BRIDGE NO. 10-25/2-0.10 (903)
BARS NO. 10A126

CSWB

LOCAL NAME: THURMOND BRIDGE OVER NEW RIVER

CR 25/2 (S.L.S.)

Located 0.10 Miles East of CR 25 (S.L.S.)
FAYETTE COUNTY
DISTRICT NINE

NON-NATIONAL HIGHWAY SYSTEM
ADT 200, YEAR 2006

BRIDGE RENOVATION STUDY

FINAL PHASE I REPORT

Prepared for

THE WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS

January 16, 2013
Revised August 4, 2013

Prepared by

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TABLE OF CONTENTS

	Sheet No.
TITLE SHEET	1
TABLE OF CONTENTS	2
EXECUTIVE SUMMARY	3
GENERAL DESCRIPTION	4
PROJECT PURPOSE	4
EXISTING CONDITIONS	4
MAINTENANCE OF TRAFFIC	5
SUMMARY OF INSPECTION FINDINGS	5
SUMMARY OF LOAD RATING RESULTS	5
PROPOSED ALTERNATIVES	7
COMPARISON OF CONSTRUCTION COST	11
RECOMMENDATIONS FOR OVERALL STABILITY	12
TEMPORARY REPAIRS FOR OVERALL STABILITY	12
ADDITIONAL RECOMMENDATIONS FOR OVERALL STABILITY	13
RECOMMENDATIONS FOR PHASE II	14

APPENDIX – Figures 1 through 9

EXECUTIVE SUMMARY

The Thurmond Bridge is a unique railroad structure with a cantilevered roadway supporting vehicular traffic and pedestrians. The bridge is situated in a sensitive historical and environmental location that limits new construction activities. The condition of bridge is critical due to dislodged truss bearings. The overall stability analysis results indicate the bridge lacks stability and uplift is occurring at the downstream girder bearings under dead load. These bearings are corroded and cannot support the predicted uplift. Therefore, we are recommending that WVDOT consider closing the bridge temporarily to vehicle traffic and/or take other precautions until proper tie-downs can be installed at the bearings. Aside from the items noted above, the bridge rates adequately, with the exception of a few locations that could be repaired to restore the H-12 and Cooper E-80 load capacities. A rehabilitation of the bridge appears to be a practical long-term solution, and we recommend further analysis of the bridge in the Phase II Renovation Study. The Phase II Study will also include evaluation of alternatives to improve pedestrian access. An alternative to replace the highway bridge will be included to provide a comparison to the renovation options.

After the draft report was submitted in February 2012, WVDOT reduces the load posting to 3 tons. WVDOT and RJ Corman coordinated to install temporary repairs to the bearings in attempt to resist the uplift at the downstream bearings. The posting has since been raised to 10 tons. After review of the as-built photographs, B&N has comments on the installation that affect the load carrying capacity.

GENERAL DESCRIPTION

This project involves the study, inspection, and analysis for renovation of the Thurmond Bridge which carries County Route 25/2 over the New River in Fayette County, West Virginia. Phase I of the project includes the inspection and load rating of the existing structure. This Phase I Renovation Study Report summarizes the results of the Phase I inspection, load rating, and recommends alternatives to be studied in Phase II of the Renovation Study. This report is supplemented by an In-Depth Periodic Inspection Report and Load Rating Report.

PROJECT PURPOSE

The intent of the project is to maintain or increase the load posting of the existing bridge while also providing handicap pedestrian access. The grid decking is not pedestrian friendly, and the current width does not accommodate vehicles and pedestrians simultaneously. The following goals have been established:

1) Determine the condition and capacity of the entire existing bridge (railroad and roadway).
2) Maintain or increase the load posting of the existing roadway portion of the bridge.
3) Provide pedestrian friendly walking surface.
4) Accommodate vehicles and pedestrians simultaneously.

EXISTING CONDITIONS

The roadway bridge is cantilevered from a railroad bridge leased by RJ Corman Railroad (Figures 1 and 2). Thirty-five spans of roadway stringers are supported by cantilever brackets that attach to the railroad girders and truss. The longest roadway bridge span is 37’-11¼”. The eight-span railroad bridge has seven girder spans up to 84’-2” long and one truss span of 226’-0”. The overall length of bridge is 826’-7”, including the bent supported spans adjacent to the railroad abutments. The roadway bridge is not skewed, but the railroad bridge is skewed 45 degrees left forward. The alignment is tangent. The clear roadway width is 11 feet, 11 inches curb to curb with an open-steel grid deck and no sidewalk. A utility conduit is suspended from the guardrail supports on the upstream side of the bridge.

Previous superstructures have been supported by the old masonry substructures. In 1908, the superstructure was destroyed by flooding. The current superstructure and three additional piers were

constructed in 1916. Repairs were made in 1939, 1953, 1957, 1975, and most recently in 1983, when the posting was raised to 12 tons.

MAINTENANCE OF TRAFFIC

The estimated 2006 average daily traffic (ADT) for CR 25/2 is 200 vehicles per day (VPD). In addition to normal traffic, other traffic consists of school buses, mail delivery, emergency vehicles, and tourists to the Interpretive Center at the rebuilt Thurmond Railroad Depot. It is anticipated that the traffic will be maintained on the existing bridge during the rehabilitation. During the 1983 rehabilitation, traffic was maintain on railroad side of the bridge using temporary planking (See Figures 3, 4 and 5).

SUMMARY OF INSPECTION FINDINGS

The general overall condition of the bridge is critical. Areas of the bridge require a three month inspection frequency to remain in service until repairs can be made. Due to the extent and severity of the deficiencies, the structure is recommended for an overall rehabilitation to restore the structural integrity. The most serious deficiencies include the dislocated truss bearings; decaying wingwalls; deterioration of the concrete substructures; undermining of girder bearings, corroded anchor bolts, and areas of advanced section loss to steel members. Repair recommendations, photographs and drawings detailing the condition of the bridge can be found in the In-Depth Bridge Inspection Report submitted under a separate cover.

SUMMARY OF LOAD RATING RESULTS

The analysis results indicate that several of the downstream girder bearings are receiving uplift just under dead load. The uplift increases to over 100 kips for H20 lane load. The uplift combined with heavily deteriorated condition of the anchor bolts indicates the bridge has zero capacity for highway live load in terms of stability (this condition has been repaired since the draft report was submitted).

The controlling load rating for the highway loading is H-9 (or 9 tons) inventory in a few isolated instances. The design load of the 1983 rehabilitation was H-12 for which most of the bridge has capacity. However, the rehabilitation plans were not clear on which stringers were to be 50 ksi steel, the ratings for the longer span stringers using 36 ksi steel controls. If 50 ksi steel is used, a more reasonable 13 tons rating controls the stringers. A few of the roadway brackets have been altered from the original design with posts onto the pier caps and a bent lower diagonal on Bracket 25. These brackets rate at 9 tons. Four

of the brackets have significant loss which lower their ratings to 10 tons. The brackets with 100% section remaining rate over 14 tons. The railroad bridge is controlled by the upstream truss upper chords at 24 tons for the H truck lane loading.

The controlling load rating for the railroad loading is Cooper E-52. The low ratings are isolated to the truss stringers which are controlled by the unbraced length and resulting reduction in bending stress. The next lowest rating is Cooper E-79 at the downstream truss low chord which has 16% section loss. The girders have isolated locations rating at Cooper E-82, but generally rate higher. A detailed summary and explanation of the load ratings can be found in the Load Rating Report submitted under a separate cover.

PROPOSED ALTERNATIVES

Several options were reviewed to improve pedestrian access across the bridge. These alternatives include:

Alternative 1: No Build.
Alternative 2: Renovation of existing bridge only.
Alternative 3: Filling a strip of the grid.
Alternative 4: Addition of refuge/observation bays. *(Preferred)*
Alternative 5: Addition of full length sidewalk, upstream side.
Alternative 6: Addition of full length sidewalk, downstream side.
Alternative 7: Add overflow parking on the Depot end of the bridge.
Alternative 8: Replace Bridge.

Alternatives 2 through 7 assume repairs and painting of the existing bridge members will be completed as recommended in the inspection report. The proposed work is not permitted to encroach upon the waterway of the New River.

The preliminary cost each alternative is compared on Sheet 10. The following is a review of each Alternative:

ALTERNATIVE 1: NO BUILD

Due to the deteriorated and unstable condition of the bridge, the No Build Alternative would result in the eventual closure of the bridge. The detour would be approximately 52 miles over unimproved routes with a travel time of approximately 1.5 hours. The No Build Alternative is not a viable option. Therefore, no further investigation was performed.

ALTERNATIVE 2: RENOVATION ONLY

Renovation to the bridge will include the following items of work:

- Anchoring of uplift at downstream girder bearings.
- Replacement of deteriorated timber ties and planking.
- Jacking and temporary support the truss and girders while the bearings are replaced.
- Bearing replacement.
- Extensive concrete patching, crack sealing, and seat re-construction.
- Wingwall reconstruction.
- Structural repairs to the deteriorated steel members and connections – including:
    - Plating of the truss low chords at a few areas of heavy loss.

  - Heat straightening the downstream diagonal with collision damage.
  - Replacement of several truss lateral gusset plates and cap plates with heavy loss.
  - Plating of several girder flanges, stiffeners and lateral gussets that exhibit significant loss with through holing.
  - Strengthening of roadway brackets 2, 5, 8 and 27-31 and several connection repairs to the bottom flanges.
- Replacement of deteriorated rivets with bolts.
- Cleaning, sealing, and painting.

Without addressing the pedestrian access, the previous issues reported to the park service will continue to occur. Pedestrians and vehicular traffic will have shared access to the 11'-11" bridge deck. Although it is not known if an incident resulting in injury has occurred in the past, the shared use presents a potential safety hazard and liability. Since a large construction contract will be needed to complete the rehabilitation, inclusion of items to improve pedestrian access may only be a small percentage of the work.

ALTERNATIVE 3: FILLING THE GRID

In addition to all items listed under Alternative 2: Renovation Only, Alternative 3 consists of filling the grid with lightweight concrete for a width of four feet providing a solid walkway (Figure 6). One of the issues previously reported is that the open grid deck is not pedestrian friendly. Users feel uneasy looking through the grid. The increase in dead load may cause the stringers to slightly exceed inventory capacity. Repairs to increase the capacity would included adding a bottom cover plate in the longer spans. The typical roadway brackets have some excess capacity but may also need strengthened at the controlling spans. Filling the grid would result in an increase in the uplift at the downstream bearings. The proposed tie-down anchorages would have to be sized to accommodate the additional uplift. Other possibilities could include using a lightweight epoxy fill or installing treated timber planking on top of the grid. The original roadway was constructed of timber planking.

ALTERNATIVE 4: UPSTREAM REFUGE BAYS ***(Preferred)***

In addition to all items listed under Alternative 2: Renovation Only, Alternative 4 consists of installing refuge bays on the upstream side of the bridge. Considering the ADT is low, a full length sidewalk may not be essential to provide safe pedestrian access. The installation of refuge (or observation) bays would provide the following benefits:

- Allows pedestrians to move clear of oncoming vehicles
- Provides unique vantage points

- Aesthetically pleasing
- Less cost since only located at 200' intervals
- Easier to support than full length walkway access

Figure 7 shows preliminary details of how the refuge bay could be supported from the stringers. The refuge bay could be positioned on the shorter span stringers which have excess capacity. Strengthening of the brackets in at the refuge bay locations may be needed to accommodate the additional loads. Adding refuge bays would result in a minor increase in the uplift at the downstream bearings. The proposed tie-down anchorages would have to be sized to accommodate the additional uplift. Lightweight materials, such as timber, FRP, and aluminum, will be considered to reduce the load effect.

Signage would be installed to inform users, such as "VEHICLES YIELD TO PEDESTRIANS" and "PEDESTRIAN USE OBSERVATION BAYS TO ALLOW VEHICLES TO PASS".

ALTERNATIVE 5: UPSTREAM SIDEWALK

In addition to all items listed under Alternative 2: Renovation Only, Alternative 5 consists of adding a sidewalk to the upstream side of the bridge. Addition of a sidewalk to the upstream side of the bridge could be accomplished by using similar details as Alternative 4. However, the additional load would require many strengthening repairs to the stringers and brackets. The overall stability of the structure would be decreased by cantilevering weight further away from the center of gravity. Uplift at the downstream bearings would be significantly increased making this alternative impractical.

ALTERNATIVE 6: DOWNSTREAM SIDEWALK

In addition to all items listed under Alternative 2: Renovation Only, Alternative 6 consists of adding a sidewalk to the downstream side of the bridge. Addition of a sidewalk to the downstream side of the bridge may be structurally feasible (Figure 8). Brackets similar to the existing could be installed to support the walkway. Most of the ratings on the downstream railroad members are well above Cooper E80, but local strengthening may be needed in a few areas to maintain the normal rating. The installation of a downstream sidewalk would provide the following benefits:

- Eliminates the shared use traffic lane.
- Increases safety to the users.
- Opportunity to provide a handicap accessible trail from the parking area.

- Serves as a counter-weight to the uplift problem providing better overall stability and less dependence on tie-downs.

Access to downstream side of the bridge would need to be provided. On the south end, a trail could be constructed from the existing overflow parking area, cross under the bridge in front of the abutment, and ascend to railroad grade with a series of ramps on the downstream side. On the Depot end of the bridge, the existing at-grade railroad crossing would need to be upgraded with signing and striping to safely inform and direct the pedestrians. Considering the speed of the trains is limited to 10 mph and trains only cross the bridge three times per week, an at-grade crossing should be feasible.

ALTERNATIVE 7: OVERFLOW PARKING NEAR THE DEPOT

In addition to all items listed under Alternative 2: Renovation Only, Alternative 7 consists of adding overflow parking lots near the depot. An area exists on the downstream side of the tracks adjacent to the Depot where an overflow parking lot could be developed (Figure 8). The existing at-grade railroad crossing would need to be improved. This alternative should eliminate the need for pedestrians to access the bridge. Signing could be installed to discourage pedestrians from walking out onto the bridge deck. However, it should be noted that pedestrian will still cross the bridge to obtain a view of the river.

ALTERNATIVE 8: BRIDGE REPLACEMENT

Replacement of the roadway bridge using new piers adjacent to the existing piers was a recommended alternative in the previous design study (See Alternative #1 of Bridge Replacement Study, January 2001). Traffic would be maintained on the railroad bridge while the existing brackets and deck are demolished. Placing the piers on the upstream side of the existing pier would maintain the hydraulic opening. The estimated cost for this alternative was $6,244,000 in 2001. The alternative will permanently encroach on the waterway of the New River.

THURMOND BRIDGE RENOVATION STUDY
COST COMPARISON OF ALTERNATIVES
WVDOT AND R.J. CORMAN RAILROAD

Prepared By: MWL 1/7/13

Revised By: MWL 3/25/13

ALT2 = Renovation Only
ALT3 = Filling the Grid with Renovation
ALT4 = Upstream Refuge Bays + ALT3
ALT6 = Downstream Sidewalk with Renovation
ALT7 = Overflow Parking Lot with Renovation
ALT8 = Bridge Replacement

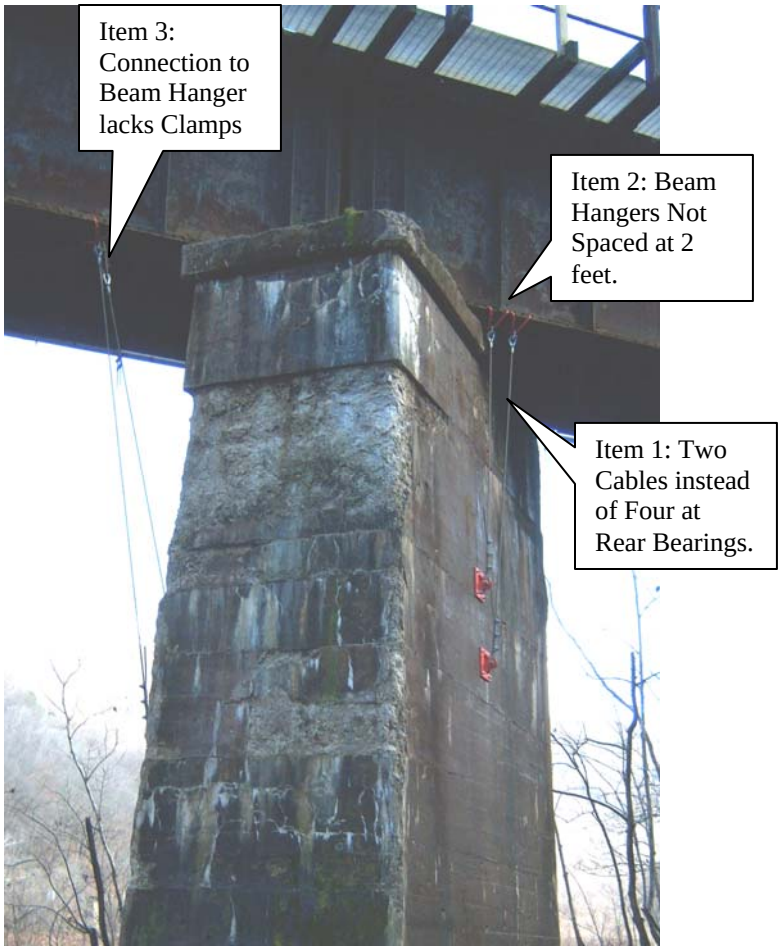
SUMMARY OF ESTIMATED QUANTITIES								COST INFORMATION						
DESCRIPTION	UNITS	QUANTITY						UNIT COST	ITEM COST					
		ALT2	ALT3	Preferred ALT4	ALT6	ALT7	ALT8		ALT2	ALT3	Preferred ALT4	ALT6	ALT7	ALT8
DISMANTLING STRUCTURE	LS	1	1	1	1	1		N/A	$75,000	$75,000	$100,000	$75,000	$75,000	
MOBILIZATION	LS	1	1	1	1	1		N/A	$85,000	$85,000	$86,000	$95,000	$85,000	
SUBSTRUCTURE CONCRETE REPAIRS	SF	3,450	3,450	3,450	3,450	3,450		$100	$345,000	$345,000	$345,000	$345,000	$345,000	
SUBSTRUCTURE MASONRY REPAIRS	LS	1	1	1	1	1		$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	
WINGWALL RECONSTRUCTION	SF	1,200	1,200	1,200	1,200	1,200		$80	$96,000	$96,000	$96,000	$96,000	$96,000	
STRUCTURAL STEEL REPAIRS	LB	20,000	20,000	20,000	15,000	15,000		$25	$500,000	$500,000	$500,000	$375,000	$375,000	
RIVET REPLACEMENTS	EA	3,500	3,500	3,500	3,500	3,500		$60	$210,000	$210,000	$210,000	$210,000	$210,000	
JACKING AND TEMPORARY SUPPORT OF GIRDERS SPANS	LS	1	1	1	1	1		$350,000	$350,000	$350,000	$350,000	$350,000	$350,000	
ELASTOMERIC BEARINGS AT GIRDERS	LS	28	28	28	28	28		$2,000	$56,000	$56,000	$56,000	$56,000	$56,000	
JACKING AND TEMPORARY SUPPORT OF TRUSS SPAN	LS	1	1	1	1	1		$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	
TRUSS EXPANSION BEARINGS	LS	2	2	2	2	2		$6,000	$12,000	$12,000	$12,000	$12,000	$12,000	
STRUCTURAL STEEL IMPROVEMENTS	LB			20,000	96,000			$10.00			$200,000	$960,000		
CLEAN AND PAINT EXISTING STEEL BRIDGE COATED W/ LEAD PAINT[1]	LS	1	1	1	1	1		$2,880,000	$2,880,000	$2,880,000	$2,880,000	$2,880,000	$2,880,000	
CONTAINMENT AND DISPOSAL OF SPENT MATERIAL[1]	LS	1	1	1	1	1		$960,000	$960,000	$960,000	$960,000	$960,000	$960,000	
BRIDGE TRACK WORK (Includes ties, rails, and fastenings)	LF	800	800	800	800	800		$100.00	$80,000	$80,000	$80,000	$80,000	$80,000	
FILLING THE GRID	SF		3,308	3,308				$50.00		$165,400	$165,400			
TRAIL CONSTRUCTION	LF				700			$200.00				$140,000		
OVERFLOW PARKING	SF					10,000		$30.00				$300,000		
MAINTENANCE OF TRAFFIC	LS	1	1	1	1	1		$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	
BRIDGE REPLACEMENT (Inflate at 3% annually from 2001 Study)	LS	0	0	0	0	0	1	$8,910,000						$8,910,000
	TOTAL CONSTRUCTION COST								$5,899,000	$6,065,000	$6,291,000	$7,184,000	$5,774,000	$8,910,000
	CONSTRUCTION CONTINGENCY (20%)								$1,180,000	$1,213,000	$1,258,000	$1,437,000	$1,155,000	$1,782,000
	SUBTOTAL								$7,079,000	$7,278,000	$7,549,000	$8,621,000	$6,929,000	$10,692,000
	MISCELLANEOUS [2] (15%)								$1,061,850	$1,091,700	$1,132,350	$1,293,150	$1,039,350	$1,603,800
	TOTAL PROJECT COST								**$8,141,000**	**$8,370,000**	**$8,681,000**	**$9,914,000**	**$7,968,000**	**$12,296,000**
	PERCENT DIFFERENCE FROM LOWEST								2%	5%	9%	24%	0%	54%

[1] *Estimated using linear feet ratio for Market Street Bridge inflated 4 years.*

[2] *Miscellaneous includes Engineering, Construction Services, Legal, Surveying, Permits, etc.*

RECOMMENDATIONS FOR OVERALL STABILITY

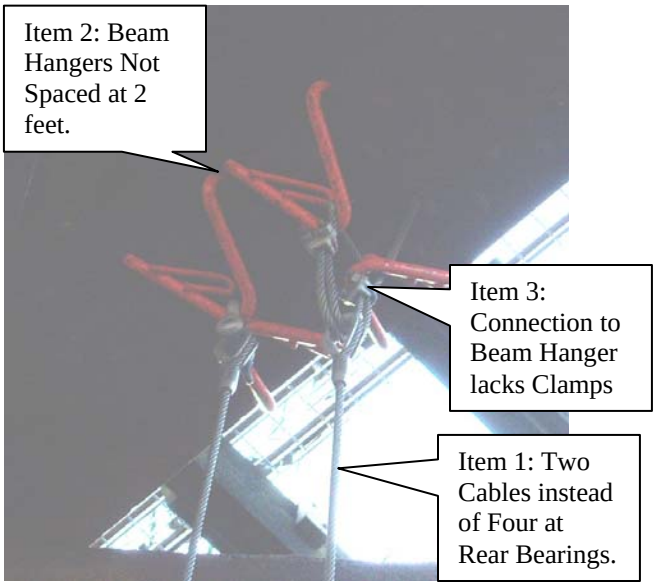
The analysis indicates that several of the downstream girder bearings are receiving uplift. Therefore, in the draft report, we recommended that WVDOT consider closing the highway spans until anchorage of the downstream bearings can be provided or the uplift is eliminated.



TEMPORARY REPAIRS FOR OVERALL STABILITY

After the draft report was submitted in February 2012, WVDOT reduced the load posting to 3 tons. WVDOT and RJ Corman coordinated to install temporary repairs to the bearings in attempt to resist the uplift at the downstream bearings. The repair consisted of cable attached to beam flange hangers. The cables were anchored to the piers using X-anchor plates with four anchor bolts. The beam flange hangers and X-anchor plates are products of Bridge Platforms, Inc. The posting has since been raised to 10 tons.

After review of the as-built photographs, we have noticed a few issues with the installations that may affect the load carrying capacity. The rear bearings required two beam hangers and four cables. It appears only two cables were installed (see call out for Item 1 in photographs). In addition, the two beam hangers lack adequate spacing (Item 2). The bending capacity of the bottom flanges was checked using a 2 foot spacing. At a few locations, it appears the cable lengths were too short and loops of cable were used at the connection to beam hanger. This connection was made with one clamp per free end instead of the normal three clamps (Item 3).



At the rear bearing on Pier 2, two cables are connected into one loop with what appears to be only two clamps. It also appears that only one beam hanger is used (Item 4).

ADDITIONAL RECOMMENDATIONS FOR OVERALL STABILITY

Cut sheet information should be provided by R.J. Corman on the materials and connectors that were used (cable spec and diameter, clevis size and capacities, etc). The number of beam hangers and cables used should be reviewed at each location. Two additional cables should be installed at the rear bearings. The cable clamps should re-positioned to provide a minimum 2 foot spacing. Additional clamps should be installed in the loop connection locations.

RECOMMENDATIONS FOR PHASE II

The Thurmond Bridge is a historic structure located in sensitive national park area. Although the existing structure is in need of major renovation, the main railroad bridge members have adequate capacity and were designed to support a cantilevered roadway. By preserving the structure, the WVDOT will reduce the use of new materials, maintain the aesthetics of the historical district, reduce initial construction costs, and minimize the environmental impact.

Alternatives 3 and 4 are recommended for further investigation in Phase II of the Renovation Study. Phase II should included:

- Review of available hydraulic data to establish the 100 year flood plain and discussion of the possible impact of future flooding on the bridge.
- Site surveying of bridge approaches, top of rail, utilities, bearing locations, low steel, wingwalls, and proposed parking and trail areas.
- Detailed inspection of the substructure units and bearing areas.
- Review of possible means and methods for substructure and bearing repairs and impact on the river.
- Utility coordination.
- Develop temporary traffic control plan.
- Coupon testing of steel in longest stringer spans, railroad stringers, and other members as practical.
- Load rating of connections in the truss members and brackets.
- Revise load rating and stability analysis for additional loading of filled grid and observation bays.
- The effects of wind load, braking and traction forces, and lateral forces from equipment should be considered in the load rating as specified by AREMA 15.7.3.2.
- Conceptual repair details including:
  - Anchoring of downstream girder bearings.
  - Jacking and temporary support the truss and girders while the bearings are replaced.
  - Substructure repairs.
  - Wingwall reconstruction.
  - Structural repairs to the deteriorated steel members and connections.
- Preliminary scope of repairs, construction sequence, and calculation of quantities.
- Itemized cost estimates for each alternative.

Figure 1: Existing Railroad Bridge

- **8 Spans = 827’ Long**
  - **7 Girder Spans = 84’, Truss Span = 226’**

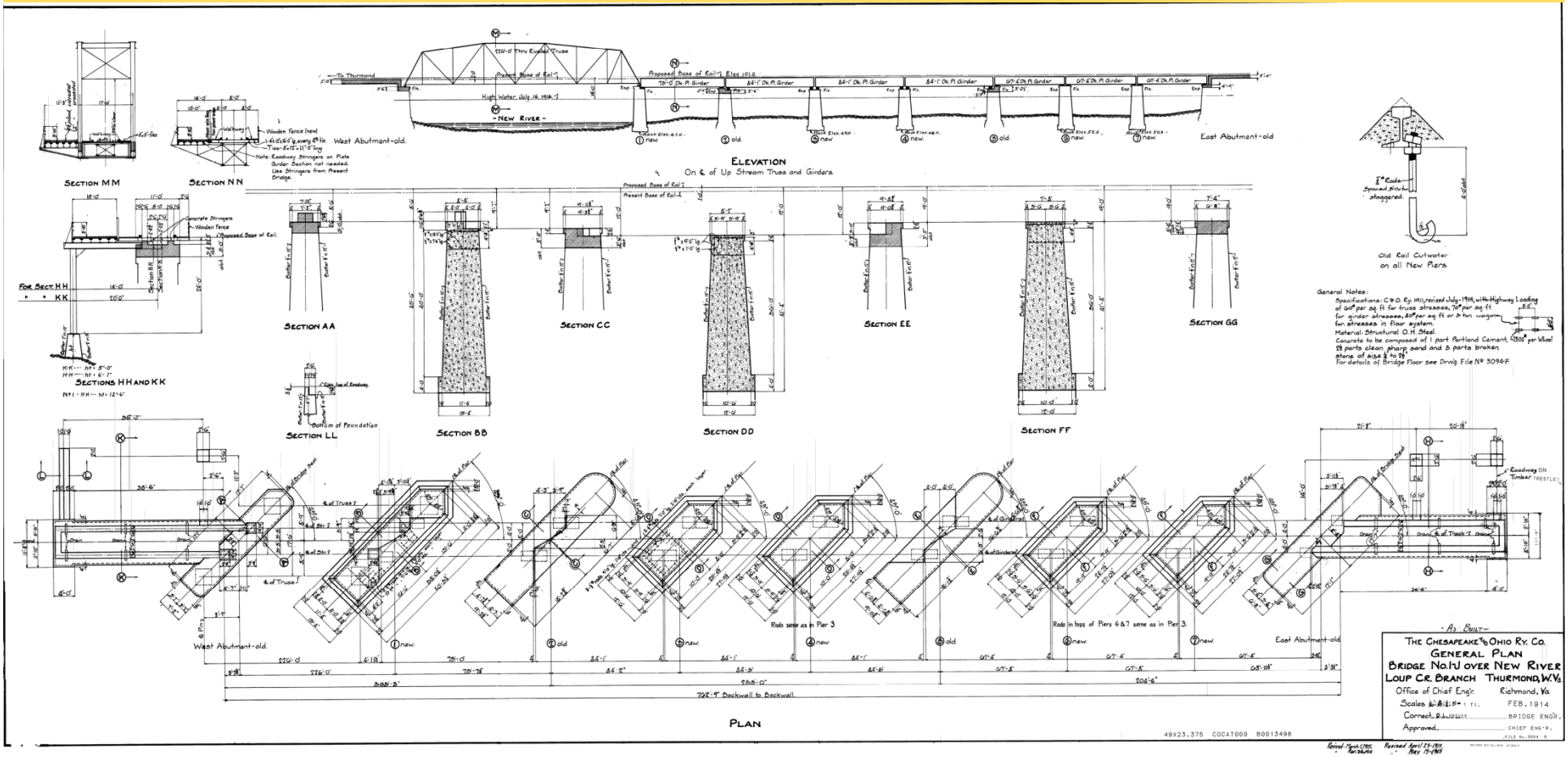
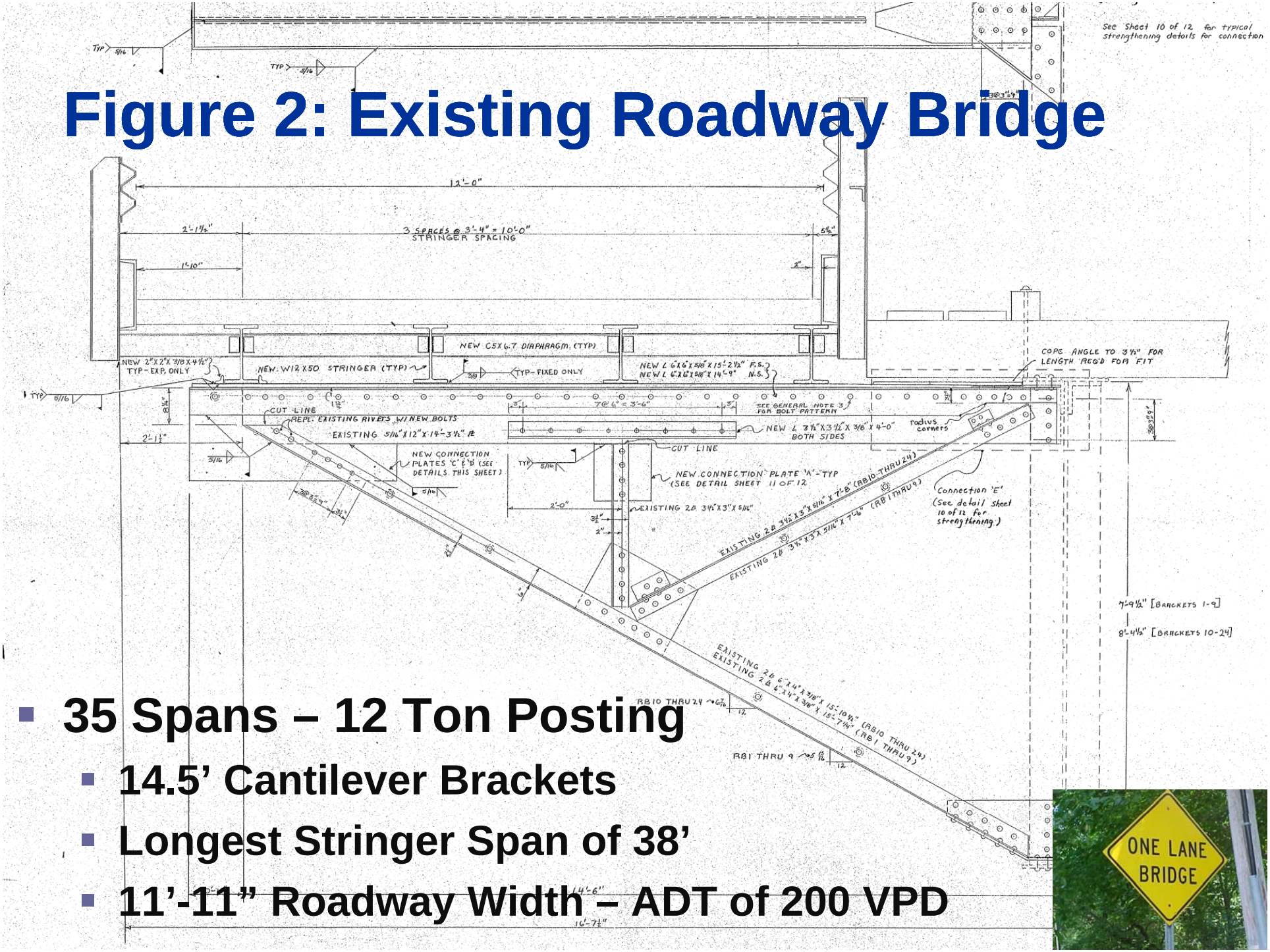
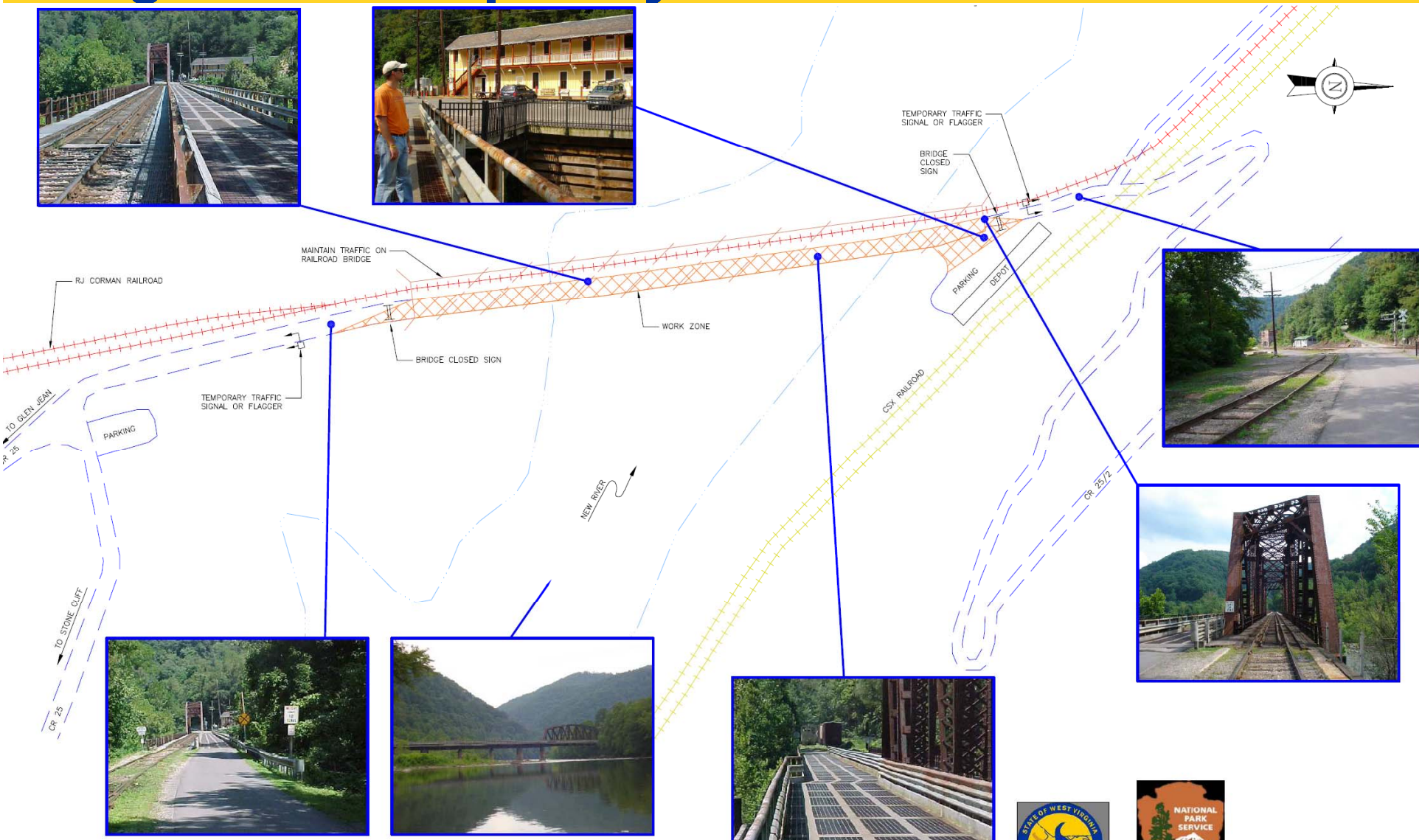


Figure 2: Existing Roadway Bridge



- **35 Spans – 12 Ton Posting**
  - **14.5' Cantilever Brackets**
  - **Longest Stringer Span of 38'**
  - **11'-11" Roadway Width – ADT of 200 VPD**

Figure 3: Temporary Traffic Control Plan



BURGESS & NIPLE
Engineers ▪ Architects ▪ Planners

TEMPORARY TRAFFIC CONTROL PLAN
THURMOND BRIDGE RENOVATION STUDY

Figure 4: 1983 Planking Details

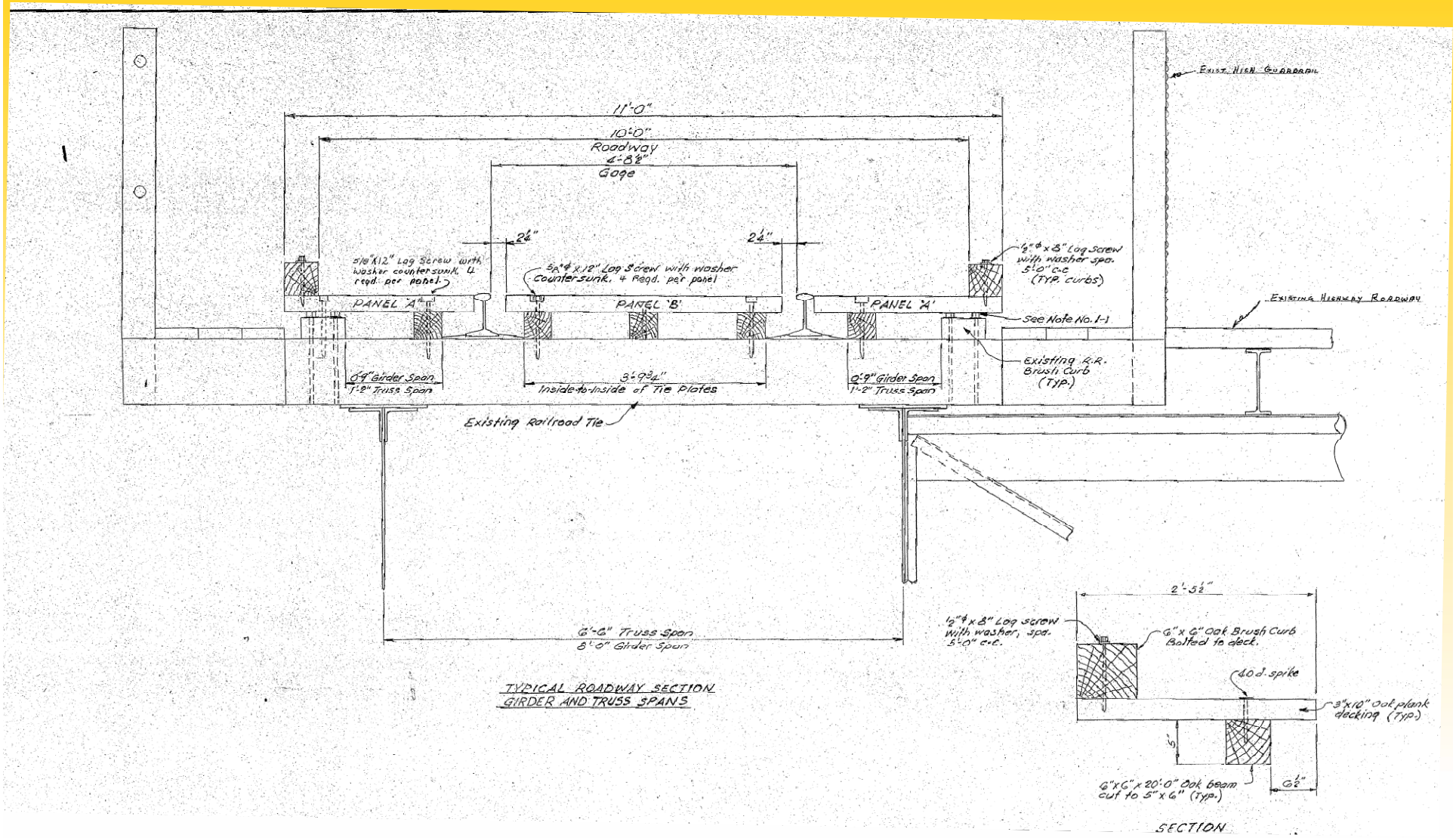


Figure 5: 1983 Approach Details

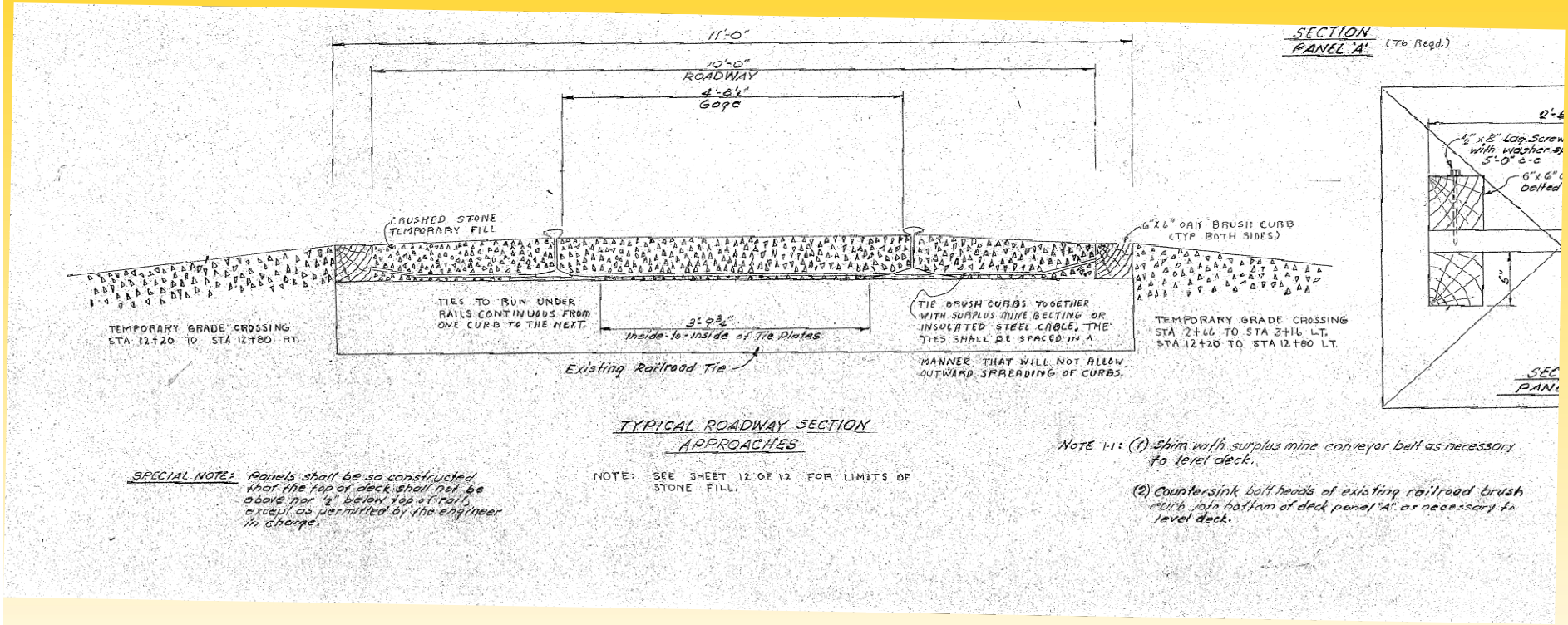


Figure 6: Fill the Grid & Refuge Bay

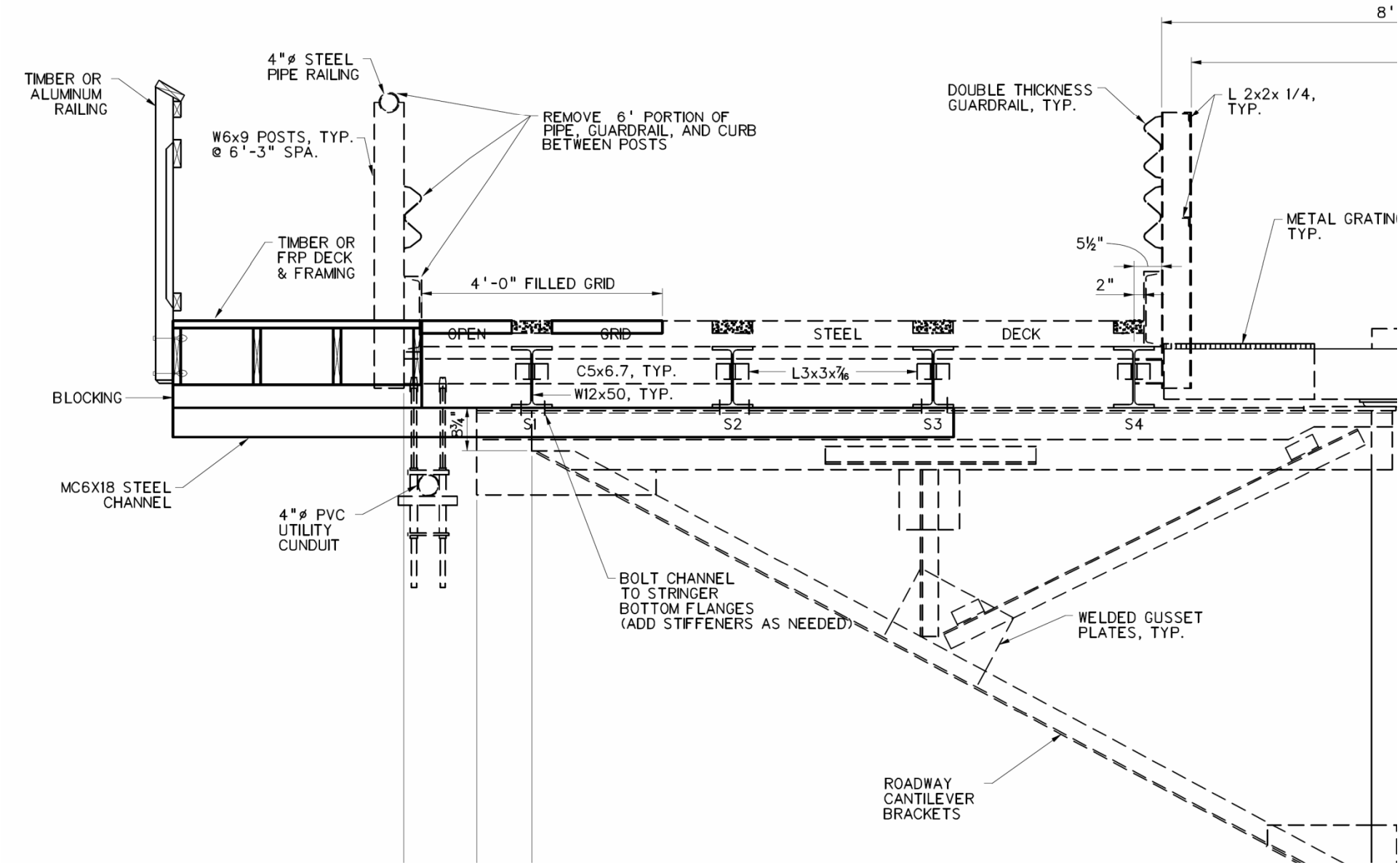
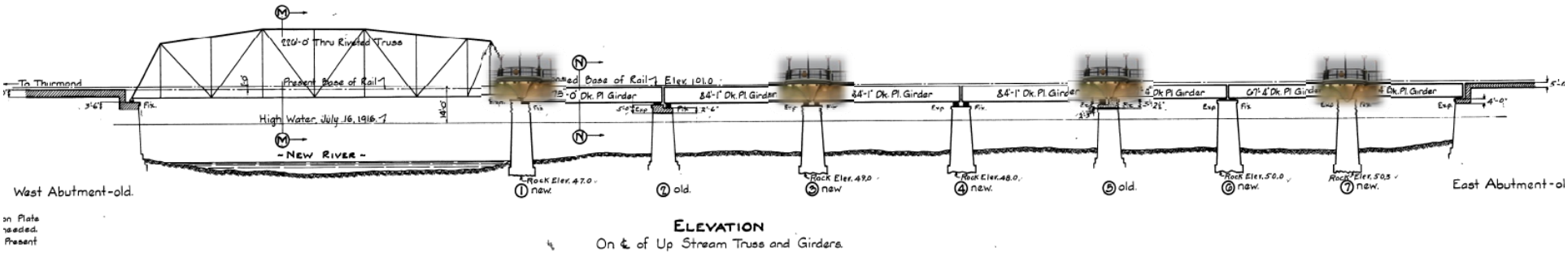


Figure 7: Upstream Refuge Bays

- **Allows Pedestrians to Move Clear of Oncoming Vehicles**
- **Provides Unique Vantage Points**
- **Aesthetically Pleasing**
- **Located Only at Piers at 200’ Intervals**
- **Easier to Support than Full Length Walkway**



Note: Looking Upstream – Bays are on Upstream Side

Figure 8: Downstream Sidewalk

- Likely to be Structurally Feasible
- New Trail From Overflow Parking
- Trail Below Bridge in Front of Abutment
- Gain Elevation with Meandering Trail
- Improve Existing At-Grade RR Crossing

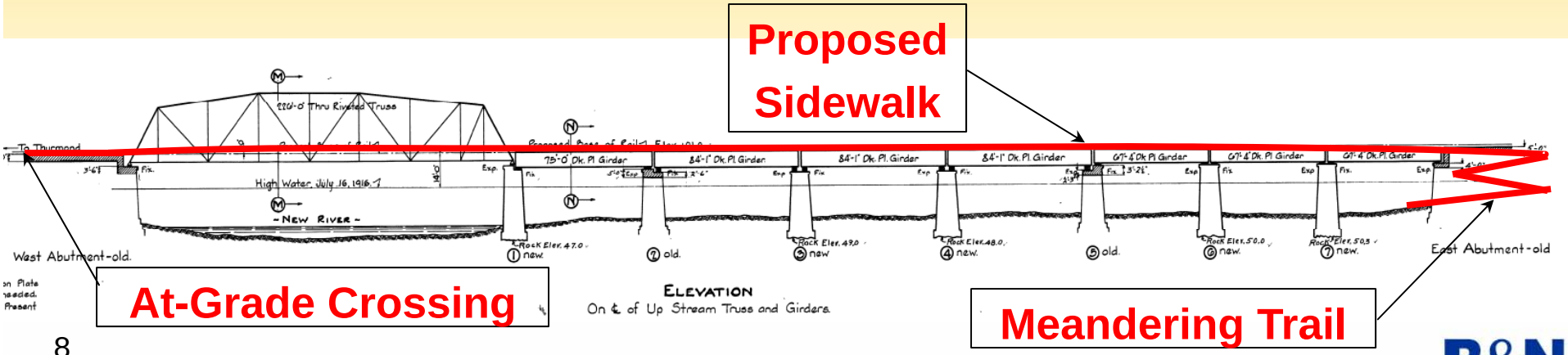


Figure 9: Overflow Parking Near Depot