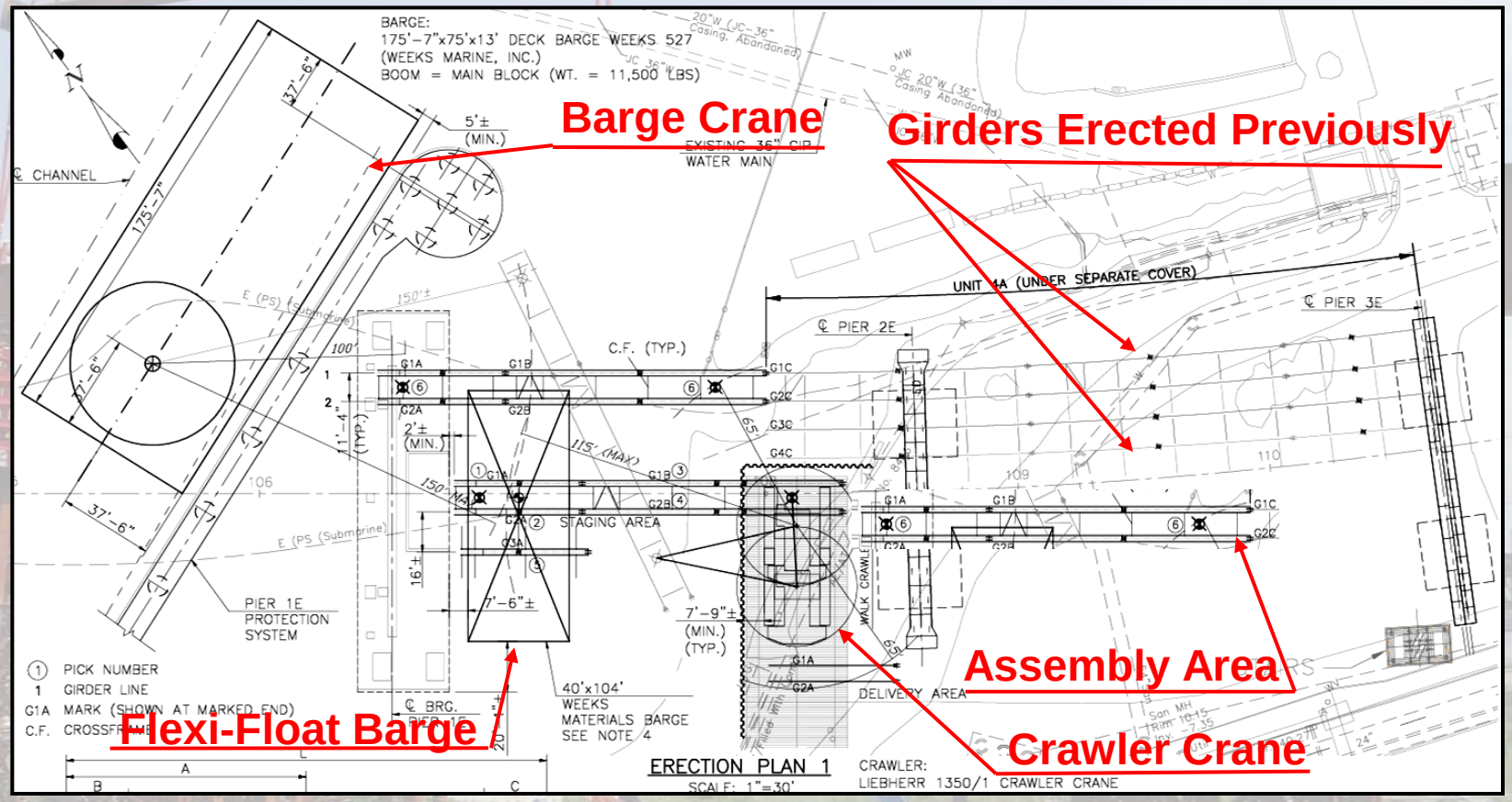


Erection Plan

- Unit 4 Girder Erection – Step 1

Erection Plan

- Unit 4 Girder Erection – Step 2

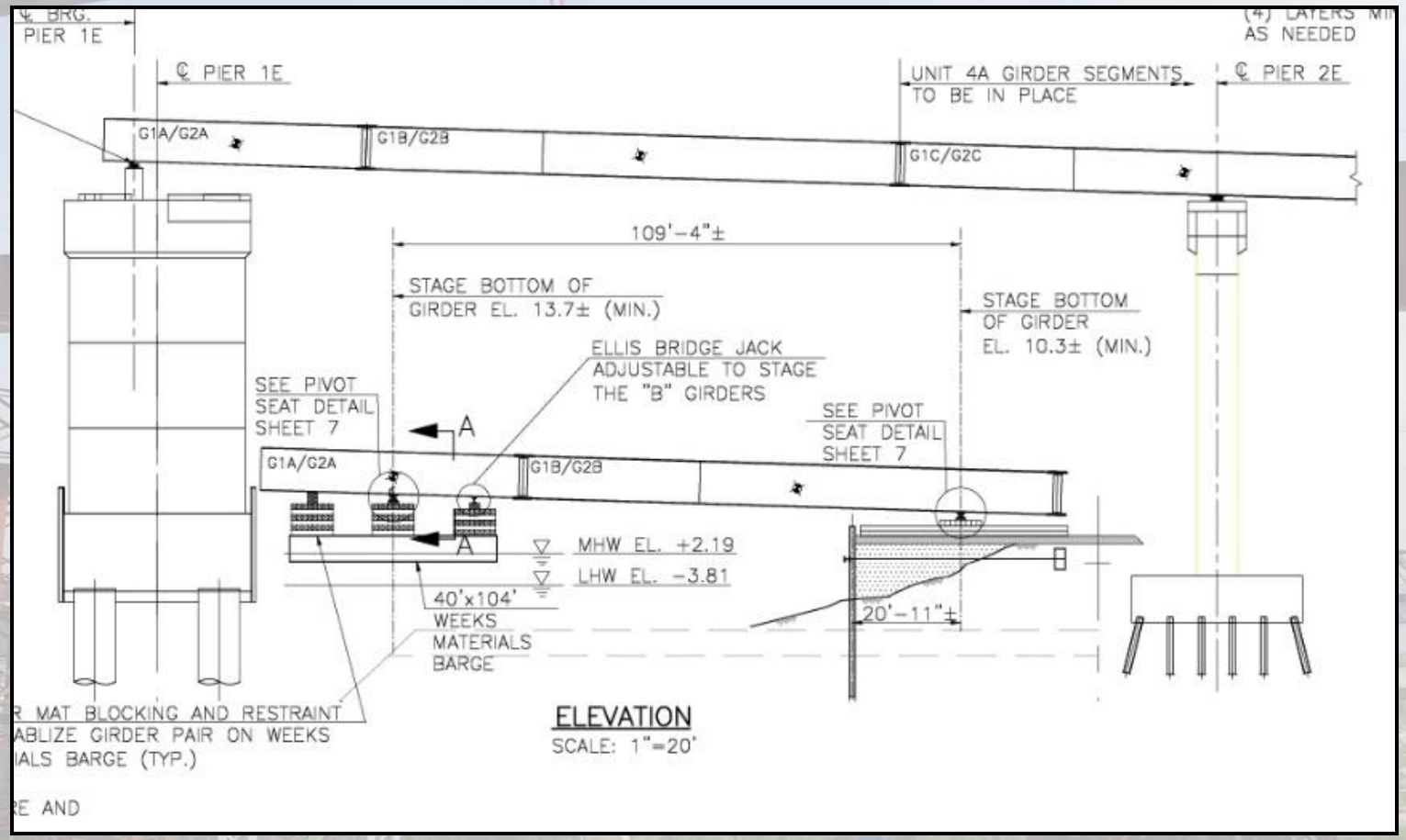


STRUCTURAL SERVICES

union paving & Construction Co., Inc.

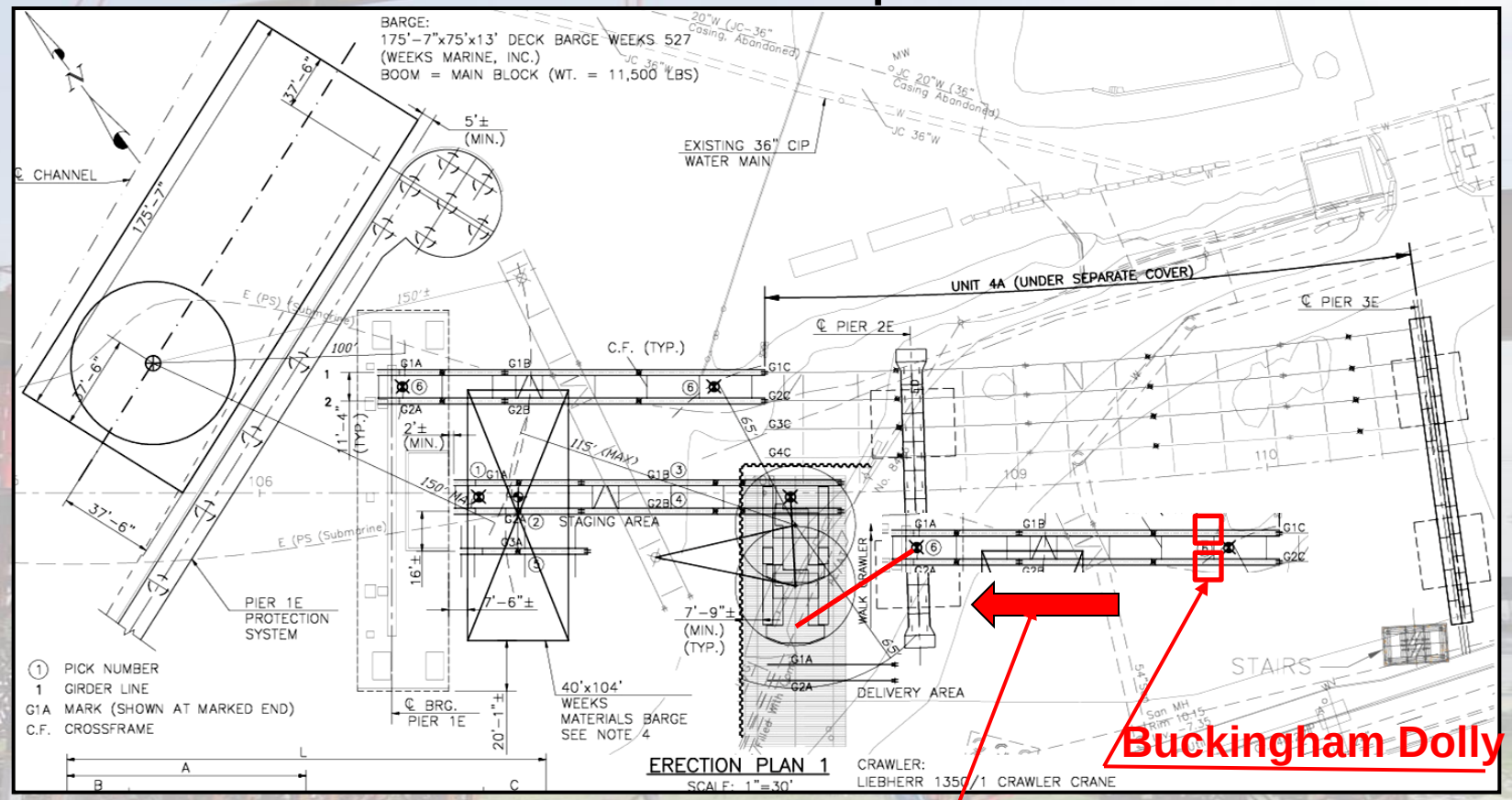
Erection Plan

- Unit 4 Girder Erection – Step 2



Erection Plan

- Unit 4 Girder Erection – Step 2



Move Pair to the West Onto Barge

Erection Plan

- Unit 4 Girder Erection – Step 2

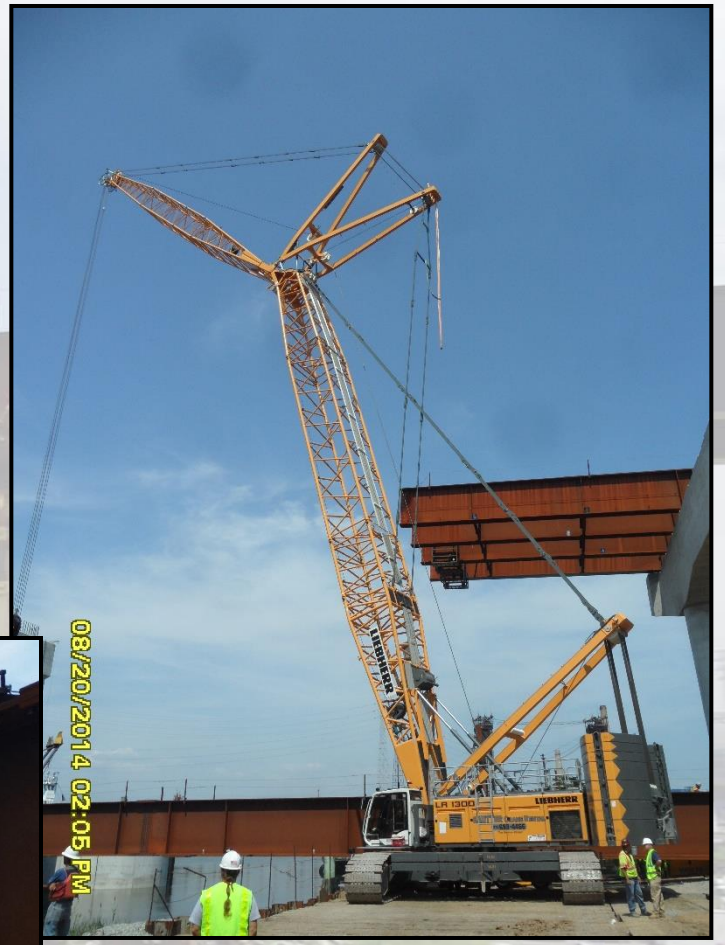
EIC Group LLC

STRUCTURAL SERVICES

union paving & Construction Co., Inc.

Erection Plan

- Unit 4 Girder Erection – Step 2



Erection Plan

- Unit 4 Girder Erection – Step 2

Erection Plan

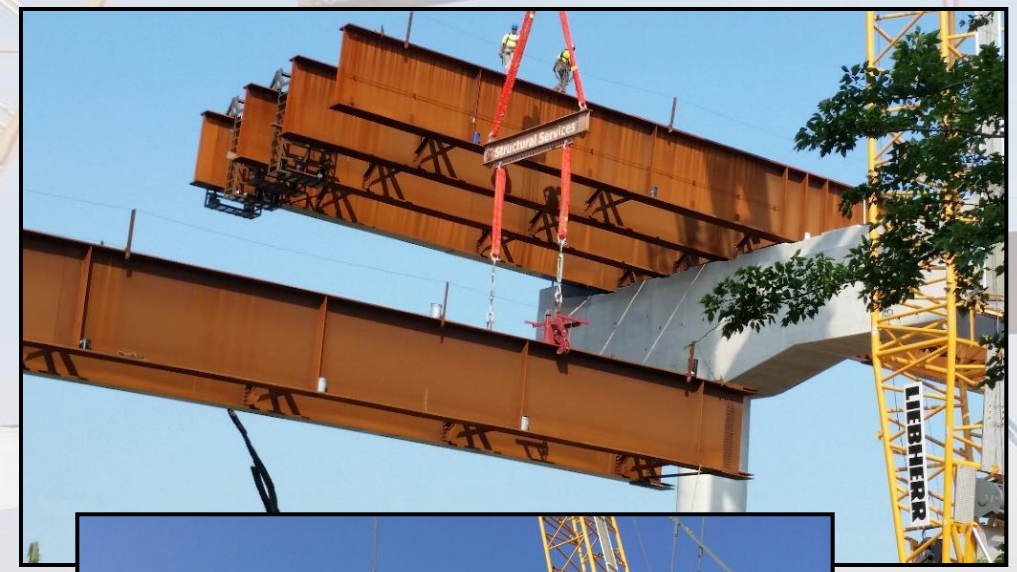
- Unit 4 Girder Erection – Step 2

Erection Plan

- Unit 4 Girder Erection – Step 2

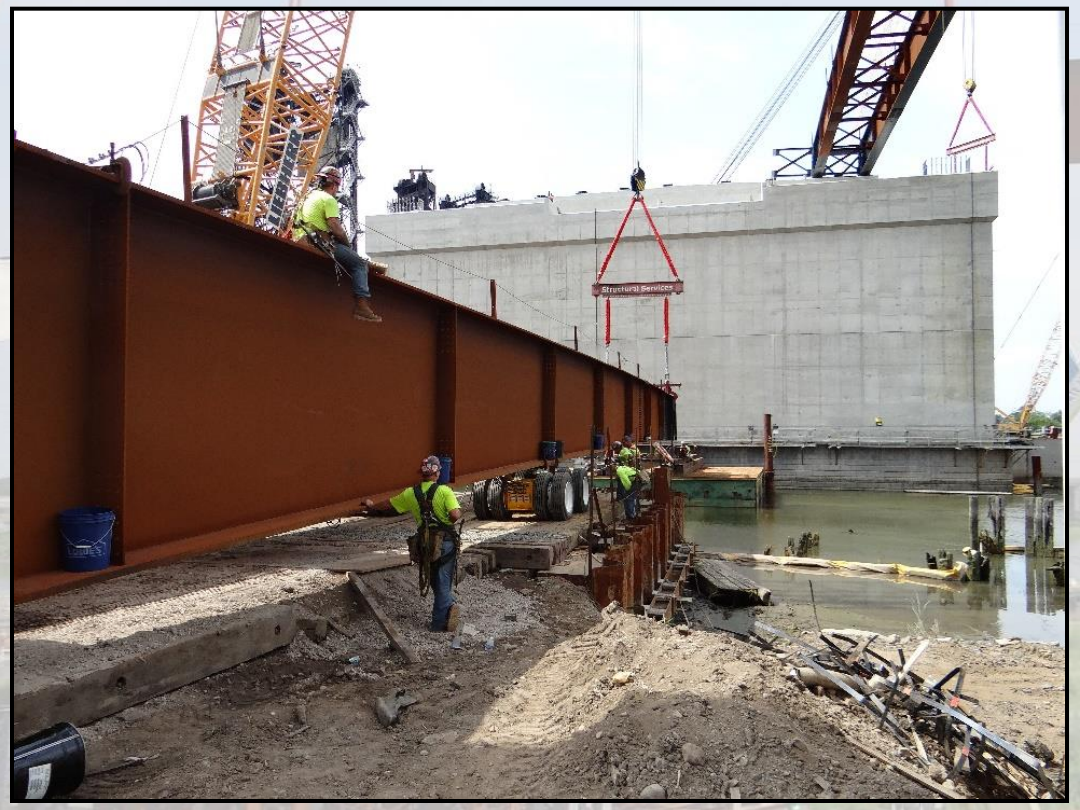
Erection Plan

- Unit 4 Girder Erection – Step 2



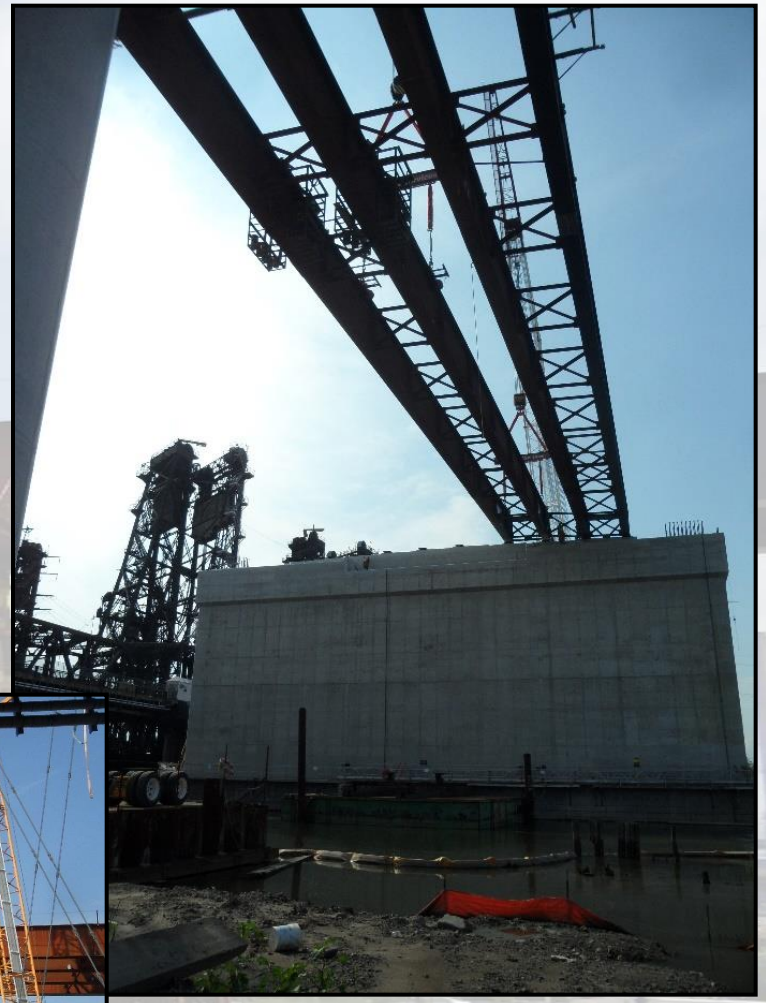
Erection Plan

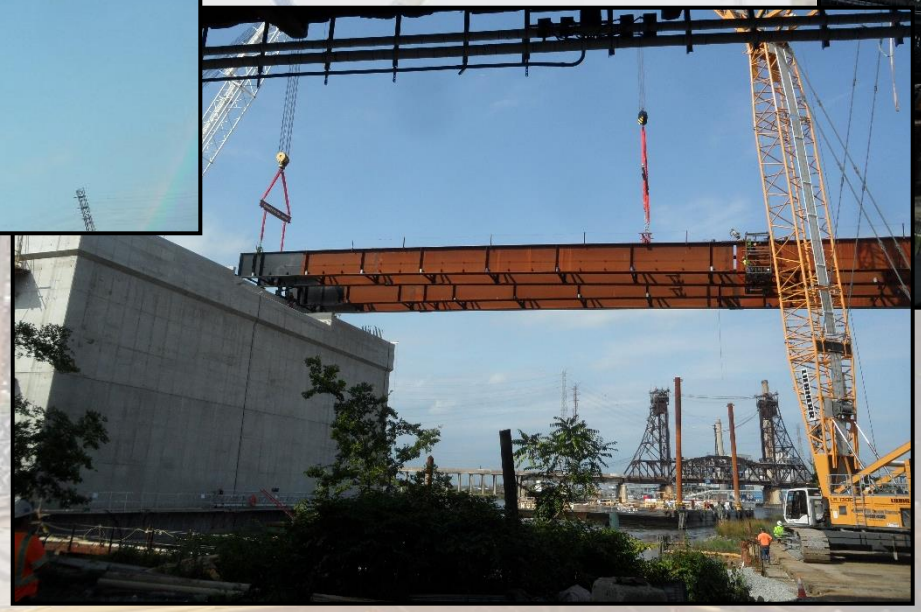
- Unit 4 Girder Erection – Step 2



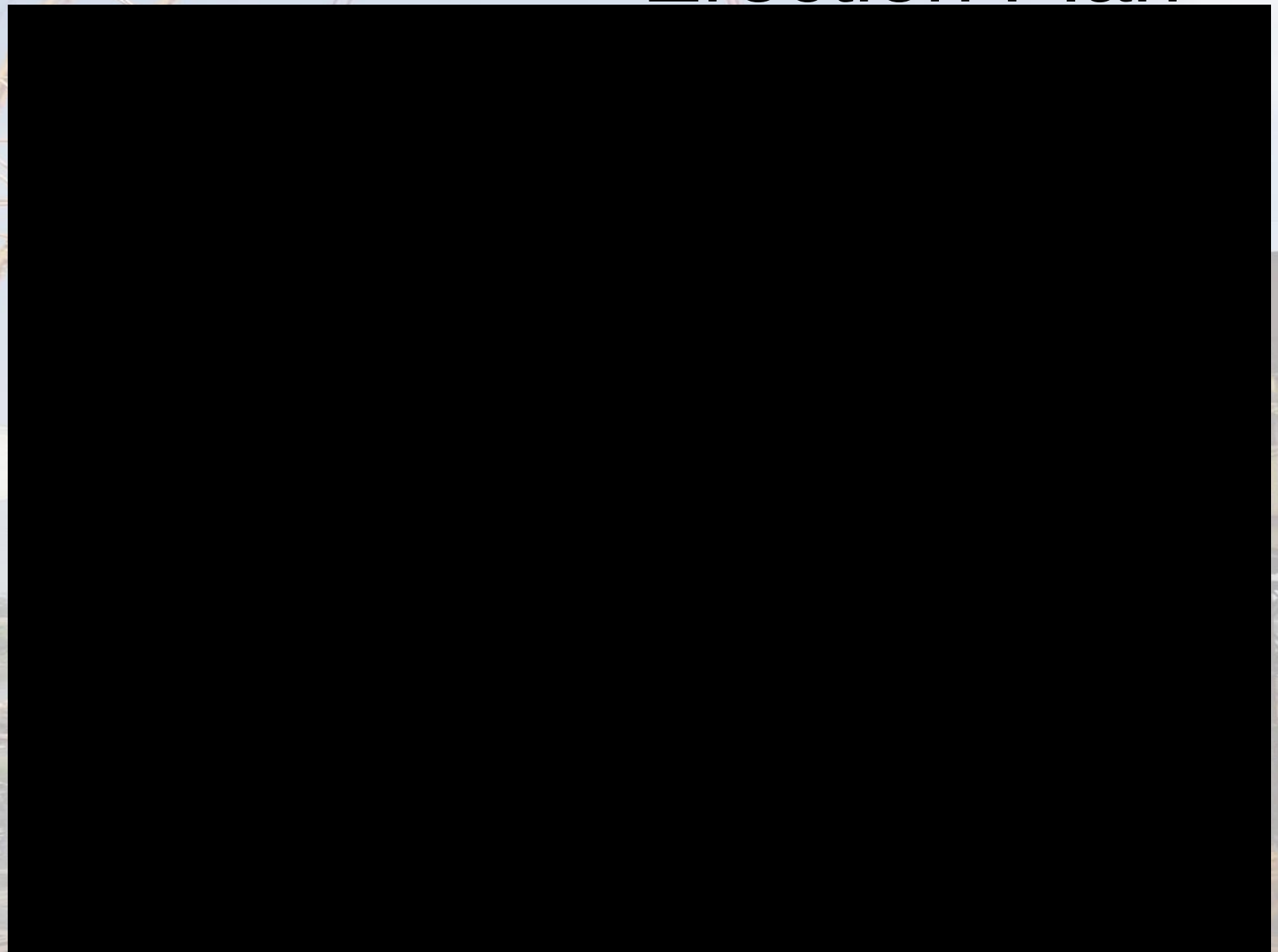
Erection Plan

- Unit 4 Girder Erection – Step 2



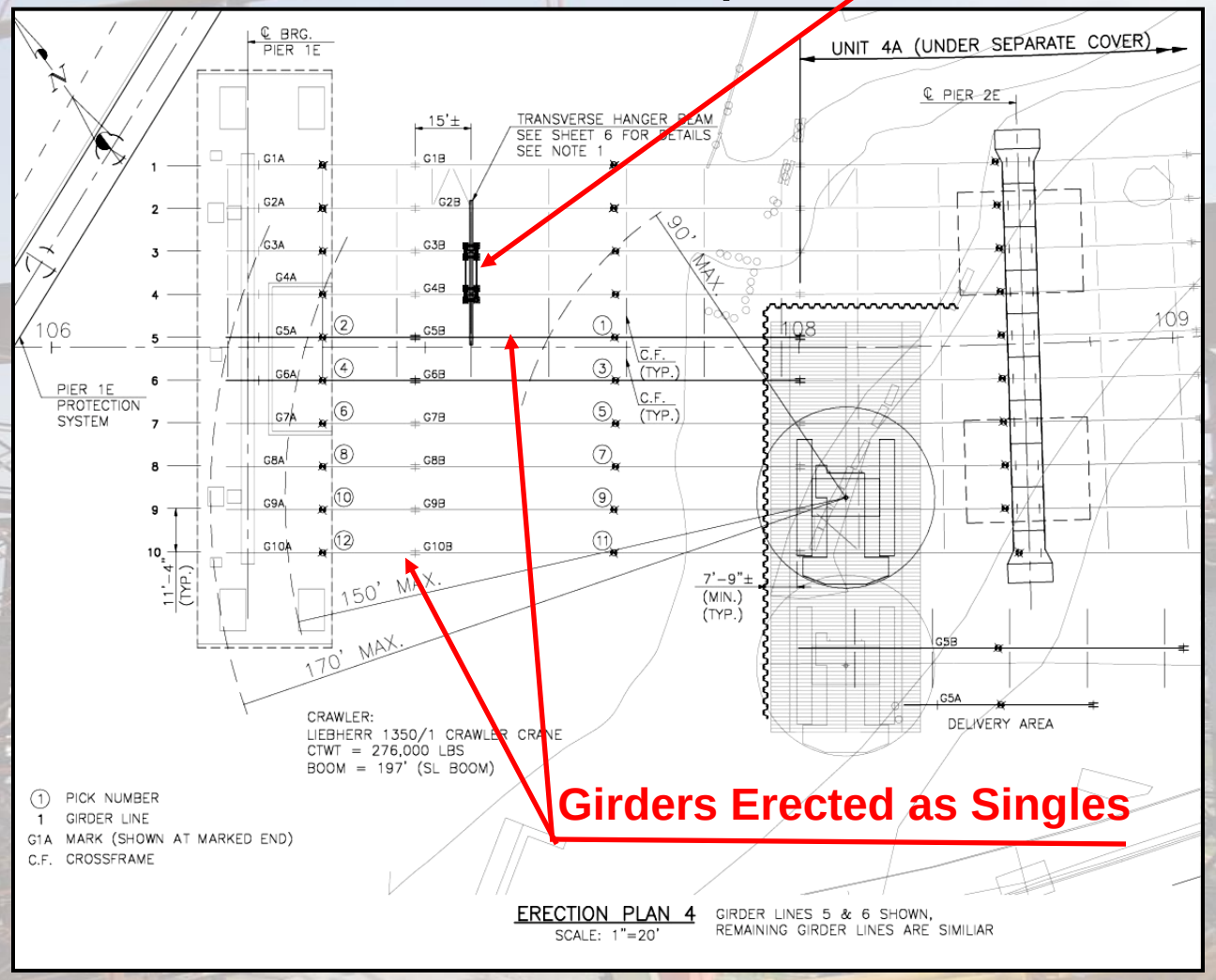


Erection Plan



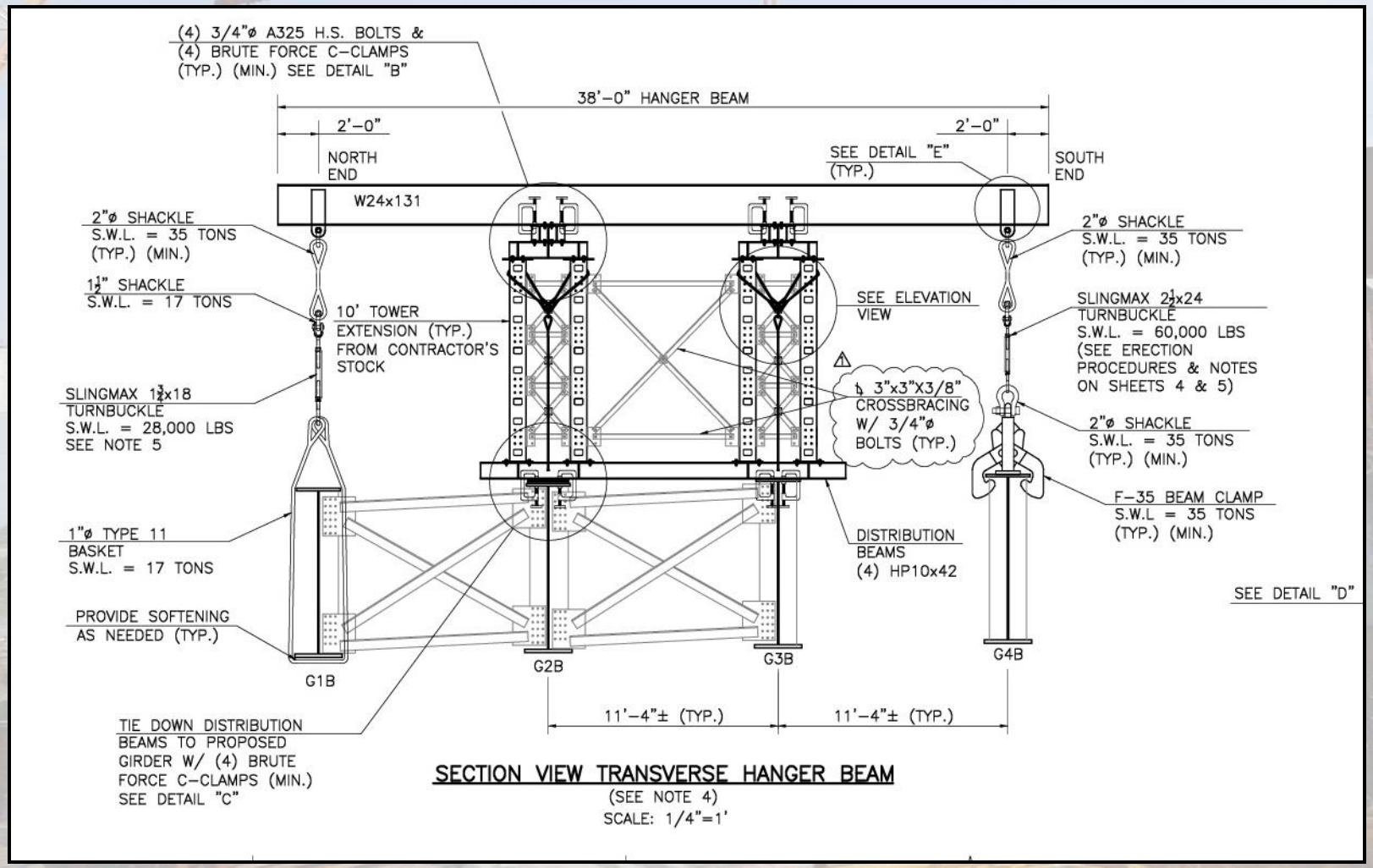
Erection Plan

- Unit 4 Girder Erection – Step 2



Erection Plan

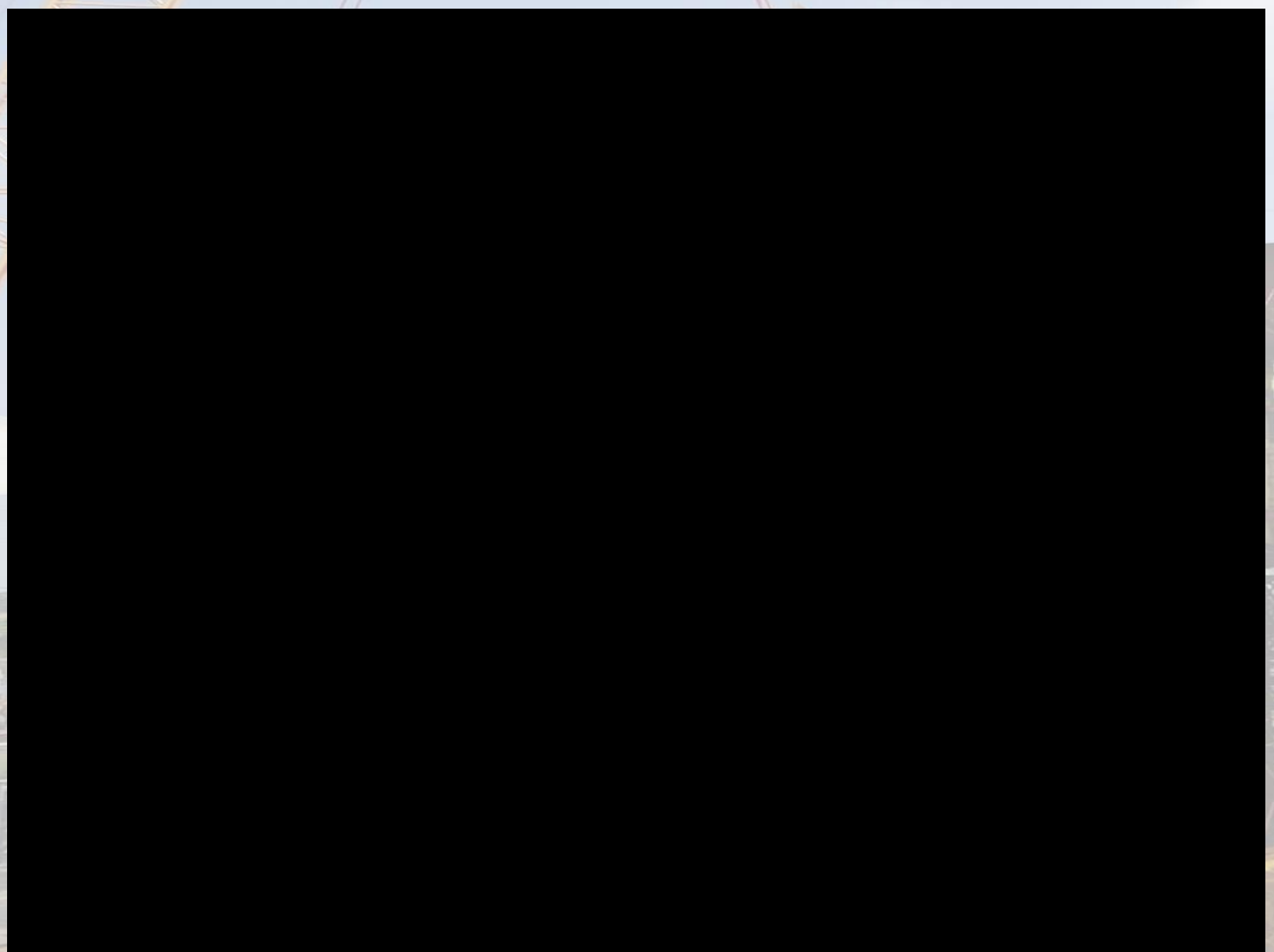
- Beam Hanger System



Erection Plan

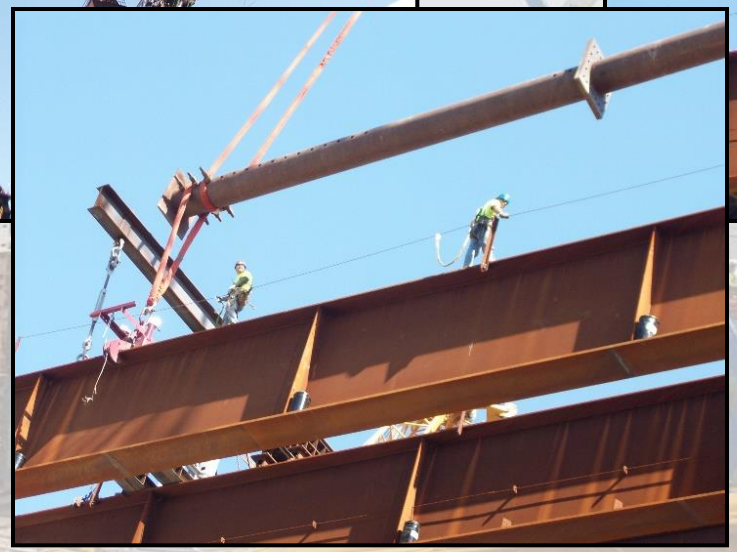
- Beam Hanger System

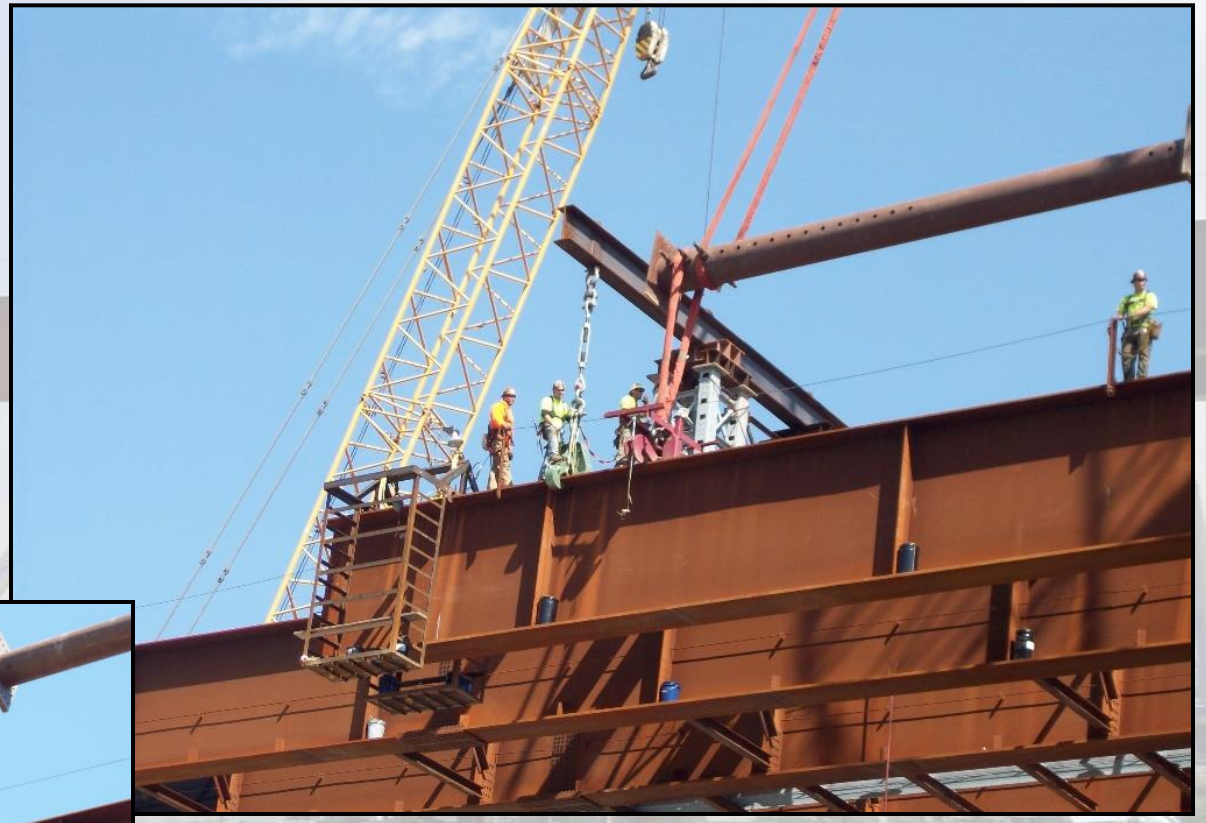
Erection Plan



Erection Plan

- Beam Hanger System



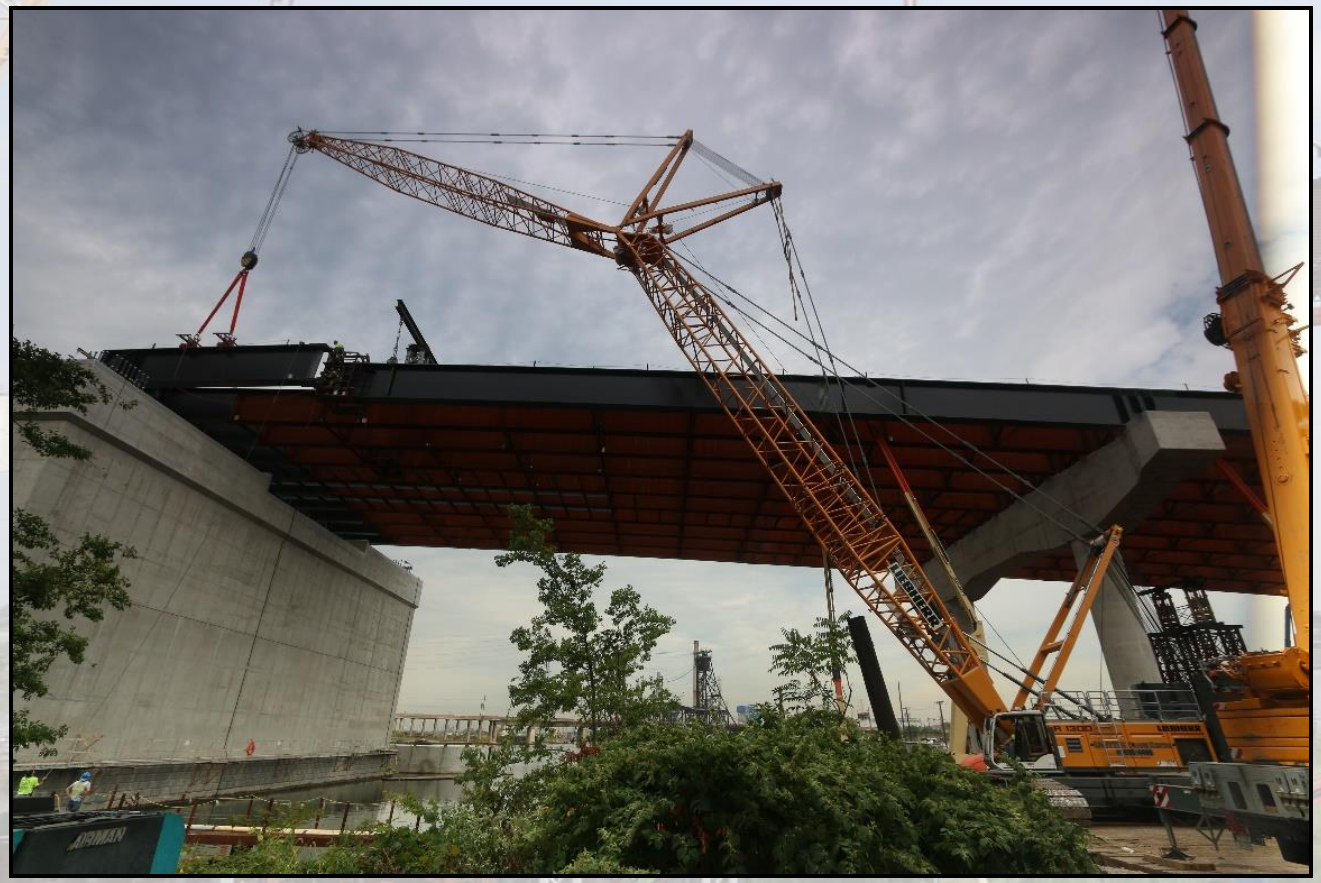


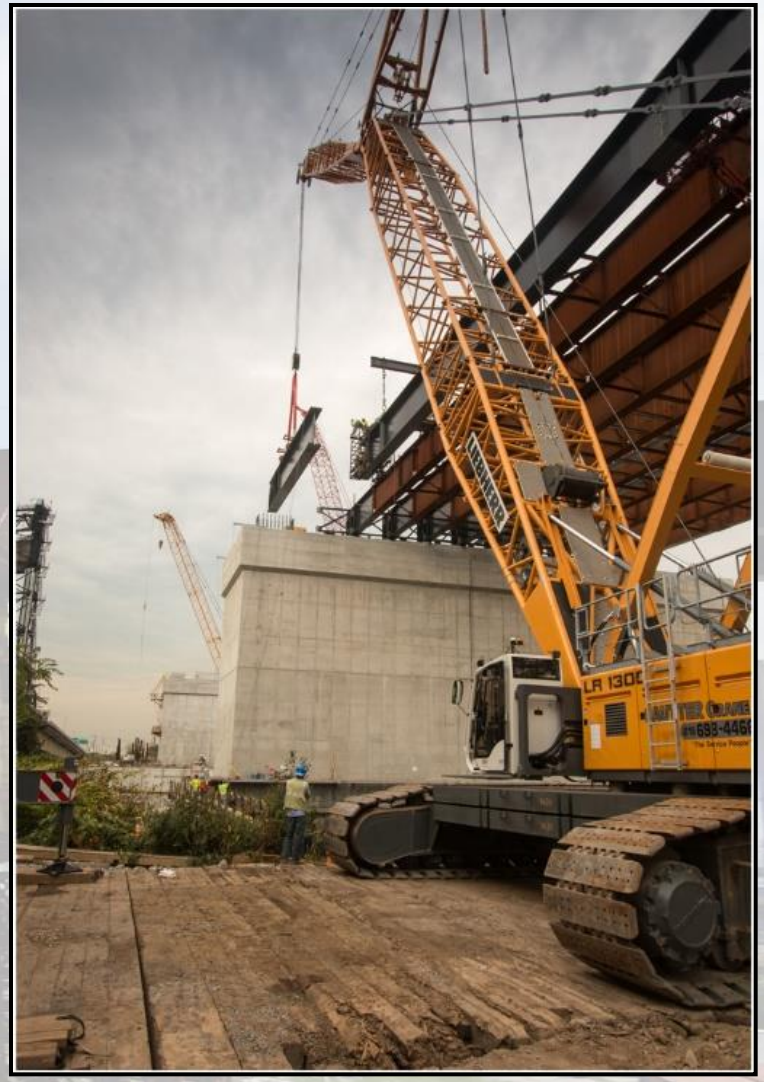
Erection Plan

- Beam Hanger System

Erection Plan

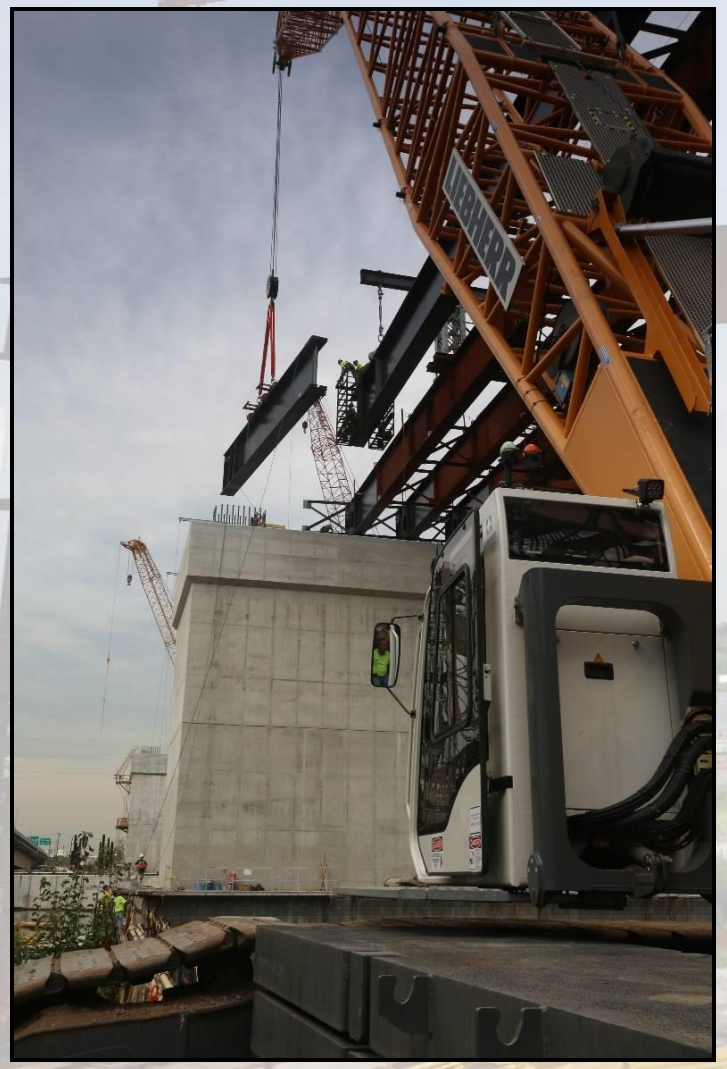
- Beam Hanger System

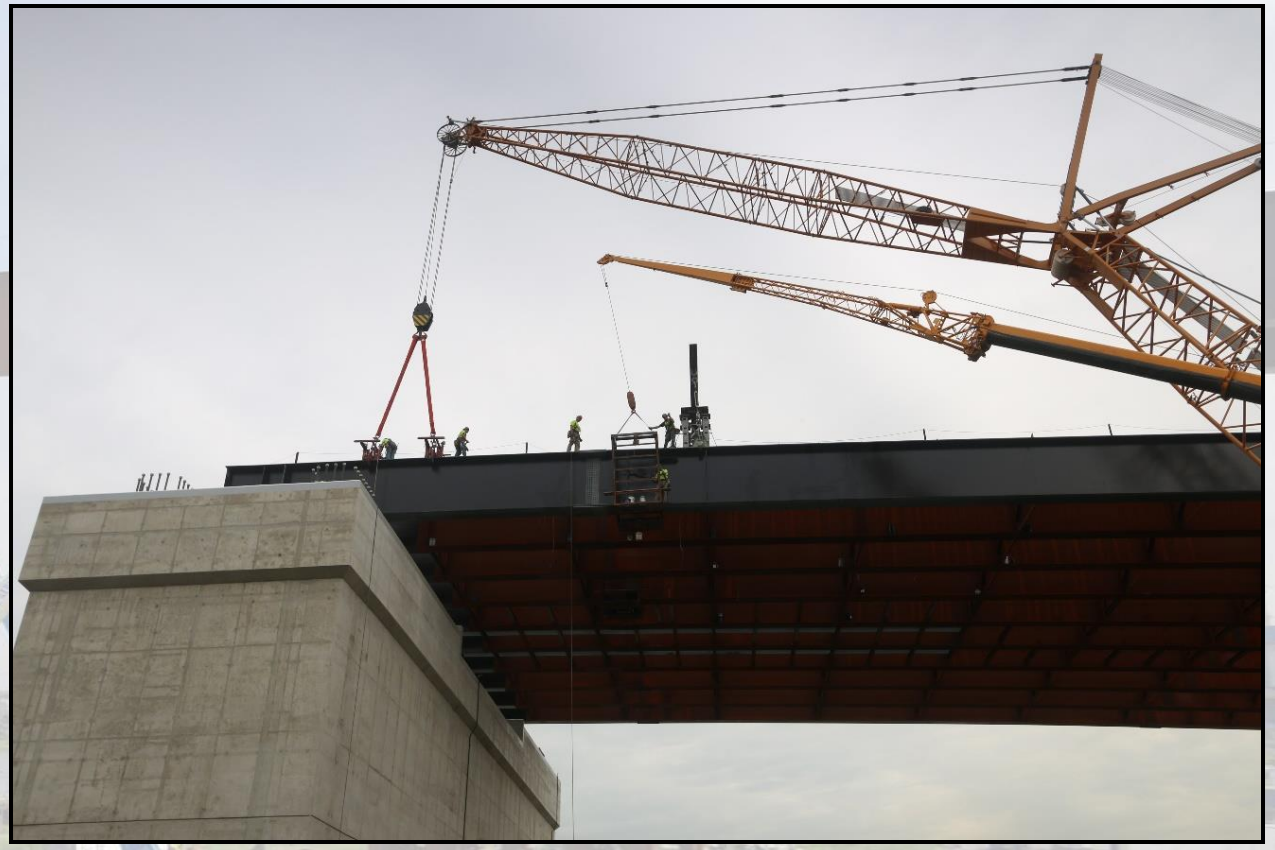




Erection Plan

- Beam Hanger System





Acknowledgements

- New Jersey Department of Transportation
- Mr. Jim Benzing, Structural Services Inc.
- Mr. Rick Lichtenwalner, Structural Services Inc.
- Mr. Louis Tomasello, PE, Union Paving and Construction.
- Mr. Andy Creteau, Union Paving and Construction
- Mr. Zeus Wu, PE, EIC Group LLC, Co-Author

Thank You!

Questions??