Prepared For:

New Hampshire DOT

Interstate 89 over the Connecticut River

Bridge No. 044/104 (N.B.)
Bridge No. 044/103 (S.B.)

Lebanon, NH – Hartford, VT

Bridge Rehabilitation Study Report

Prepared By:

McFarland Johnson

53 Regional Drive • Concord, NH 03301

State Project No. 16148

July 2014

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Purpose and Need Statement

The Purpose and Need statement is fundamental to the analysis of the project under the National Environmental Policy Act (NEPA) and other environmental regulations.

Purpose

The purpose of the proposed project is to improve highway safety and preserve the structural integrity of the existing bridges, while maintaining this vital, high-volume transportation link between New Hampshire and Vermont.

Need

The need for the project is as follows:

- ☼ The SB Bridge is currently on the State's Red List and is considered structurally deficient based on its deteriorated superstructure.
- ☼ The NB Bridge is currently on the State's Red List and is considered structurally deficient based on its deteriorated deck.
- ☼ The existing inside and outside shoulder widths on both bridges are non-standard at only 3'-0" wide.
- ☼ The on-ramp from northbound Interstate 91 (I-91) to southbound Interstate 89 (I-89) has an insufficient merge distance.
- ☼ There is less than the desirable 2,000 feet between the southbound on-ramp from I-91 and the off-ramp to Exit 20.
- ☼ There are crashes occurring on the southbound on-ramp from I-91 as a result of the above mentioned geometric deficiencies.

Project Description

State Project No. 16148 evaluates the rehabilitation of State Bridge Nos. 044/104 & 044/103. The bridges carry northbound and southbound traffic on I-89 over the Connecticut River and the New England Central Railroad between Lebanon, NH and Hartford, VT. The primary purpose of the project is to correct structural deficiencies and improve traffic safety between the I-91 interchange in Vermont and the Exit 20 interchange in New Hampshire. The project proposes to widen the existing bridges and rehabilitate the existing substructures.

Project Decisions

Key project decisions have been made by the NHDOT Front Office and VTrans Executive Staff based on the conducted evaluations and analyses. The following project decisions were approved by the NHDOT Front Office at the dates noted below and by VTrans Executive Staff at the October 7, 2013 meeting. The key project decisions include:

- Widen bridges to the inside. Two widening alternatives were reviewed; widen the bridges to the outside or widen to the inside gap between the bridges. The decision to widen to the inside was based on several factors including highway alignment, proximity of adjacent interchanges, environmental permitting, and traffic control/construction phasing.

- In-Fill the existing gap between the bridges. The final lane configurations on the bridge would not require a full in-fill of the gap between the existing bridges (see Appendix F). However, a full in-fill of the deck would provide significant benefits related to traffic control during construction and foundation alternatives. The decision to widen the deck to provide one full-width bridge deck was approved at the August 12, 2013 NHDOT Front Office meeting.
- Provide a southbound auxiliary lane. The traffic analysis conducted for the project recommended that an auxiliary lane be provided on southbound I-89 between the on-ramp from I-91 and the off-ramp at Exit 20. The analysis also indicated that an auxiliary lane should be considered for northbound, but the need was not as compelling. The decision to provide a six-lane bridge, four through lanes and two auxiliary lanes, was approved at the August 12, 2013 NHDOT Front Office meeting.
- Replace existing superstructure structural steel. The original scope for the bridge widening included rehabilitating and repainting the existing structural steel and providing new steel girders for the in-fill widening. A load rating analysis and fatigue evaluation of the existing structural steel was completed. The load rating used current AASHTO HL-93 live loading, but was based on the original girder section properties without consideration of structural steel deterioration. The fatigue evaluation was performed with the same criteria. The load rating indicated the design condition had sufficient capacity at most locations for current loading, and the remaining locations could be modified to comply. The fatigue evaluation indentified several details with a finite life remaining, which was less than the proposed service life. The decision to replace the existing steel was based on concerns with the condition of the existing steel, the numerous details that would need to be rehabilitated to conform to fatigue requirements, and the significant cost associated with the rehabilitation and repainting the existing structural steel. The decision to replace the existing superstructure steel was approved at the August 12, 2013 NHDOT Front Office meeting.
- Construct full-height in-fill piers. Two pier options were evaluated for support of the proposed in-fill superstructure widening; an in-fill pier and a connected existing pier option (see Appendix F). The in-fill pier option would construct a new pier between the existing piers matching the basic geometry of the adjacent existing piers. This option requires a deep foundation (piles) and associated construction access and environmental impacts. The connected existing pier option would connect the existing pier caps to support the new in-filled superstructure. This option would use top-down construction and eliminate the environmental impacts associated with work in the river. Both options were evaluated for capacity of existing piers with proposed loading conditions. Evaluation of the connected existing pier option determined that the piles and upper portion of the pier stem would be significantly overstressed due to the induced frame action inherent with this option. The effort associated with retrofitting the piers to accommodate the loads from the connected pier option negates any benefit from the option. The decision to progress the in-fill pier option was approved at the March 31, 2014 NHDOT Front Office Meeting.

EXISTING CONDITIONS

Roadway

Figure RD1 is an aerial photo of the project area. I-89 connects smaller cities and rural areas within New Hampshire and Vermont, and maintains two lanes of traffic in each direction throughout the route. The Connecticut River bridges are located along I-89 between two interchanges approximately one mile apart. On the west side in Hartford, Vermont is the I-91 system interchange. On the east side is Lebanon, a major NH population center, where the final exit in NH (Exit 20), provides access to West Lebanon's large retail district along NH Route 12A. I-89 is one of Vermont's most important roads, as it is the only Interstate highway to directly serve both Vermont's capital city (Montpelier) and largest city (Burlington).

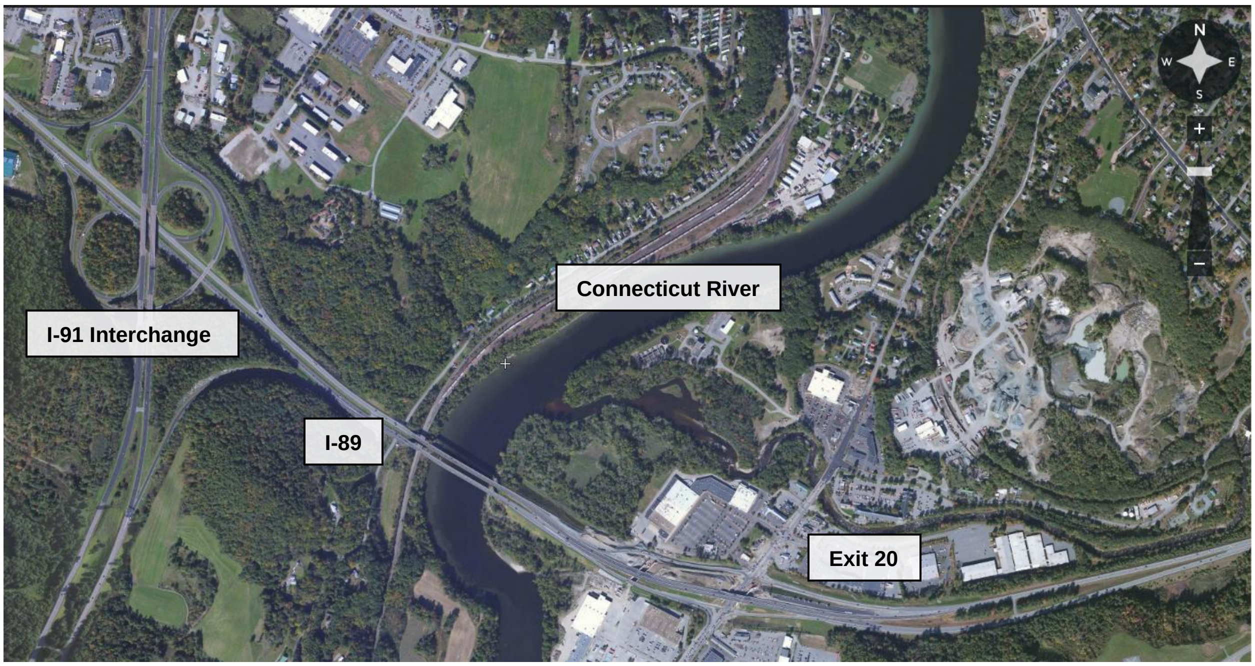


Figure RD1: Project Study Area

Within the project limits I-89 is a four-lane (two northbound and two southbound) divided urban principal arterial highway with full access control. The normal posted speed limit on the bridge is 65 miles per hour. The most recent Average Annual Daily Traffic (AADT) from 2013 indicates approximately 38,048 vehicles per day (vpd) use these bridges between Vermont and New Hampshire.

The lanes on both bridges are all 12-feet wide, however, the inside and outside shoulders are all 3-feet wide. The shoulders on all approaches are wider.

Northwest of the project is the I-89/I-91 Interchange, which is a partial cloverleaf with three loop ramps. Southeast of the bridges is Exit 20, which is a recently reconstructed diamond interchange.

Waterway & Scour

The Connecticut River is a rural, sinuous waterway that flows in an overall north-south direction from its headwaters at the Fourth Connecticut Lake in Pittsburg, NH, and defines the border between New Hampshire and Vermont. The Connecticut River ultimately discharges into Long Island Sound in southern Connecticut. In the immediate bridge reach, the channel bed is comprised primarily of sand and gravel. The valley setting generally provides low to moderate relief with narrow flood plains. The river is incised with alluvial channel boundaries, and trees generally cover 50 to 90 percent of the bank.

The river generally does not anabranch, but is locally braided within immediate reaches, in particular downstream at Johnston Island. The Mascoma River outlets into the Connecticut River immediately upstream (~700 feet) of the bridge. The White River outlets into the Connecticut River approximately 7,000 feet upstream of the bridge.

The NHDOT Bridge Inspection Reports indicate that light erosion exists along the riverbanks in the vicinity of the SB bridge, and heavy riverbank erosion exists upstream of the NB bridge. There is lateral movement (drift) of the river in addition to slumping of the stone rip rap slope in front of the abutments on the NH embankment.

The NHDOT underwater inspection reports document exposed abutment and pier footings, as well as localized scour holes at the piers.

The NHDOT commissioned a waterway and scour assessment of the bridges. In a June 2010 report, the waterway ratings of both bridges were determined, and both bridges were classified as scour critical, as highlighted in Tables WS-1 and WS-2.

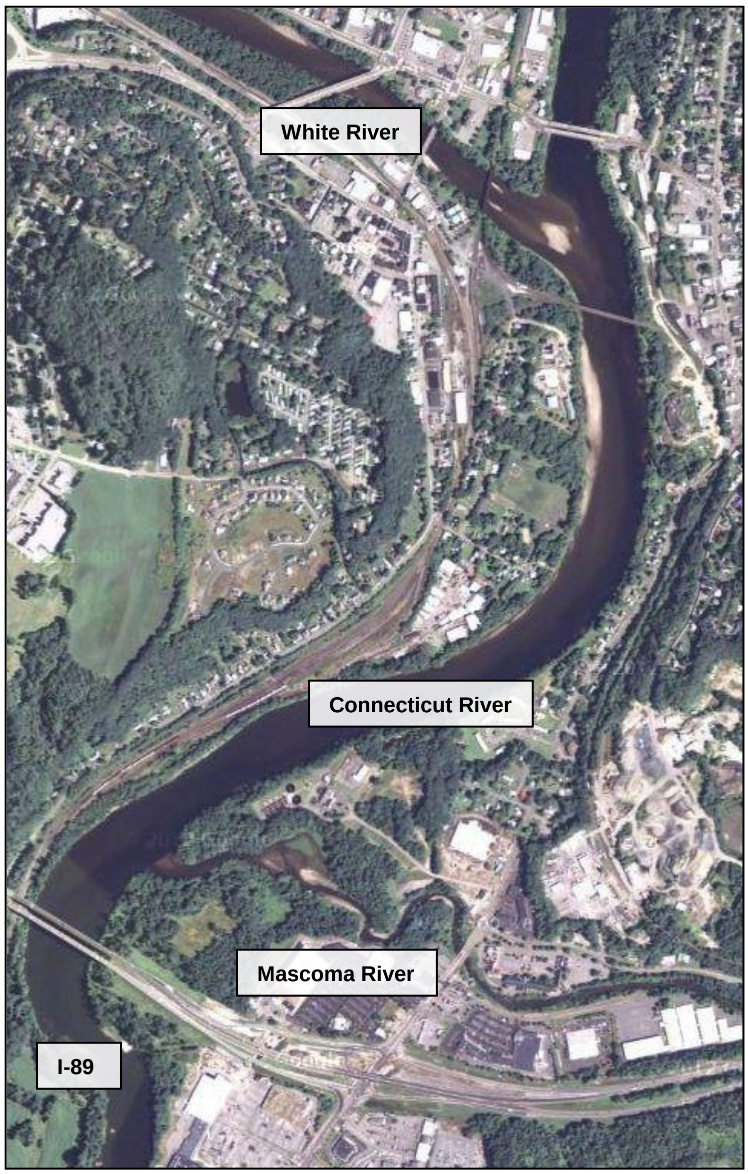


Figure WS-1: Aerial of Connecticut River in project area

Table WS-1: NBIS Waterway Ratings (044/104 I89 NB)			
Item	**Description**	**Rating**	**Description**
61	Channel & Channel Protection	7	Bank protection is in need of minor repairs. River control devices and embankment protection have a little minor damage. Banks and/or channel have minor amounts of drift.
71	Waterway Adequacy	9	Superior to present desirable criteria
113	Scour Critical Bridges	3	Bridge is scour critical; bridge foundations determined to be unstable for calculated scour conditions.
			Depth of Potential Scour (100-year) = 20 feet at Pier 2 (Undermining of pile cap would occur)

Table WS-2: NBIS Waterway Ratings (044/103 I89 SB)			
Item	**Description**	**Rating**	**Description**
61	Channel & Channel Protection	7	Bank protection is in need of minor repairs. River control devices and embankment protection have a little minor damage. Banks and/or channel have minor amounts of drift.
71	Waterway Adequacy	9	Superior to present desirable criteria
113	Scour Critical Bridges	3	Bridge is scour critical; bridge foundations determined to be unstable for calculated scour conditions.
			Depth of Potential Scour (100-year) = 20 feet at Pier 3 (Undermining of pile cap would occur)

Hartford and West Lebanon have a history of severe seasonal ice-jam related damage and flooding along the Connecticut River. The *Cold Regions Research Engineering Laboratory* (CRREL) Ice Jam Database and other sources record ice-related events in the project area. Data has been collected over the last 100-years in the area of the Connecticut River from its confluence with the White River at White River Junction downstream through the Johnston Island area. A recent March 2011 report recorded:

> *"An ice jam has caused the Connecticut River at West Lebanon to jump over 9 feet in less than two hours and is now approaching flood stage. The river will likely top flood stage overnight and continue to fluctuate through the night due to the unpredictable nature of ice jams."*

Bridge

General

The I-89 bridges span the Connecticut River and New England Central Railroad (NECRR) between the city of Lebanon, New Hampshire and the town of Hartford, Vermont. The NB and SB barrels each consist of two travel lanes, with direction of travel carried by separate, but identical, bridge structures. Bridge No. 044/103 carries I-89 SB traffic, while Bridge No. 044/104 carries I-89 NB traffic.


Figure BR1: Westerly Elevation View of Bridges

The six-span, 840-foot sister bridges were constructed in 1966 and consist of non-composite, haunched steel plate girders founded on cantilever abutments and hammerhead piers. The bridges are inspected and maintained by the NHDOT through a mutual agreement with the Vermont Agency of Transportation (VTrans).

The NHDOT bridge records indicate that no major rehabilitation or reconstruction of the bridge has been performed. The concrete deck was rehabilitated in 1984, with work including wearing surface replacement, deck concrete repairs, resetting the granite bridge curb, and bridge rail rehabilitation. More recently, the NHDOT Bureau of Bridge Maintenance has installed supplemental steel plates and members to repair section loss and web cracks at isolated locations.


Figure BR2: FAST Anti-Icing System Nozzle Installed in SB Bridge Pavement

In September 2006, a Fixed Automated Spray Technology (FAST) anti-icing system was installed along the centerline of the SB bridge. The system is controlled by a weather information system that uses deck sensors to detect environmental conditions and automatically apply liquid de-icing chemicals to the bridge before the deck is able to freeze. The anti-icing system was recently removed according to the 2013 Bridge Inspection Report.

Superstructure – General

The bridges are comprised of five non-composite welded steel (A36) plate girders supporting a 7-inch reinforced concrete deck protected by membrane with a bituminous concrete wearing surface. The six-span configuration consists of two 120'-0" end spans and four 150'-0" interior spans on a three percent tangent profile grade aligned on a ten degree skew. The typical section for each bridge (presented in Figure BR3) measures 35'-10" wide from the outside edge of deck and consists of symmetrically placed 3'-0" shoulders, two 12'-0" travel lanes, and reinforced concrete brush curbs measuring 2'-11" wide each. Per the original design plans, the constant clear distance between the adjacent NB and SB decks is 38'-2".

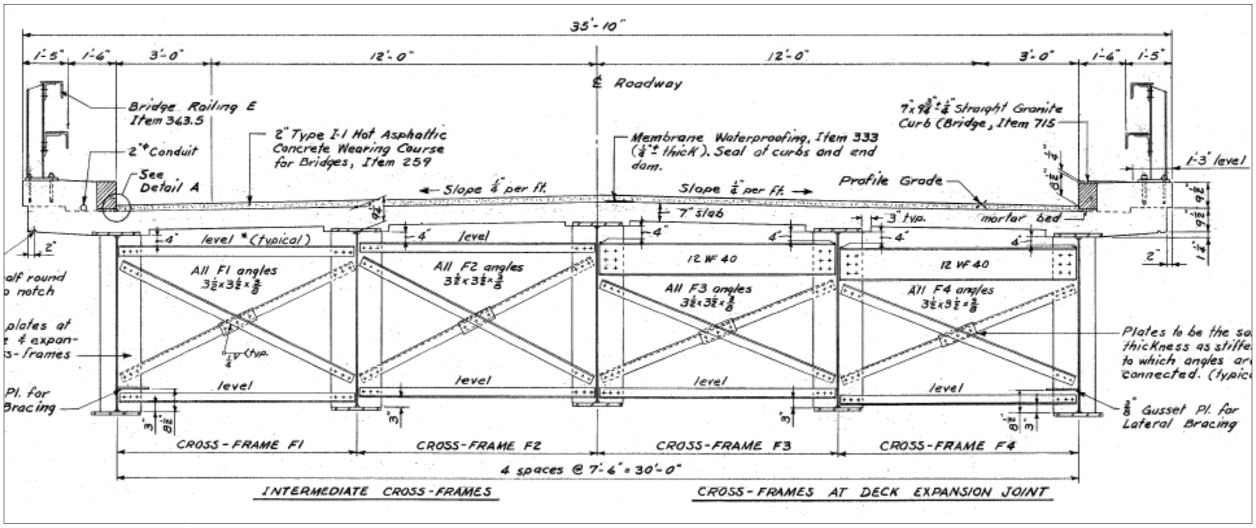


Figure BR3: Existing Bridge Section

The girder web depth is haunched at each pier (Figure BR4). Vertical web stiffeners are provided along the entire bridge length, and longitudinal web stiffeners are provided at approximately 1/5 of the clear web depth from the bottom flange within the tapered pier sections. Reference Appendix A, Existing Bridge Plans, for additional information.

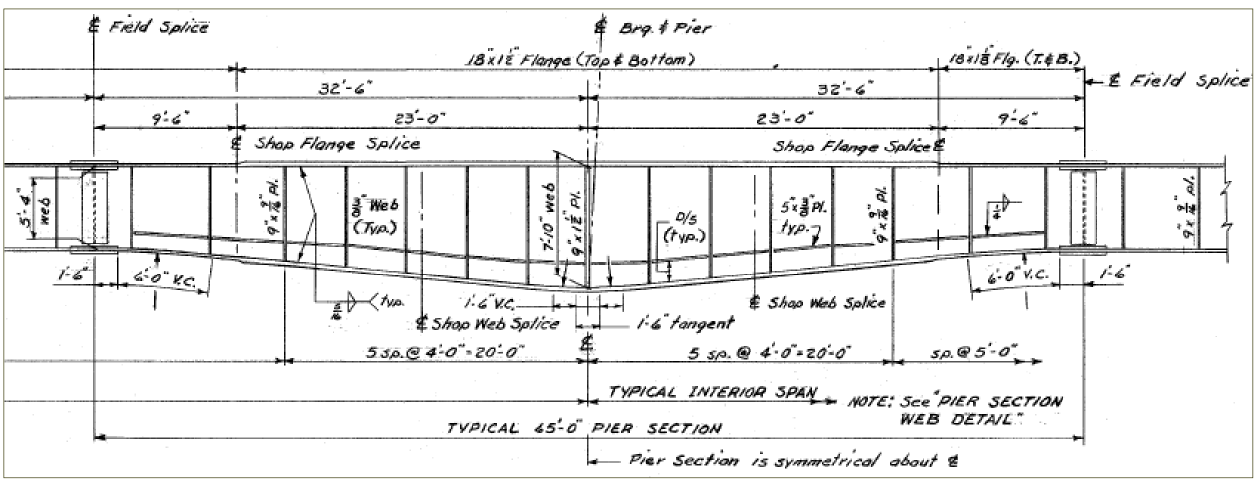


Figure BR4: Typical Girder Detailing at Intermediate Piers

Figure BR5: Typical Corrosion at Deck Expansion Joint

The concrete bridge decks exhibit signs of distress, including cracking, delamination, and efflorescence at various locations. The lead-based girder paint system is failing as evidenced by cracking, flaking, and peeling, and light rust has formed in many locations on the steel members. Section loss of the girders and bracing members has been documented, most notably near the bridge deck expansion joints where the section loss is moderate to severe (See Figure BR5).

Severe pitting has occurred along the bottom flanges and at the base of the web, the girder webs exhibit holes from section loss and are nearly perforated in multiple locations, and severe section loss on transverse stiffeners has resulted in a knife edge condition (Figure BR6). Secondary lateral bracing members and their gusset plates exhibit severe section loss beneath the deck expansion joints.

Figure BR6: Knife-Edge. Heavy Section Loss at Stiffener & Gusset Plate

Recent repairs by the NHDOT Bureau of Bridge Maintenance (BBM) have included sandblasting and recoating of corroded steel, installation of bolted plates at a large web crack, and welded plate repairs. These major deficiencies are primarily located near the leaking deck joints in Spans 3 and 4. Bridge Inspection reports also note formwork from deck repairs being left in place on the deck underside.

The condition rating of the deck and superstructure is Fair to Poor for both the northbound and southbound structures. The Northbound October 2013 and the Southbound January 2014 bridge rating reports are provided in Appendix B. Specific details regarding the condition of each superstructure are taken from the NHDOT bridge inspection reports and are outlined below:

Superstructure: Bridge No. 044/103 (I-89 SB)

- The deck exhibits moderate concrete delamination at multiple underside locations, with light leaking at the relief joints in Spans 3 and 4 where they pass through the brush curbs. Span 5 exhibits a cracked and depressed area of pavement near the roadway centerline.

Figure BR7: Bottom Flange Pitting

- Concrete brush curbs contain cracks and moderate spalls, and the granite curb stones have become dislodged.

- The girders exhibit paint coating failure and light rust throughout. Flanges of exterior girders have moderate section loss and heavy pitting near the deck relief joints. Lateral bracing members, gusset plates, and the girder web show signs of severe section loss in these areas.

- Isolated web perforations have been noted in the exterior girders, concentrated primarily near the welded gusset plate attachments for lateral bracing. There is an approximate 1 inch hole in the web of Exterior Girder #1 in Span 3, and another location exists in Span 5 where the web is nearly perforated. Section loss of up to ¼” has been measured along the middle of the exterior girder flanges near the web in this area as well.

Figure BR8: Hole and Crack in Web at Transverse Stiffener

- In December of 2011, the NHDOT repaired a large crack in the westerly exterior girder in Span 4. The crack had progressed approximately 15 inches along the toe of the weld between a vertical stiffener and the web and appeared to have initiated at a nearby hole in the girder web caused by corrosion at the leaking joint (Figure BR8). The repair consisted of removing the stiffener, drilling holes to arrest the crack, and bolting steel splice plates to the web and bottom flange of the girder. The completed repair is presented in Figure BR9.

Figure BR9: Web Crack Bolted Plate Repair by NHDOT BBM (outside face)

- Moderate corrosion and some light damage have been noted on the bridge rail.

- Roadway drainage has reduced effectiveness, because multiple deck scuppers are clogged with debris.

Figure BR10: Web Crack Bolted Plate Repair by NHDOT BBM (inside face)

Superstructure: Bridge No. 044/104 (I-89 NB)

- The concrete deck exhibits cracks, isolated light efflorescence, and water staining from leakage through the deck. Leaking is evident at the deck relief joints. Moderate to heavy delamination of the concrete has been observed throughout. Several previously patched areas in the deck are deteriorating as they lose integrity.

- Minor to light rust on the girders is evident throughout. Paint system failure characterized by cracking and flaking.

Figure BR11: Heavy Section Loss Under Deck Relief Joint

- Heavy corrosion has been observed under the deck relief joints, and on the exterior girders in the north span (Figure BR11).

- The lateral wind bracing and its gusset plate attachment located below the deck relief joint in span 3 exhibit heavy section loss from joint leakage.

☼ NHDOT BBM repaired severe pitting and section loss on the web of interior girder #4 in July of 2012. The repair consisted of a steel angle welded on at the intersection of a transverse stiffener and the web. Refer to Figures BR12 and BR13.

Figure BR12: Heavy Pitting on Web at Transverse Stiffener

Figure BR13: Welded Angle Web Repair by NHDOT BBM

☼ Loose bolts were noted at the end connections of some lateral bracing members.

☼ The bridge rail exhibits moderate corrosion with some observed section loss.

☼ The asphalt wearing surface shows signs of rutting, cracks, and delaminating.

☼ Granite bridge curb stones are becoming dislodged due to deterioration along the concrete brush curb.

☼ Roadway drainage is marginalized by plugged deck scuppers along curb lines.

Substructures

The ends of each bridge are supported on cast-in-place cantilever abutments with U-back butterfly wingwalls. The abutments and wingwalls are supported on three (3) rows of steel 12BP53 end-bearing piles driven to refusal, with the front two rows of piles battered and back row vertical. Buried approach slabs are utilized, which are twenty (20) feet long.

The piers are cast-in-place concrete hammerhead piers with tapered solid shafts. The footing for Piers I, II, and III are supported on six rows of 14BP73 steel end-bearing piles driven to refusal. Piles battered at a 4:12 slope are used to resist lateral forces in both orthogonal directions. Pier IV, located near the Vermont riverbank, has a spread footing foundation bearing on a concrete seal which bears directly on bedrock. Pier V, situated on top of the Vermont riverbank adjacent to the NECRR, is founded on four rows of 12BP53 steel end-bearing piles driven to refusal. Piles around the perimeter of the group are battered on a 2:12 vertical slope to resist lateral loads in both orthogonal directions. Piers I, II, III, and IV have similar heights ranging between approximately 60 ft and 80 ft tall measured from the top of footing, while Pier V extends approximately 40 ft from the top of its footing. Reference Appendix A, Existing Bridge Plans, for additional information.

Fixed bearings are provided at Pier III which lies at mid-length of the bridge. All other support locations have steel rocker expansion bearings. Finger joints are provided at the abutments to accommodate thermal displacements.

Figure BR14: North abutment on SB Bridge

The substructures generally exhibit relatively minor deterioration according to the October 2013 and January 2014 NHDOT bridge inspection reports for the Northbound and Southbound bridges respectively. Partial-depth concrete repairs on the abutments and wingwalls from the 1984 rehabilitation exhibit cracking. Minor to moderate concrete spalls along the abutment backwalls were also noted, and moderate spalling of the north abutment footing for the NB bridge has been observed. Steel fingers are missing from the abutment expansion joints, presumably from snow plowing operations, weld repairs are present, and the steel plates exhibit corrosion. Heavy debris buildup is present on the abutment seats. The girder bearings are heavily corroded, with heavy section loss noted on the anchor rods in some locations. Pack rust has lifted the interior bearings at the north abutment of the NB superstructure.

The NHDOT inspection reports found the piers to be in overall good condition, with some fine cracking and minor spalling. For the SB bridge, fine cracks have been observed in the cap of Pier II. For the NB bridge, a light crack has been noted in the downstream (south) end of the cap for Pier V and minor spalls were detected on top of the cap of Pier IV.

NATURAL & CULTURAL RESOURCES

Environmental resources were identified using GIS and other mapping resources and through a brief field visit. A summary of existing resources and permits that may be involved with the proposed project follows. The referenced figures can be found in Appendix C.

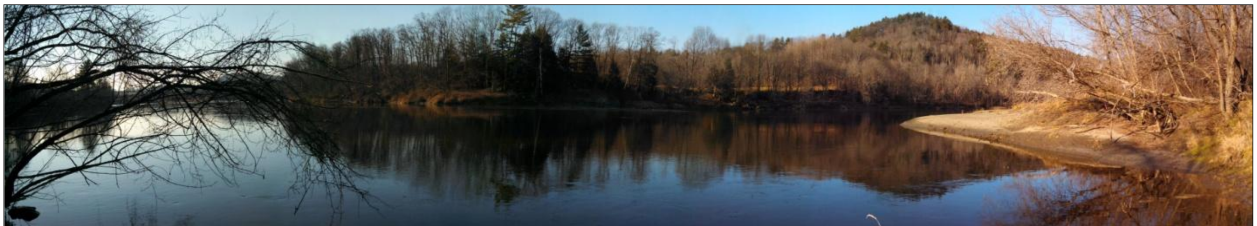


Figure ENV1: New Hampshire side - view north, south of bridge

Landscape Setting

Bridges 044/104 and 044/103 carry I-89 across the Connecticut River, which forms the border between New Hampshire and Vermont. The river has a width of approximately 550 feet at the bridge location, and is a 7th order river with a watershed (from the project area) measuring 4,286 square miles, extending north into Canada.

On the Vermont side, under the bridge, the riverbank is armored with stone from the train track down to a low floodplain that parallels the river. Vegetation on either side of the bridge includes hemlock, poplar, white birch, elm, and box elder. The low floodplain supports green ash, elm, and honeysuckle.

The land on the New Hampshire side of the river is generally lower and supports tree species including white pine, sycamore, and elm along with invasive species such as knotweed, honeysuckle, and barberry. The riverbanks on both sides show evidence of past disturbance.

Water Resources

Wetlands

Wetlands have not yet been delineated for this project. Jurisdictional limits for wetlands and waterways on the New Hampshire side will extend to the top of the riverbank, in keeping with New Hampshire wetland regulations, and on the Vermont side to the Ordinary High Water Line. The Cowardin classification for the Connecticut River at the project location is R2UBH, or riverine, lower perennial, with an unconsolidated bottom, permanently flooded. The river lies mostly in New Hampshire, since the state line was set at the low water line on the Vermont side as it existed in the 1930's (decided by the U.S. Supreme Court in 1934). Army Corps of Engineers jurisdiction extends to the ordinary high water line on both sides. Jurisdictional limits for the Shoreland Water Quality Protection Act extend 250 feet from the ordinary high water line on the New Hampshire side. The project will likely involve a New Hampshire Standard Dredge and

Fill Wetland Permit from the NH Department of Environmental Services for work in the river and/or on the river bank, and a Shoreland Water Quality Protection Act permit for work in the protected shoreland area on the New Hampshire side. The river is also a Designated River under NH RSA 482, so wetland and shoreland permit applications would be reviewed by the Connecticut Joint River Commission. The project may also require coordination with the Vermont Agency of Natural Resources River Management Engineers to satisfy Title 19 of Vermont Statutes.

Floodplains

The floodplain of the Connecticut River extends east into New Hampshire and west into Vermont on either side of the river. There is also a regulatory floodway spanning the river. Filling within the floodplain could necessitate the creation of equivalent flood storage capacity, under Executive Order 11988. (See Appendix C-1, Floodplains.)

Navigable Waters

The Connecticut River is regulated as a Navigable Water under both the US Coast Guard Bridge Permit program and the Army Corps of Engineers Section 10 and 404 permit programs. The proposed bridge rehabilitation will require coordination with the US Coast Guard or a US Coast Guard Bridge Permit. Under the Army Corps of Engineers' Programmatic General Permit, any navigable waterway or wetland impacts in excess of one acre would require an Individual Permit from the Army Corps of Engineers. (In Vermont, the Army Corps' threshold for requiring an individual permit is 5,000 square feet of impact in navigable waters, However, the state line is on the Vermont side of the river, and all wetland impacts would probably be in New Hampshire, other than impacts between the low water line and the ordinary high water line, if any.) It is anticipated that the proposed bridge rehabilitation will involve well under an acre of work in the water, so it will probably be permitted under New Hampshire's Programmatic General Permit with the Army Corps.

Impaired Waters

The NHDES 2010 List of All Impaired Waters (most recent available) identifies this segment of the Connecticut River as being impaired for primary contact recreation by combined sewer overflows. Vermont's 2012 List of Priority Surface Waters identifies this portion of the river as impaired for aquatic life support by flow alteration caused by fluctuating flows associated with hydropower production from the Wilder Dam upstream. The proposed project is not anticipated to have any effect on the pollutants or conditions responsible for these impairments.

Figure ENV2: Beaver work, New Hampshire side, north of bridge.

<u>Wildlife Habitat</u>

Wildlife habitat in New Hampshire has been mapped in the 2010 New Hampshire Wildlife Action Plan (Appendix C-2). Habitat in the immediate vicinity of the bridge is mapped as "Tier 2, top-ranked in region." Although the area surrounding Route 12 in Lebanon is developed and unlikely to provide valuable wildlife habitat, the area along the river is well vegetated and likely provides habitat for a variety of mammals, including deer, coyote, beaver, otter, raccoons, and other mammals (See Figure ENV2).

The Vermont side of the river is dominated by farmland and mixed hardwood and conifer (hemlock and pine) forest. Farmland in the vicinity likely provides habitat for a variety of mammals, songbirds, and birds of prey. Forested land likely provides habitat typical of the area for large and small mammals, songbirds, and birds of prey. Vermont roadkill records (which are not comprehensive) include three records of moose kills on Route I-91 and I-89 west of the project location. The New Hampshire Fish and Game Fisheries Department was contacted to request information about fisheries in the Connecticut River. NHF&G's response, attached to this report, indicated that there were a variety of warm water fish inhabiting the river (Appendix C-3). No specific recommendations or restrictions regarding construction were provided. Vermont's Agency of Natural Resources considers all rivers and streams to be cold water fish habitat. The Connecticut River is designated as Essential Fish Habitat for Atlantic Salmon, so work in the water will require an Essential Fish Habitat Assessment and coordination with the National Marine Fisheries Service, as required under the Magnuson-Stevens Fishery Conservation and Management Act.

Recreational fishing and boating is common in this area of the Connecticut River. Consideration should be given during construction planning to accommodate these activities.

<u>Rare Species</u>

Project review requests were submitted to both the State of Vermont and the State of New Hampshire Natural Heritage Programs in April 2013. Both programs will need to be contacted for updated rare species records during the next phase of the project. New Hampshire Natural Heritage responded that there were records of the following species in the vicinity of the project:

Invertebrate Species

- Cobblestone Tiger Beetle (*Cicindela marginipennis*) (State endangered)
- Dwarf Wedge Mussel (*Alasmidonta heterodon*) (State and federally endangered)
- Tule Bluet (*Enallagma carunculatum*) (State tracked)

Correspondence with the US Fish and Wildlife Service indicated that the records for the dwarf wedge mussel were over a mile away from the project, and indicated that they had no further concerns about this species (see e-mail correspondence in Appendix C-7). No further guidance was provided on the cobblestone tiger beetle or tule bluet.

Plant Species

- Mudflat spikesedge (*Eleocharis intermedia*) (State endangered)

New Hampshire Natural Heritage Bureau indicated that appropriate habitat in the vicinity of the project should by surveyed for *Eleocharis intermedia* prior to construction.

Vertebrate species

- ☼ Bald Eagle (*Haliaeetus leucocephalus*) (State threatened)

New Hampshire Fish and Game responded that the eagle population is increasing in the vicinity of the bridge, and requested that there be additional coordination as the construction date approaches.

Vermont Natural Heritage responded that there were two species (Siberian chives [*Allium schoenoprasum]* and musk flower [*Mimulus moschatus]*) that occurred on a rock outcrop approximately 500 feet downstream of the project, but said that unless there was a direct impact to the outcrop they would not be affected (see e-mail correspondence in Appendix C-6).

<u>Historical Resources</u>

The bridge was constructed in 1966. By agreement with the Advisory Council of Historic Preservation, federal actions on elements of the interstate highway system are exempt from the requirements of Section 106 review unless specifically excluded from the exemption. The Lebanon-Hartford bridge is not excluded from the exemption. Therefore, although the bridge itself is almost fifty years old, it will not be subject to Section 106 or 4(f) review.

<u>Archaeological Resources</u>

The area surrounding the bridge was the subject of a Phase 1A Preliminary Archaeological study in 1994 ("Lebanon IM-89-1(177)60 / 11700 Exit 20") that found no areas of archaeological sensitivity within the New Hampshire study area. One area of sensitivity in New Hampshire, south of the Exit 20 interchange on I-89, is outside of this project's Area of Potential Effect. The project was discussed with NHDOT's cultural resource staff and it was agreed that no further archaeological survey would be needed in New Hampshire for the project (see response from New Hampshire Division of Historical Resources in Appendix C-9). An archaeological subconsultant was retained to perform a Phase 1A study for the Vermont portion of the Area of Potential Effect. Results of the study indicate that there are three areas of sensitivity within the Area of Potential Effect. Additional coordination with the Vermont State Historic Preservation Officer will occur as the project proceeds to determine if these areas will be affected by the project.

<u>Hazardous Materials</u>

The Vermont and New Hampshire GIS databases were reviewed for records of hazardous materials or hazardous waste remediation in the immediate vicinity of the bridge. There were several remediation sites on Route 12 in Lebanon, including leaking underground storage tanks, but the files are closed and the sites are not within the project area. There are no records of hazardous materials on the Vermont side.

TRAFFIC EVALUATION

Traffic Analysis Summary

A Traffic Assessment Memorandum was prepared for the project by Resource Systems Group (RSG) which is included as Appendix D. The assessment included a design standard review, traffic analysis, safety analysis and conclusions.

The Design Standard Review concluded that there are several geometric deficiencies associated with the existing bridge, these are:

- Non Standard shoulder widths on I-89.
- Non Standard ramp merge on the on ramp from northbound I-91 to southbound I-89.
- No auxiliary lane on southbound I-89 between I-91 and Exit 20.

The Traffic Analysis was performed to determine the future capacity needs on the bridge. Traffic volumes projected for the future indicate that the existing four lanes are sufficient for I-89. However, the close proximity of Exit 20 in New Hampshire and the I-91 Interchange in Vermont required further analysis to determine if auxiliary lanes are warranted. An Origin-Destination (O-D) study was conducted using blue tooth sensors to determine the volume of traffic that uses the bridge to travel between I-91 and Exit 20. See below for the recommendation.

The safety analysis was conducted to determine if any of the existing deficiencies contribute to the crashes in the area. One area in particular, the on-ramp from northbound I-91 to southbound I-89, indicates that the poor geometry likely contributes to the high number of multiple vehicle crashes.

Recommended Configuration

The Traffic Assessment recommended that an auxiliary lane be provided on the southbound bridge between I-91 and Exit 20 to address geometric, safety, and operational deficiencies. The case for a northbound auxiliary lane was not as compelling; however, it would have operational benefits. The recently completed Exit 20 project provided standard ramp geometry and the distance between the ramps is sufficient. However, there is a noticeable decrease in vehicle speeds for northbound traffic due to the steep grade (5%) north of the bridge.

The final configuration for northbound I-89 will be determined during final design. Both two and three lane configurations of I-89 will be developed so that the costs and impacts of each can be determined. Also, the public will be engaged to determine their configuration preference.

EXISTING BRIDGE EVALUATION

Load Rating Analysis

Introduction

A load rating analysis of the existing interior and exterior plate girders was performed in accordance with the provisions of the *AASHTO Manual for Bridge Evaluation, 2nd Edition* (AASHTO MBE) including the 2010 interim revisions, and the *AASHTO LRFD Bridge Design Specifications, 6th Edition* (AASHTO LRFD), using the HL-93 notional live load model. The load rating utilized "As-Designed" girder section properties (no section loss) and details obtained from the original design plans. Deterioration which has developed on the structure since the 1966 construction, as well as the repairs undertaken by the NHDOT Bureau of Bridge Maintenance (BBM), was not considered.

The intent of the rating was to establish a baseline load rating for the structure according to current design standards. NHDOT and AASHTO legal load configurations were not evaluated at this time. The "sister bridges" are identical and were originally designed for the AASHO H20-S16 live load, including the alternate military loading, in accordance with the *AASHO 1961 Specifications for the Design of Highway Bridges*.

The existing bridges consist of five (5) continuous non-composite welded plate girders with a concrete deck. The girders are stiffened both transversely and longitudinally and have haunched webs near the intermediate piers. Detailed girder elevation views from the original construction drawings are shown below in Figure LR1.

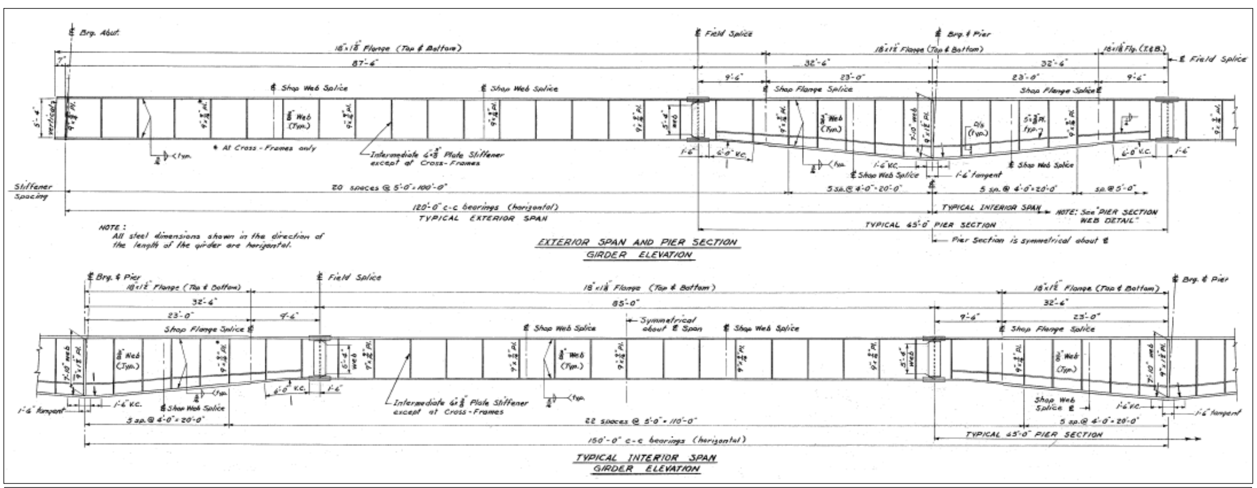


Figure LR1 – Girder Elevation Views from Original Design Plans

Load Rating Procedure and Methodology

The non-composite interior and exterior girders were modeled using the Merlin-DASH software program. Dead loads were manually computed and input for each girder. Live load distribution factors were computed by hand using the approximate formulas in AASHTO LRFD Article 4.6.2.2, and compared to those computed by Merlin Dash. Since the distribution factors calculated by hand and calculated by Merlin Dash were not in compliance, the hand calculated values were manually input into Merlin Dash.

Based on the values provided by Merlin Dash, the program is not accounting for the portion of the equations in AASHTO LRFD table 4.6.2.2.2b-1 related to the longitudinal stiffness parameter, K_g.

Per AASHTO MBE (Article 6A.6.9.3), the load rating considered the top flange of the girders to be continuously braced by the concrete deck in areas of positive flexure, despite a lack of shear connectors joining the girders and deck. The top flange lateral support mechanism for this bridge is twofold: friction between the deck and the top flange (provided there are no visible gaps), and the original plans show the top flange embedded in the deck haunch which provides additional lateral support. Refer to Figure LR2.

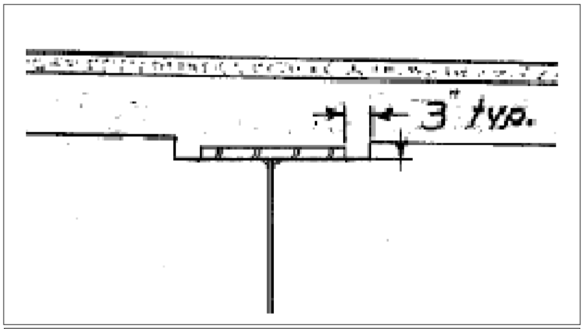


Figure LR2 –: Deck Haunch Detail

Results

The controlling flexure and shear LRFR Rating Factors were developed for the abutments, piers, and within each span, and are tabulated below.

Table LR-1: Exterior Girder Controlling LRFR Rating Factors (HL-93 Loading)

	Abutments	Spans 1 & 6	Piers 1 & 5	Spans 2 & 5	Piers 2 & 4	Spans 3 & 4	Pier 3
Flexure							
Inventory	N/A	**0.97**	1.05	1.08	1.06	1.04	1.03
Operating	N/A	1.26	1.36	1.4	1.37	1.35	1.34
Shear							
Inventory	**1.06**	2.6	2.99	2.5	2.97	2.48	2.96
Operating	1.38	3.37	3.87	3.25	3.85	3.22	3.84

Table LR-2: Interior Girder Controlling LRFR Rating Factors (HL-93 Loading)

	Abutments	Spans 1 & 6	Piers 1 & 5	Spans 2 & 5	Piers 2 & 4	Spans 3 & 4	Pier 3
Flexure							
Inventory	N/A	**1.09**	1.14	1.27	1.18	1.22	1.15
Operating	N/A	1.42	1.48	1.64	1.52	1.58	1.49
Shear							
Inventory	**0.88**	2.11	2.42	2.03	2.41	2.01	2.4
Operating	1.14	2.73	3.14	2.63	3.12	2.6	3.11

Summary of Findings

- The governing Inventory Rating Factor of 0.97 (flexure) for the exterior girder is associated with the compression flange factored flexural resistance for positive bending within the end spans (Spans 1 and 6).
- Inventory Rating Factors for positive and negative flexure for the exterior girder in the other spans (Spans 2 - 5) and at the piers were relatively uniform, ranging from 1.03 to 1.08.
- The controlling exterior girder Inventory Rating Factor for shear is 1.06 at the abutments. The stiffened end panels at the abutments are the only web panels for which shear capacity does not include tension-field action, hence, a reduced shear resistance results in reduced rating factors. Minimum rating factors for shear at other locations along the bridge were approximately 2.5 times greater than at the abutments.
- The governing Inventory Rating factor for the interior girder of 0.88 is associated with shear at the abutments. Consistent with the behavior noted for the exterior girders, the shear ratings factors elsewhere along the bridge are significantly higher.
- The controlling Inventory Rating Factor of 1.09 for the interior girder is associated with the compression flange factored flexural resistance for positive bending within the end spans (Spans 1 and 6).
- Minimum Inventory Rating Factors for the interior girder in positive flexure in other spans range from 1.22 to 1.27, and rating factors for negative flexure at the piers vary between 1.14 and 1.18.

Fatigue Analysis

Introduction

The existing bridge was reviewed for fatigue-prone details to determine whether additional members should be retrofitted or replaced as part of the proposed rehabilitation, and to estimate the remaining fatigue life of the fatigue prone details. The fatigue life analysis of the bridge utilized "As-Designed" girder section properties and details obtained from the original design plans. Deterioration which has developed on the structure since the 1966 construction, as well as the repairs undertaken by the NHDOT Bureau of Bridge Maintenance (BBM), was not considered in this analysis.

The fatigue life analysis was conducted in accordance with the *AASHTO Manual for Bridge Evaluation, First Edition* (AASHTO MBE) including the 2010 interim revisions, with reference to the *AASHTO LRFD Bridge Design Specifications, 6th Edition* as appropriate. Fatigue of steel is comprised of two mechanisms:

1. *Load-induced fatigue* is produced by cyclical tensile stresses acting on a local defect that serves to initiate and propagate a crack over time. Compressive stresses do not propagate cracks.
2. *Distortion-induced fatigue* is caused by repeated deformation of a member, many times a result of out-of-plane bending, and often occurs in girder webs.

Load-Induced Fatigue

Load-induced fatigue is the result of net tensile stresses induced by the repeated passage of trucks across the structure. Details sensitive to load-induced fatigue are currently grouped into eight detail categories (A through E') which consider fatigue resistance derived from a constant amplitude fatigue threshold.

In evaluating estimated fatigue life, the life expectancy falls into one of two categories: *infinite fatigue life* or *finite fatigue life*. When the maximum anticipated stress range at a fatigue-prone detail is less than the fatigue threshold, the detail will theoretically have *infinite fatigue life*. For details with a stress range that exceeds the fatigue threshold, there is an associated estimated *finite fatigue life* for the detail.

For details classified as having *finite fatigue life*, further analysis was conducted to estimate the expected lifespan and remaining fatigue life. Finite fatigue life is dependent upon traffic volume, specifically the number of load cycles produced by trucks. NHDOT traffic data was incorporated into the fatigue analysis. A summary of the traffic data used is presented in Table FA-1.

The bridge was modeled using the Merlin-DASH software program and live load fatigue stress ranges for the details of concern for a typical interior and exterior girder were estimated. The fatigue evaluation was based on the SB bridge (NHDOT Bridge No. 044/103), since a higher volume of truck traffic crosses that structure. Tables FA-2 and FA-3 summarize the load-induced fatigue-prone details identified on the superstructure and the results of the fatigue analysis for an exterior and interior girder, respectively. Illustrative Example figures from the *AASHTO LRFD Bridge Design Specifications* have been included for reference (See Figures F1 to F6).

Table FA-1: Traffic Data Used For Finite Fatigue Life Analysis

1965 Estimated AADT (both directions)[1]	4,920 vehicles per day
2010 AADT (both directions)[2]	38,000 vehicles per day
Estimated Annual Growth Rates[3]	4.65% (1965-2010)
	4.65% (post-2010, Assumed)
Percentage of Trucks in Traffic[4]	9% (SB Bridge)
	6% (NB Bridge)

[1] Original Design Plans

[2] NHDOT Bureau of Traffic

[3] Uniform growth rate calculated based on 1965 and 2010 traffic counts

[4] NHDOT Bridge Inspection Reports

Table FA-2: Summary of Exterior Girder Fatigue Analysis (Load-Induced)

Detail of Concern	Det Cat [1]	Fig. No.	Quantity per Girder	Constant Amplitude Fatigue Threshold[2]	Maximum Fatigue Stress Range	Finite/ Infinite Life	Estimated Remaining Fatigue Life
Bolted Field Splice	B	F1	10	16.0 ksi	9.2 ksi	Infinite	N/A
Longitudinal Flange-to-Web Welds	B	F2	2	16.0 ksi	10.4 ksi	Infinite	N/A
Transverse Stiffener Welds	C'	F3	179	12.0 ksi	10.4 ksi	Infinite	N/A
Longitudinal Stiffener Weld Terminations	E	F4	75	4.5 ksi	5.1 ksi	Finite	37 years
Welded Flange Transition	B	F5	20	16.0 ksi	7.2 ksi	Infinite	N/A
Girder Web Base Metal at Wind Bracing Gussets	E	F6	90	4.5 ksi	7.6 ksi	Finite	12 years

[1] Per AASHTO LRFD Table 6.6.1.2.3-1

[2] Per AASHTO LRFD Table 6.6.1.2.5-3

Table FA-3: Summary of Interior Girder Fatigue Analysis (Load-Induced)

Detail of Concern	Det Cat[1]	Fig. No.	Quantity per Girder	Constant Amplitude Fatigue Threshold[2]	Maximum Fatigue Stress Range	Finite/ Infinite Life	Estimated Remaining Fatigue Life
Bolted Field Splice	B	F1	10	16.0 ksi	6.9 ksi	Infinite	N/A
Longitudinal Flange-to-Web Welds	B	F2	2	16.0 ksi	7.4 ksi	Infinite	N/A
Transverse Stiffener Welds	C'	F3	179	12.0 ksi	7.4 ksi	Infinite	N/A
Longitudinal Stiffener Weld Terminations	E	F4	75	4.5 ksi	3.7 ksi	Infinite	N/A
Welded Flange Transition	B	F5	20	16.0 ksi	5.4 ksi	Infinite	N/A
Girder Web Base Metal at Wind Bracing Gussets	E	F6	89	4.5 ksi	5.8 ksi	Finite	29 years

[1] Per AASHTO LRFD Table 6.6.1.2.3-1

[2] Per AASHTO LRFD Table 6.6.1.2.5-3

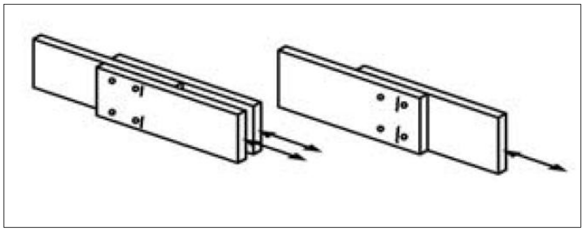


Figure F1 – Bolted Field Splice (Illustrative Example)

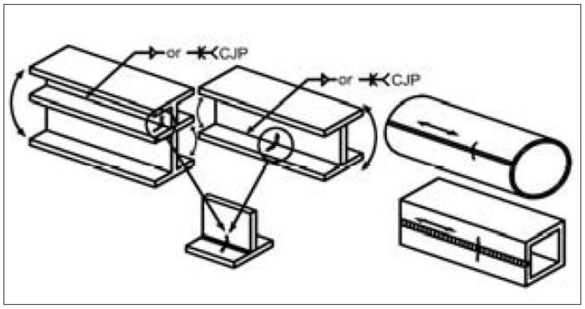


Figure F2 – Longitudinal Flange-to-Web Welds (Illustrative Example)

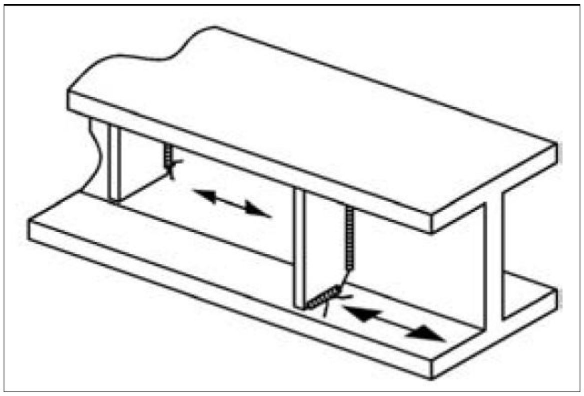


Figure F3 – Transverse Stiffener Welds (Illustrative Example)

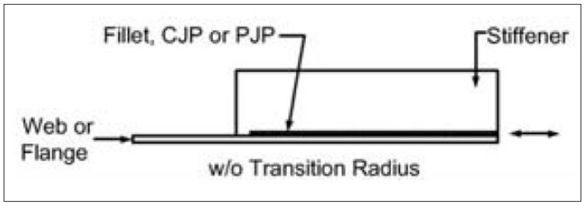


Figure F4 – Longitudinal Stiffener Weld Termination (Illustrative Example)

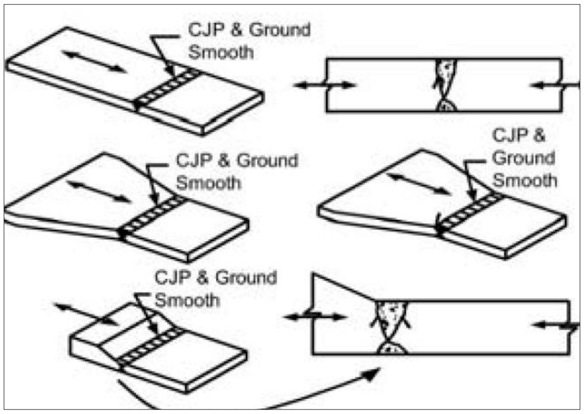


Figure F5 – Welded Flange Transition (Butt Splice) (Illustrative Example)

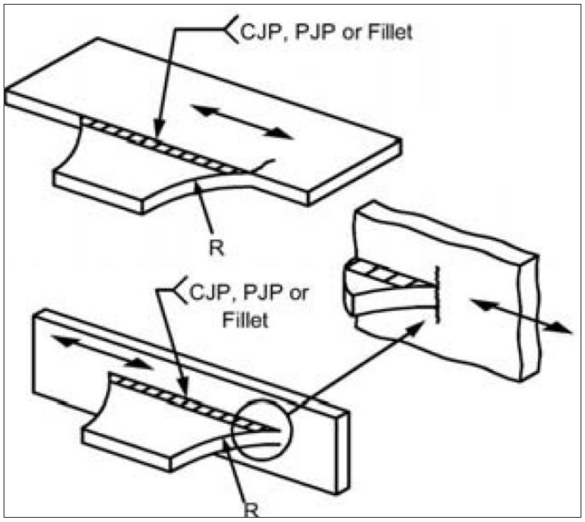


Figure F6 – Gusset Attached at Horizontal Lateral Bracing (Illustrative Example)

Distortion-Induced Fatigue

Distortion-induced fatigue is where localized stress concentrations (cracks) develop from out-of-plane distortions between members. A preliminary assessment of distortion-induced fatigue was investigated based on guidelines provided in the *AASHTO MBE* and *AASHTO LRFD* Design Specifications. Concerns regarding distortion-induced fatigue are typically minimized through proper detailing to provide sufficient rigidity or flexibility at details. This approach reduces the secondary stresses (out-of-plane bending) to non-destructive levels to prevent cracks from forming. The *AASHTO LRFD* Specifications present detailing requirements in Articles 6.6.1.3.1 and 6.6.1.3.2 to discourage the use of susceptible details. Details in violation of these modern requirements were identified on the girders and include the following:

- Connection plates at cross frames are welded to one flange only, but AASHTO presently requires welded or bolted attachment to both flanges.
- Horizontal bracing gusset plates welded to the girder webs do not meet current AASHTO requirements for required offset from the girder flanges.
- The clear distance provided between the ends of horizontal bracing members and the web and vertical stiffeners does not meet the minimum 4-inch requirement.

Summary of Findings

The results of this analysis include:

- Six superstructure load-induced fatigue-prone details were identified.
- Four of the six load-induced fatigue-prone details on the exterior girder and five of the six load-induced fatigue-prone details on the interior girder were found to have theoretically infinite life based on the calculated stress levels.
- The minimum remaining fatigue life calculated for the load-induced fatigue-prone details was estimated to be 12 years at the location where gusset plates for the horizontal wind bracing are welded to the exterior girder webs in the mid-span positive moment regions. The remaining fatigue life for the same load-induced fatigue-prone detail on the interior girder was estimated to be 29 years.
- Several details were identified that violate current AASHTO steel detailing requirements intended to prevent distortion-induced fatigue issues.
- Fracture toughness of the A36 steel used to fabricate the girders is unknown, since these bridges were constructed prior to adoption of the *AASHTO Guide Specifications for Fracture-Critical Nonredundant Steel Bridge Members* in 1978.

PROPOSED CONDITIONS

The proposed conditions must satisfy the purpose and need of the overall project. The focus of the purpose and need is to improve highway safety and the structural integrity of the bridges.

Rehabilitation vs. Replacement

Rehabilitation alternatives were compared to complete bridge replacement at a conceptual level. The rehabilitation alternatives would require deck replacement, structural steel rehabilitation or replacement, and associated substructure rehabilitation. The existing piers are in good condition and are expected to have adequate capacity to accommodate the rehabilitation alternatives. The comparison of the rehabilitation and replacement alternatives did not specifically look at construction phasing, noting only that each would need to be completed with similar constraints. The replacement bridge concept was based on the construction of a segmental concrete 3-span bridge or a steel plate girder 4-span bridge, both with new foundations. Conceptual costs were prepared for two rehabilitation alternatives (shoulder widening and filling in between the bridges (full widening)) and a replacement structure. The results of the conceptual cost analysis are presented in Table RvR-1 and indicate a 50% increase in cost for a replacement structure versus bridge rehabilitation. Based on the significant cost increase for a replacement structure, the project focus was directed towards rehabilitation alternatives.

Table RvR-1: Conceptual Construction Cost Break Down

Cost Item (2013 Costs)	Rehabilitated Bridge (Shoulder Widening)	Rehabilitated Bridge (Full Widening)	Complete Bridge Replacement
Permanent Bridge Cost	$17.0 M	$24.0 M	$37.5 M
Bridge Demolition Cost	$1.5 M	$1.5 M	$3.0 M
Temporary Bridge Cost	$6.5 M	N/A	N/A
Approach Roadway Cost	$3.0 M	$5.5 M	$5.5 M
Total Estimated Construction Cost	**$28 M**	**$31 M**	**$46 M**

See Appendix E for further details on cost analysis

Proposed Roadway

Improvement of highway safety is a primary need of the project. The proximity of the I-91 interchange in Vermont to the Exit 20 interchange in New Hampshire combined with two travel lanes on the bridge and limited shoulder width create a less than desirable safety condition. There are no auxiliary lanes and the existing shoulder widths create a safety hazard for disabled vehicles. RSG was sub-consulted to provide traffic analyses and recommendations (see Appendix D for Report). The report discussed various improvements including shoulder widening and the addition of travel lanes or auxiliary lanes.

A widening of the existing bridges to provide standard shoulder widths is the minimum option to improve highway safety. However, this would not provide improvements to the interstate between the I-91 interchange and the exit 20 interchange (southbound) or provide a climbing lane on the northbound interstate. Widening the bridge to accommodate up to three lanes in each direction (auxiliary lanes included) and standard shoulder widths would increase highway safety and alleviate highway congestion.

Traffic control and phasing during construction are significant design considerations. A requirement of the project is to maintain two lanes of traffic in each direction throughout construction. There are two primary options available to maintain the required traffic: a temporary bridge or widening the bridge to a sufficient width to accommodate traffic control. A temporary bridge could be constructed between the existing bridges while maintaining traffic. This option would require construction of temporary supports on the existing piers and temporary abutment units. The temporary bridge would encompass the majority of the opening between the existing bridges, forcing any widening alternatives to the outside of the existing bridges.

Bridge widening could be constructed to the inside or outside of the existing bridges. A combination of widening to the inside and outside is impractical due to constraints associated with construction phasing. Widening to the outside would require major rehabilitation of the existing piers to support the widening. The outside widening would also create undesirable highway alignments through this section of Interstate 89.

Two options were considered for widening to the inside: widening the minimum to achieve the desired lane and shoulders or widening to completely fill in the gap between the existing bridges. Widening the minimum amount would require major rehabilitation of the existing piers and create challenging construction phasing scenarios. A complete in-fill of the gap between the existing bridges would require major modifications to the existing piers or construction of new piers, but would provide flexibility with construction phasing and traffic control operations.

Conceptual costs were prepared for the shoulder widening option (requiring a temporary bridge) and the in-fill widening option. The results of the conceptual cost analyses presented in Table RvR-1 indicate only a $3 million savings in the shoulder widening versus the in-fill widening. Based on the greater benefits of the in-fill widening (improved highway safety and construction phasing/traffic control opportunities), combined with the minimal cost increase, the full widening alternative is recommended. The full widening alternative was presented to the NHDOT Front Office on August 12, 2013 and to the VTrans Executive Staff on October 7, 2013 and was approved by both parties.

Bridge Rehabilitation

The condition of the bridge decks and superstructures is rated as Fair to Poor; requiring rehabilitation or replacement to improve the structural integrity of the bridges to remove them from the NHDOT red-list. The existing concrete decks will be replaced with new concrete decks removing them as a factor in the low condition rating of the bridges. The existing steel can be rehabilitated or replaced. Both options were evaluated for cost efficiency.

The rehabilitation of the steel would include repairing areas of corrosion, strengthening members to meet load rating requirements, improving fatigue details to provide a 75 year life, and repainting the structural steel. The replacement of the steel would include removal of the existing structural steel and replacement with weathering steel plate girders and new bearings. Costs associated with steel rehabilitation and replacement were prepared and presented in Table BRR-1. Given the potential toughness issues with the existing steel, the large number of fatigue details to improve, and the high cost associated with repainting the steel, the replacement of the steel is desirable. The cost differential is $0.8 million with the new steel providing 75 years of service life with significantly less maintenance and potential safety concerns expected. The decision to replace the existing structural steel was presented to the NHDOT Front Office on August 12, 2013 and to the VTrans Executive Staff on October 7, 2013 and was approved by both parties.

Table BRR-1: Cost Analysis for Steel Replacement vs. Rehabilitation

Work Item	Steel Rehabilitation Fatigue Retrofits and Complete Repainting	Steel Replacement Constant Depth Weathering Steel Plate Girders
Existing Steel Girder Fatigue Retrofits	$0.9 M	N/A
Existing Steel Girder Repairs	$1.2 M	N/A
Clean & Paint Existing Steel Girders	$4.0 M	N/A
Removal of Existing Steel Girders	N/A	$1.5 M
New Steel Plate Girders	N/A	$4.5 M
Bridge Seat Modifications	N/A	$1.0 M
Estimated Initial Steel Costs (2015)	**$6.1 M**	**$7.0 M**
Estimated Remaining Service Life	50 Years	75 Years
Bridge Life Cycle Cost Analysis (Base Year = 2015)	**$10.2 M**	**$9.4 M**

See Appendix E for further details on cost analysis

Substructure Evaluation

Introduction

An analysis of the existing substructure was conducted in accordance with the appropriate provisions from the *AASHTO LRFD Bridge Design Specifications, 6th Edition with 2013 Revisions* (AASHTO LRFD) and the *NHDOT Bridge Design Manual*, 2000 Edition. The analyses were based on the "As-Designed" substructures and details obtained from the original 1964 design plans. Changes to the condition and/or strength of the concrete, which may have occurred since the construction of the bridges in 1966, was not considered in the analyses.

The intent of these analyses was to determine if the existing substructure units are adequate for reuse to carry the proposed superstructure replacement as well as meet the current AASHTO design specifications and live loading requirements. The original bridges were designed for the AASHO H20-S16 live load, including the alternate military loading, in accordance with the *AASHO 1961 Specifications for the Design of Highway Bridges.*

The existing substructure of each bridge is comprised of two cast-in-place cantilever abutments with U-back butterfly wingwalls and five cast-in-place concrete hammerhead piers with tapered solid shafts. All abutments are supported on three rows of steel 12BP53 end bearing piles driven to refusal, with the front two rows battered and the back row vertical. Piers I, II, III, and V are founded on six rows of steel 14BP73 end bearing piles driven to refusal. The remaining pier, Pier IV, is supported by a spread footing founded on a concrete cofferdam seal bearing directly on bedrock. Fixed bearings are currently provided at Pier III, located at mid span of each bridge.

The preliminary analysis of the existing substructure consisted of the investigation of one typical pier with fixed bearings founded on piles (Pier III), one typical pier supported by a spread footing on bedrock (Pier IV), one typical pier with expansion bearings founded on piles (Pier I), and one typical Abutment founded on piles (Abutment A). Abutment A was analyzed as it was similar to Abutment B, but slightly taller and with longer piles. Pier I was selected over Pier II and Pier V for the typical pier founded on piles because it was taller than Pier V, and further than Pier II from the fixed bearing pier (larger induced thermal loading).

As part of this preliminary investigation, two pier configurations were considered to accommodate the proposed bridge widening. One alternative was to connect each pair of existing pier caps forming a frame to carry the proposed superstructure (Connected Pier option, see Appendix F). This was the more desirable option as it would allow for top down construction; keeping all construction out of the river thereby providing significant cost savings and reducing environmental impact. The second alternative was to build new full height piers down the middle to support the new bridge section (In-Fill Pier option, see Appendix F). This option requires conventional construction to occur in the waterway increasing construction time and costs. The sections to follow detail the analysis results and the factors that show the In-Fill Pier Option to be the preferred foundation solution for this bridge widening and superstructure replacement project.

Summary of Initial Analysis Loading Conditions

Prior to determining which pier configuration would be more optimal for the proposed improvements, a base line analysis was completed for a typical abutment, Pier I, Pier III, and Pier IV. This base line analysis assumed that the original bridge width would be replaced (ignoring any widening) with new steel girders and proposed 8½ inch reinforced concrete deck. The purpose of this analysis was to uncover deficiencies per current AASHTO and NHDOT standards, and to determine if modifications would need to be made in the application of loads from the superstructure to the substructure before considering the different pier configurations (i.e. could elastomeric bearings be used or would a non-traditional bearing type be required).

Lead core seismic isolation bearings were utilized in the initial analysis. Seismic isolation bearings were chosen to mitigate the amount of load transfer from the superstructure to the substructure during a seismic event. Lead core seismic isolation bearings are essentially a conventional elastomeric bearing with a solid lead core in the middle. During a seismic event the lead core dissipates energy through plastic deformation, and the rubber accommodates these deformations while providing a restoring force to re-center the bridge when the event has concluded. During seismic events this seismic isolation bearing system has a stiffness ideally equal to a similarly sized conventional elastomeric bearing. Under service load conditions, the lead core stiffens the bearing as compared to a conventional elastomeric bearing; therefore increasing the service loading transferred to the substructure. The preliminary lead core bearing assembly used in this initial analysis was determined through the technical specification sheets provided by Dynamic Isolation Systems. The chosen geometry of the bearing was based on a balance of minimizing the service load transfer, while providing adequate seismic energy dissipation (i.e. an adequately sized lead core). The stiffness of this assumed system was used to determine the service loads transferred to the substructure, and the preliminary assumptions set in the NHDOT Bridge Design Manual were followed for the seismic loading.

The loads considered in the initial analysis are as follows:

- Dead loads due to the proposed superstructure including steel girders, 8½" deck, 2⅝" wearing surface, brush curbs, and metal bridge rail.
- Current design vehicular loading (HL-93) as defined in AASHTO LRFD Article 3.6.1.2.
- Live Load Surcharge according to AASHTO LRFD Article 3.11.6.4.
- Wind loading applied directly to the substructure according to Article 3.8.1.2.3.
- Thermal forces due to expansion and contraction of the superstructure, Article 3.12 AASHTO LRFD.
- Ice loading due to ice drifts found in the Connecticut River, Article 3.9 AASHTO LRFD.
- Braking force due to vehicles on the superstructure, Article 3.6.4 AASHTO LRFD.

- ☼ Seismic forces in soil pressure by a Mononobe-Okabe Analysis (abutment only).
- ☼ Seismic reactions resulting from the superstructure according to the preliminary design requirements for seismic isolation bearings defined in section 603.5.1 of the NHDOT Bridge Design Manual. In accordance with section 603.5.1, the seismic force from the superstructure was estimated at 12% of the superstructure dead load.

Summary of Initial Analysis

To conduct the initial analysis three software packages were utilized: ABLRFD, RC-Pier, and LPILE. ABLRFD is a software package produced by the Pennsylvania Department of Transportation that was used to analyze a typical existing abutment. The Bentley RC-Pier software was used to analyze piers I, III, and IV. Lastly, LPILE was used to approximate the lateral pile capacity due to the soil-pile interaction. One LPILE run was conducted using a typical abutment pile. The results from the abutment pile were also used for the piers. This was assumed to be a conservative approximation for the lateral geotechnical capacity of the piles supporting the piers because the pier piles are larger than the abutment piles.

Preliminary results of the initial analysis suggest that the reinforcement in all of the Piers is insufficient to meet current code standards for crack control, and the abutment reinforcement is insufficient to meet current code standards for temperature and shrinkage requirements. The abutments fail to meet the requirements of section AASHTO LRFD 5.10.8 for temperature and shrinkage steel. This is largely due to the 40 ksi steel that was used for the reinforcement. The piers do not comply with limits for compression member reinforcement set in section 5.7.4.2 of AASHTO LRFD. Similar to the abutments, this code requirement is significantly impacted by the 40ksi rebar in the existing piers.

Along with the identified code deficiencies, the substructure elements exhibited inadequacies in their respective supporting elements (piles or spread footing). The deficiencies identified in the abutments were minor as compared to the piers. Tables SSE-1 and SSE-2 below summarize the results of the initial abutment analysis. The lateral loads calculated in the bridge longitudinal direction show the piles as being slightly over stressed when compared the available preliminary lateral resistance. At the time of these analyses there was relatively little known about the geotechnical properties of the rock and soil present at the site other than what was provided with the original plan set. Therefore, for these preliminary analyses the axial pile stresses will be compared to the original design axial pile stresses. When compared to the original design stresses the results of the analysis suggest that the proposed axial loading will overstress the existing piles axially.

Table SSE-1: Initial Abutment Pile Lateral Load Summary (Bridge Longitudinal Direction)			
	Total Lateral Load (Kips)	**Total Available Lateral Capacity From Piles (Kips)**	**Performance Ratio**
Service I	673	653	0.971
Strength I	828	759	0.917
Strength III	738	726	0.983
Strength V	811	753	0.929
Extreme I	563	781	1.39

Table SSE-2: Initial Abutment Pile Axial Load Summary	
	Total Axial Load (ksi)
Original Design Stress	5.8
Service I	8.8
Strength I	9.9
Strength III	7.6
Strength V	9.4
Extreme I	6.8

Pier I displayed the least favorable results of the three piers analyzed. The poor performance of Pier I can be attributed to its height and distance from the fixed support (resulting in higher thermal loading). Lateral pile capacity was not an issue for Pier I as the applied lateral loads were accommodated with the batter component of the piles without considering any geotechnical capacity of the piles. Conversely, the axial stress in the piles greatly exceeded the original design stress (more than doubled). The high axial pile loads are a product of the higher modern longitudinal bridge loads combined with the height of the pier structure. Table SSE-3 summarizes the axial stress calculated in the Pier I piles.

Table SSE-3: Pier I Pile Axial Stress Summary	
	Total Axial Stress (ksi)
Original Design Stress	5.6
Service Stress	11.4
Factored Stress	12.2

Pier III exhibited similar results to Pier I; however the axial pile stress for the Pier III piles were much closer to the original design pile stress. Like Pier I, lateral resistance of the pile batter was sufficient to handle the proposed lateral loads. Table SSE-4 summarizes the axial stresses in the piles at Pier III.

Table SSE-4: Pier III Pile Axial Load Summary	
	Total Axial Load (ksi)
Original Design Stress	5.6
Service Stress	6.2
Factored Stress	10.1

The third pier assessed during the initial analysis was Pier IV which is founded on a spread footing supported by rock. The spread footing was found to be adequate for sliding and overturning calculations. The issue noted with Pier IV was the bearing pressure. Without geotechnical information on the integrity of the rock which the pier is bearing on, original design bearing force was all the analysis could be based on. The resulting bearing pressure from the current code loading condition was significantly higher than the original design bearing force. Table SSE-5 summarizes the bearing pressures determined as part of the initial analysis.

Table SSE-5: Pier IV Spread Footing Bearing Pressure Summary	
	Bearing Pressure (ksi)
Original Design Stress	5.6
Service Stress	15.2
Factored Stress	20.7

It was evident at the conclusion of the initial analyses that the applied loads would be too large to allow for the reuse of the existing substructure elements. In order to accommodate the modern loading conditions provisions were made to reduce the applied loading and another bearing system was selected to further reduce the transfer of load to the substructure.

Revised Loading Conditions

Based on the findings of the initial substructure analysis, it was evident that reduction in the proposed longitudinal loads would be necessary for reuse of the existing substructure. The controlling factored load case for all piers was Extreme Event I. The seismic load used in Extreme Event I was based on the 12% of the superstructure dead load assumption set in section 603.5.1 of the NHDOT Bridge Manual. The provisions of this assumption allow the designer to reduce this percentage to as low as 7% of the superstructure dead load. Doing so provided much more favorable results for the

Extreme Event I load case; however this assumption does not help to address the other remaining service load cases. Since the start of the preliminary analysis there has been discussion in the T-3 Technical AASHTO Subcommittee on Bridges and Structures for Seismic to reduce the seismic loading requirements for bridges such as this one found in Zone 1. The proposed amendment would eliminate the requirement to carry the design connection force from the point of application through the substructure to the foundation elements. In their June 2014 meeting, the Subcommittee on Bridges and Structures voted in favor of this amendment to the AASHTO LRFD section 3.10.9.2. This amendment allows for the dismissal of superstructure seismic forces from the evaluation of the existing substructure, and subsequently eliminates the need for seismic isolation bearings. Without the need for seismic isolation bearings, low friction bearing systems could be utilized to reduce the applied longitudinal service loads transferred to the substructure.

The revised loads considered for the investigation of a typical abutment and the existing piers associated with both the In-Fill Pier and Connected Pier configurations were as follows:

- Dead loads due the proposed superstructure including steel girders, 8½" deck, 2⅝" wearing surface, and metal bridge rail.
- Current design vehicle (HL-93) as defined in AASHTO LRFD Article 3.6.1.2.
- Live Load Surcharge according to AASHTO LRFD Article 3.11.6.4.
- Wind loading applied directly to the substructure according to Article 3.8.1.2.3.
- Seismic forces in soil pressure by a Mononobe-Okabe Analysis (abutment only).
- Ice loading due to ice drifts found in the Connecticut River, Article 3.9 AASHTO LRFD.
- Frictional loads applied to each bearing location equal to 7% of the superstructure dead load. A value of 7% was chosen because it was assumed to be a conservative value and that the true percentage transmitted by a low friction bearing could be lower.

Revised Abutment Analysis Results

The use of low friction bearings for the abutment analysis reduced the pile reactions much closer to compliance with the original design loads and preliminary capacity predictions. Tables SSE-6 and SSE-7 summarize the pile performance with the use of low friction bearings. It should be noted that under service conditions the existing piles now have sufficient resistance to support the proposed lateral loads. Also, the predicted axial pile stress now matches the original design pile stress. The remaining load cases exhibit minor deficiencies; however, these can be rectified in the final design calculations and through the connection of the existing abutment footings with the proposed in-fill abutment footing.

Table SSE-6: Abutment Pile Lateral Load Summary with Low Friction Bearings			
	Total Lateral Load (Kips)	**Total Available Lateral Capacity From Piles (Kips)**	**Performance Ratio**
Service I	503	548	1.09
Strength I	753	721	0.95
Strength III	655	670	1.02
Strength V	732	710	0.97

Table SSE-7: Abutment Pile Axial Stress Summary with Low Friction Bearings	
	Total Axial Load (ksi)
Original Design Stress	5.8
Service I	5.8
Strength I	8.6
Strength III	6.9
Strength V	8.1

In-Fill Pier vs. Connected Pier Analysis Under the Revised Loading Condition

For the analysis of the In-Fill Pier and Connected Pier configurations, Pier I was the only pier location considered. The Pier I location was chosen because the majority of the piers are founded on piles with similar pile configurations. Pier I also exhibited the most deficiencies during the initial analysis when compared to the original design loads. Pier IV, the spread footing, was not considered because the lack of current geotechnical data at this preliminary stage would have made the analysis of the Connected Pier option difficult.

The original assumption with this analysis was that the Connected Pier option would not be able to sustain the longitudinal loads with only the existing supporting elements. Through the use of low friction bearings this proved to not be the case, and that existing foundation elements could satisfactorily carry the proposed longitudinal loads. What was not initially considered was the effect that the frame action, caused by connecting the two piers, would have on the substructure elements in the transverse direction. The frame action of the connected piers greatly increased the transverse lateral loads in the piles when compared to the In-Fill pier option. Table SSE-8 summarizes the calculated loads associated with the In-Fill and Connected existing pier options.

Table SSE-8: Pier I Lateral Pile Loads in the Transverse and Longitudinal Direction			
Substructure Configuration	**Lateral Load (Kips)**	**Resistance From Pile Batter (Kips)**	**Performance Ratio**
New In-Fill Pier Option (Longitudinal to the Bridge)	160	219	1.3
Connected Existing Pier Option (Longitudinal to the Bridge)	220	302	1.3
New In-Fill Pier Option (Transverse to the Bridge)	23	155	6.7
Connected Existing Pier Option (Transverse to the Bridge)	733	387	0.52

The use of low friction bearing systems made the axial stresses for the In-Fill Pier option more compliant with the original design axial pile stresses. An increase in axial pile performance was calculated for the In-Fill Pier option through a reduction in the applied longitudinal loads due to a subsequent reduction in the overturning force applied to the piles. The low friction bearings apply the same benefit to the Connected Pier option, just not to the same degree as the In-Fill Pier option due to the frame action experienced by the Connected Pier option. Table SSE-9 summarizes the axial pile stresses observed in each pier configuration compared to the original design stress.

Table SSE-9: Pier I Pile Axial Load Summary	
	Total Axial Load (ksi)
Original Design Stress	5.6
In-Fill Pier Option	7.3
Connected Existing Pier Option	11.2

In conclusion, it is recommended that low friction bearings and the In-Fill Pier Option be pursued in final design. The frame action effects experienced by the Connected Pier option are too severe to consider connecting the existing piers as an economically viable solution.

APPENDIX A – EXISTING BRIDGE PLANS

FED. ROAD DIV. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N.H.	I 89 I(41)59	1965	1	26

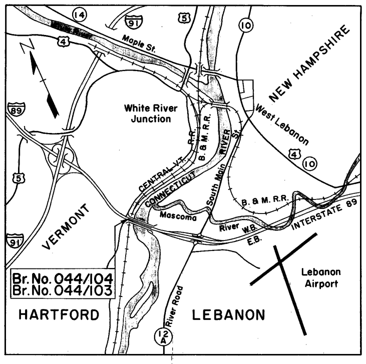
INDEX OF SHEETS

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

PLANS OF PROPOSED
FEDERAL AID PROJECT
I 89-I(41)59

N. H. PROJECT NO. P-3821-F

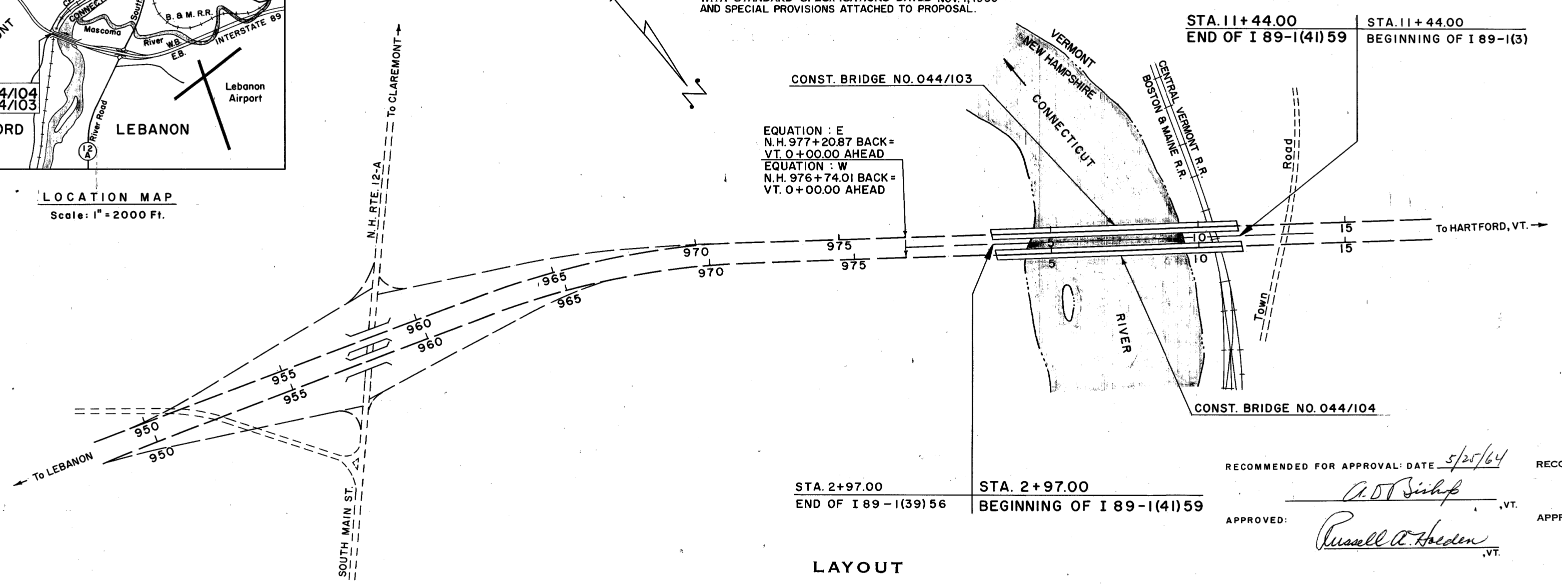
DESIGN DATA		
AVERAGE DAILY TRAFFIC 1965	4,920	
AVERAGE DAILY TRAFFIC 1985	11,760	
TRAFFIC CLASSIFICATION	M	
DESIGN SPEED	70	M.P.H.
MAXIMUM CURVATURE		DEGREES
MAXIMUM GRADIENT	3	%
NON-PASSING SIGHT DISTANCE K FACTOR – CREST 330 SAG 170		
LENGTH OF PROJECT	0.160	MILES



LOCATION MAP
Scale: 1" = 2000 Ft.

SCALES AS NOTED

THIS PROJECT TO BE CONSTRUCTED IN ACCORDANCE WITH STANDARD SPECIFICATIONS DATED NOV. 1, 1960 AND SPECIAL PROVISIONS ATTACHED TO PROPOSAL.



LAYOUT
SCALE 1" = 200 FEET

RECOMMENDED FOR APPROVAL: DATE 5/25/64
A. D. Bishop, VT.
APPROVED: Russell A. Holden, VT.

RECOMMENDED FOR APPROVAL: DATE May 6, 1964
Robert H. Whitaker
DEPUTY COMMISSIONER AND CHIEF ENGINEER, N.H.
APPROVED: John O. Morton
COMMISSIONER, N. H.

CONVENTIONAL SIGNS

STATE LINE
TOWN LINE
FENCE
STONE WALL
UNFENCED PROPERTY
TRAVELED WAY
RAILROADS
RETAINING WALL
SEWER MANHOLE
HYDRANT
LEDGE
R O W LINE
SURVEY LINE
CULVERTS
POWER POLES
TELEPHONE POLES
GROUND ELEVATION
GRADE ELEVATION
SLOPE LINE
CATCH BASIN
DROP INLET
BRUSH LINE

CITY OF LEBANON, N. H. TOWN OF HARTFORD, VT.

COUNTY OF GRAFTON COUNTY OF WINDSOR

DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
APPROVED: Albert R. Purchase 5/25/64
DIVISION ENGINEER DATE

DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
APPROVED:
DIVISION ENGINEER DATE

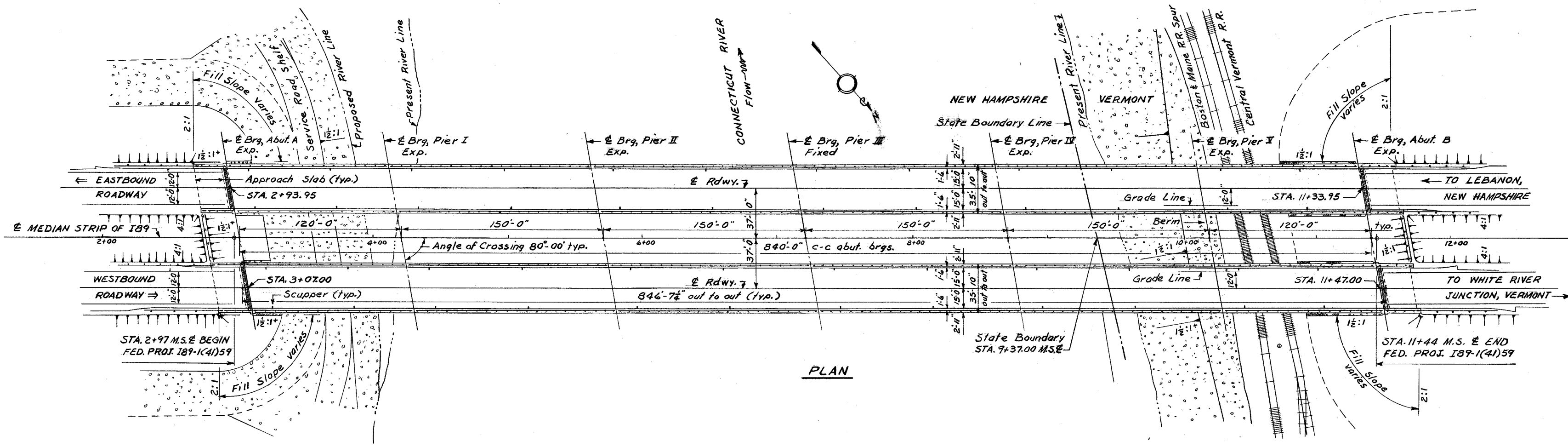
DRAWN BY	Aldrich	DATE	4-22-64
CHECKED BY		DATE	

300-12-55 MODERN BLUE PRINT CO. NO. 70 REVILO 32935

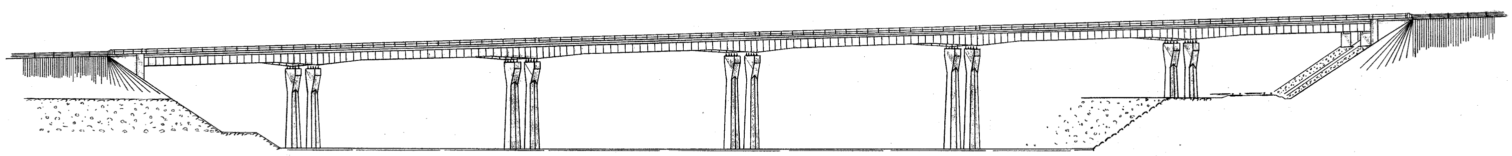
PROJ. NO.	SHEET NO.	TOTAL SHEETS
I 89-I(41)59	1	26

17-4-1

FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.				



PLAN



ELEVATION

GENERAL NOTES

Design Loading H20-S16 as modified for Military Loading.
Specifications A.A.S.H.O. 1961 and New Hampshire Department of Public Works and Highways 1960.
Foundations:
Abutment A & B, Pier V - 12BP53 Steel Brg. Piles. Design Load 45 tons per pile.
Pier I, II, III - 14BP73 Steel Brg. Piles. Design Load 60 tons per pile.
Pier IV - Bedrock. Design Load 5 tons per square foot.
All reinforcing steel shall be Intermediate Grade.

SUMMARY OF BRIDGE QUANTITIES

Item No.	Description	Quantity	Unit	Item No.	Description	Quantity	Unit
111	Clearing and Grubbing	1.22	Acre	322.22	Concrete Class A (Land Pier - Abuts. - Above Footings)	1,066.5	Cu. Yd.
163	Unclassified Channel Excavation	74,200	Cu. Yd.	322.3	Concrete Class A (Approach Slabs)	89.8	Cu. Yd.
171.1	Earth Structure Excavation (Land Piers)	200	Cu. Yd.	327	Concrete Bridge Deck	1	Unit
171.2	Earth Structure Excavation (River Piers)	3,370	Cu. Yd.	333	Membrane Waterproofing	5,680	Sq. Yd.
172	Ledge Structure Excavation (River Piers)	15	Cu. Yd.	334	Water Repellent	214	Gal.
214.1	Gravel for Special Purposes	7,400	Cu. Yd.	336	Epoxy Coating for Concrete	16	Gal.
214.2	Gravel for Special Purposes	3,430	Cu. Yd.	344	Reinforcing Steel	865,275	Lbs.
259	Type I-1 Hot Asphalt. Concr. Wear. Course for Br.	630.0	Ton	351	Structural Steel	1	Unit
303	Cofferdams	1	Unit	352	Bridge Shoes	1	Unit
310.1	Pile Driving Equipment	1	Unit	362	Sealer for Expansion Joints in Bridges	1,160	Cu. In.
310.2	Pile Loading Tests	12	Each	363.5	Bridge Railing E	3,563.6	Lin. Ft.
316	Furnishing Steel Bearing Piles	2,482,285	Lbs.	364	Bridge Lighting System	1	Unit
317	Driving Steel Bearing Piles	2,482,285	Lbs.	385.01	Stone Fill	150	Cu. Yd.
319	Pile Splices	48	Each	385.02	Stone Fill (Class A Stone)	9,730	Cu. Yd.
322.11	Concrete Class A (Cofferdam Seal)	2,350	Cu. Yd.	715	Straight Granite Curb (Bridge)	3,544.0	Lin. Ft.
322.12	Concrete Class A (River Pier Footings)	1,089.8	Cu. Yd.	813	State Reference Monument	1	Unit
322.13	Concrete Class A (Land Pier - Abut. Footings)	684.6	Cu. Yd.	813.1	State Line Markers	1	Unit
322.21	Concrete Class A (River Piers Above Footings)	2,975.7	Cu. Yd.	829	Field Office	1	Each

NOTE: Quantities shown above include the combined WB & EB bridge totals.

APPROVED Robert H. Whitaker RWW DATE 5-26-64
DEPUTY COMMISSIONER AND CHIEF ENGINEER

Sheet Scale: 1" = 40'

△	DESCRIPTION	BY	DATE
	REVISIONS		

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION

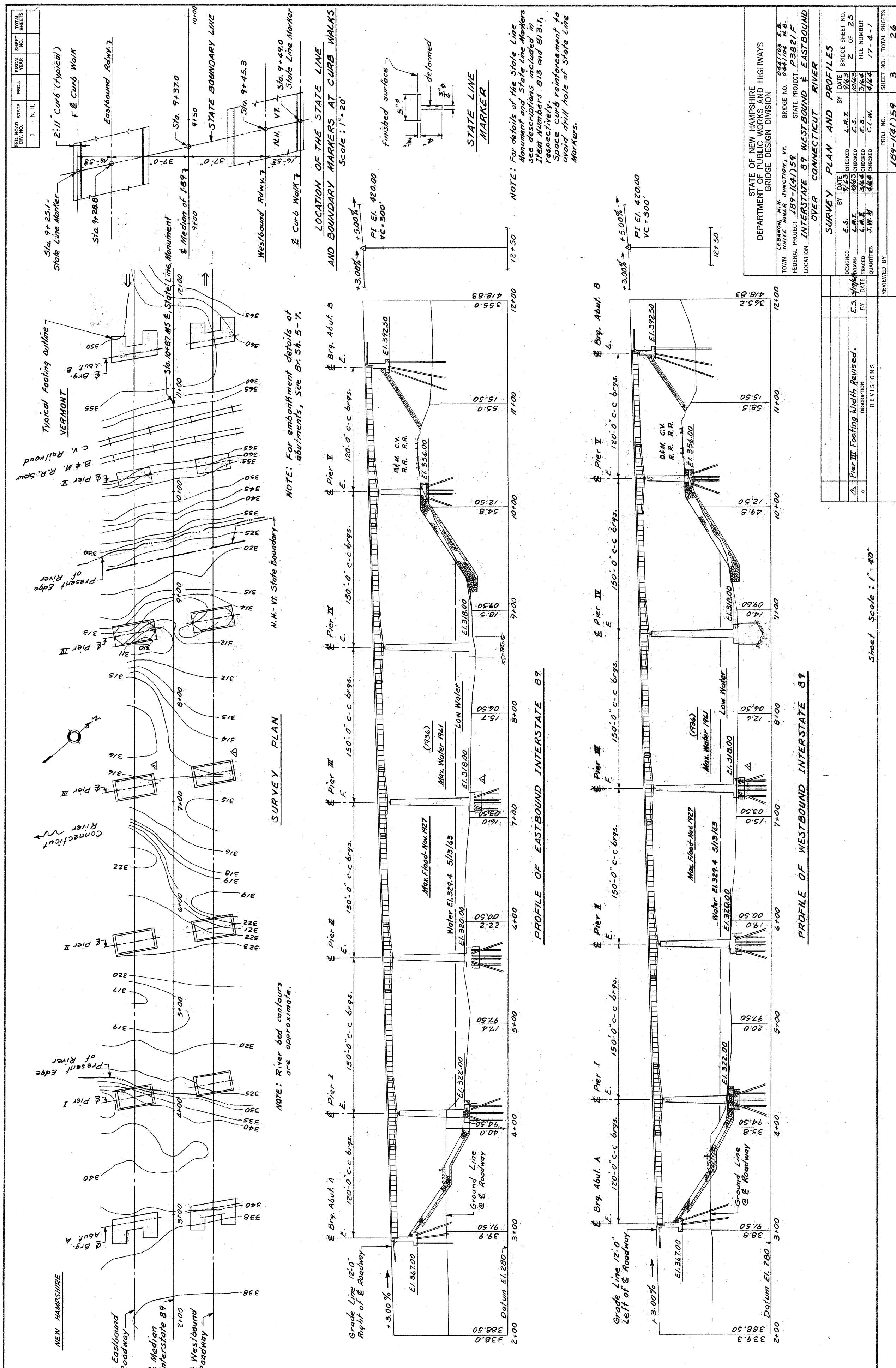
TOWN LEBANON, N.H. / WHITE RIVER JUNCTION, VT. BRIDGE NO. 044/103 E.B. / 044/104 W.B.
FEDERAL PROJECT I89-1(41)59 STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

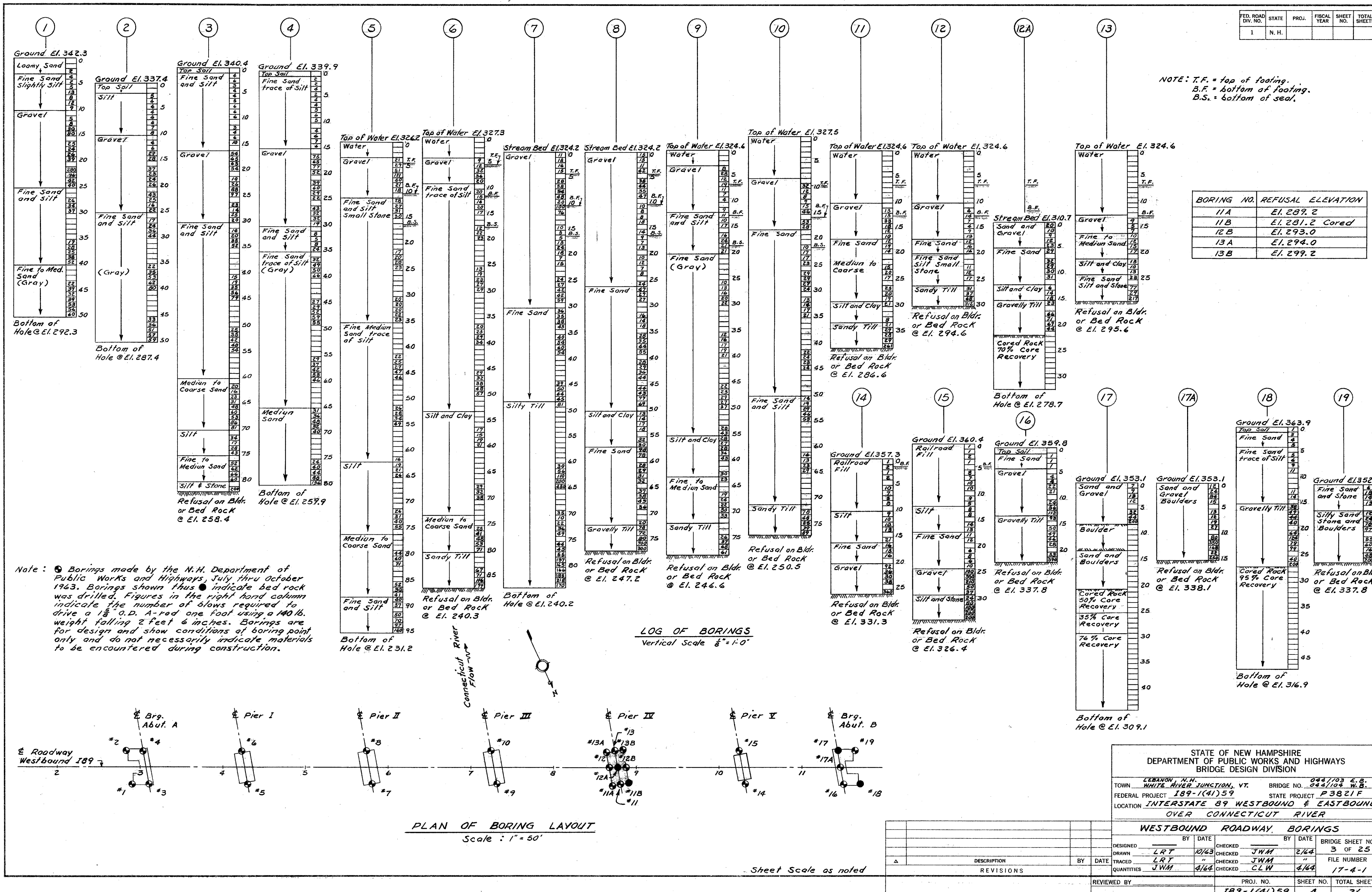
GENERAL PLAN AND ELEVATION

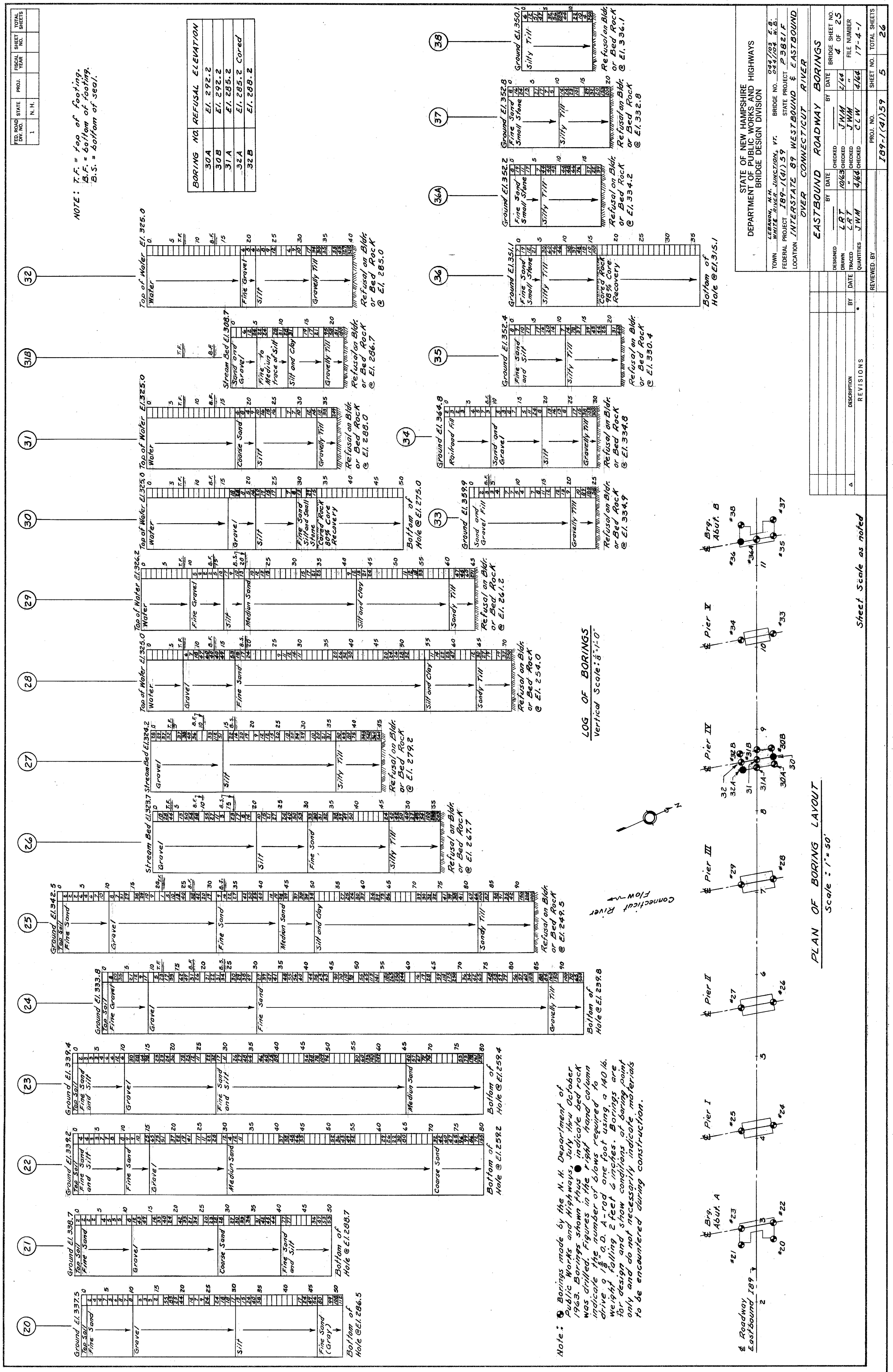
	BY	DATE		BY	DATE
DESIGNED	E.S.	10/63	CHECKED	L.R.T.	10/63
DRAWN	E.S.	4/64	CHECKED	L.R.T.	4/64
TRACED	L.R.T.	4/64	CHECKED	E.S.	4/64
QUANTITIES	J.W.M.	4/64	CHECKED	C.L.W.	4/64

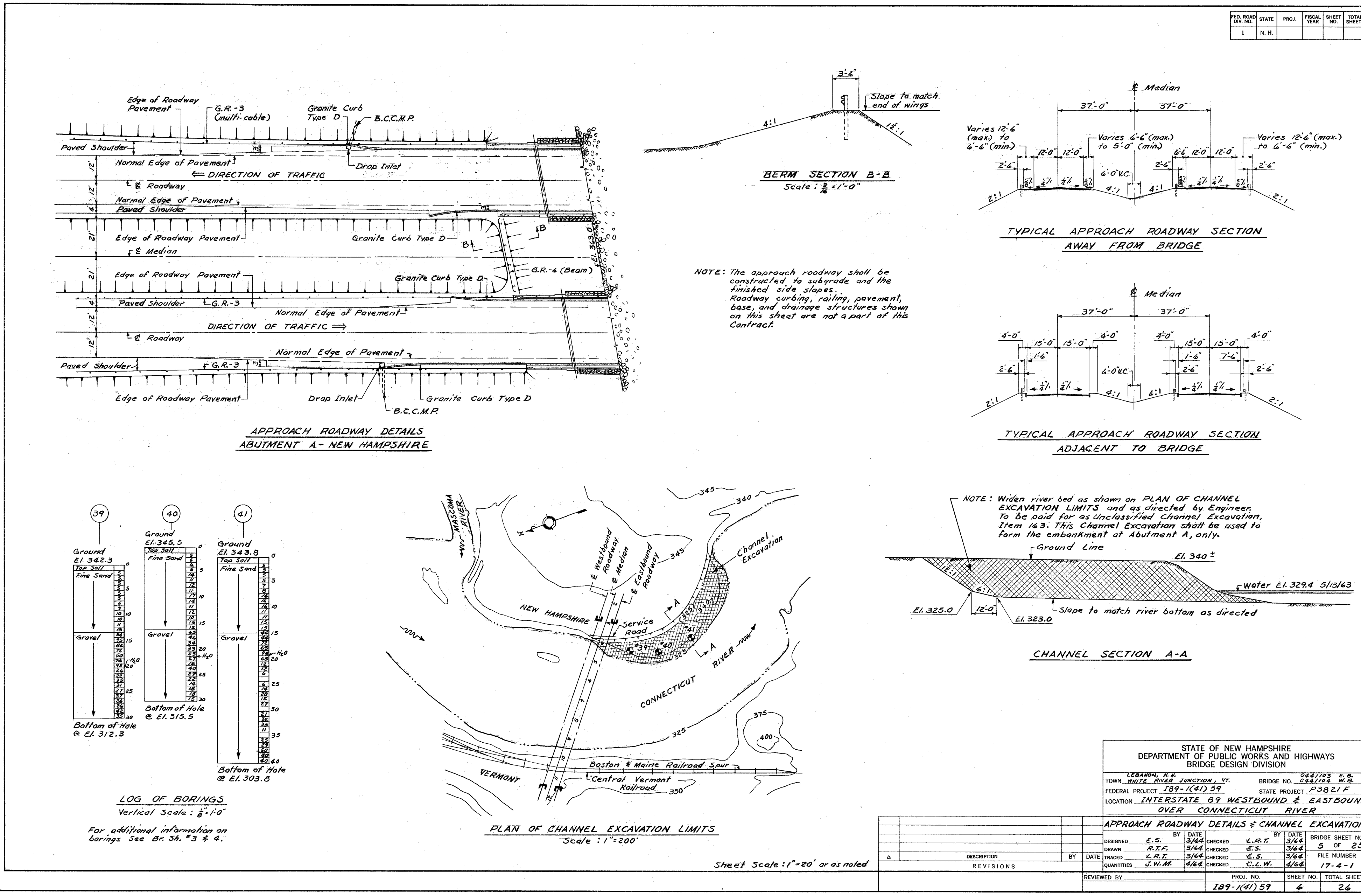
BRIDGE SHEET NO. 1 OF 25
FILE NUMBER 17-4-1

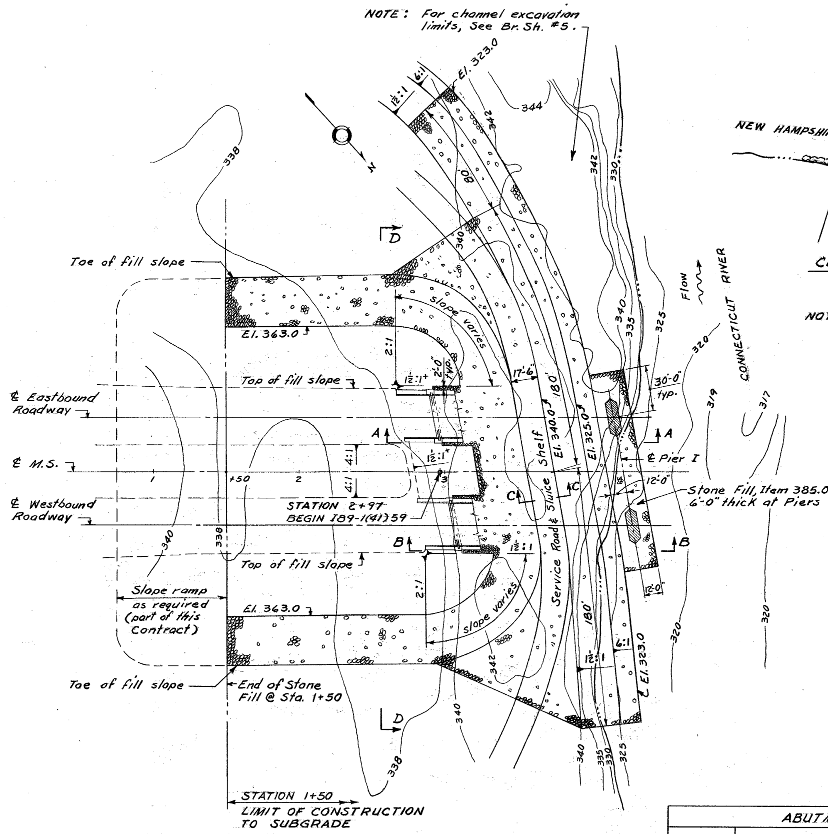
REVIEWED BY	PROJ. NO.	SHEET NO.	TOTAL SHEETS
	I89-1(41)59	2	26


STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION
TOWN LEBANON, N.H. WHITE RIVER JUNCTION, VT.
BRIDGE NO. 044/103 E.B. 044/104 W.B.
FEDERAL PROJECT I89-1(41)59
STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER
SURVEY PLAN AND PROFILES
DESIGNED E.S. 9/63 CHECKED L.R.T. 9/63
DRAWN L.R.T. 10/63 CHECKED E.S. 10/63
TRACED L.R.T. 3/64 CHECKED E.S. 3/64
QUANTITIES J.W.M. 4/64 CHECKED C.L.W. 4/64
BRIDGE SHEET NO. 2 OF 25
FILE NUMBER 17-4-1
PROJ. NO. I89-1(41)59
SHEET NO. 3
TOTAL SHEETS 26
REVIEWED BY
Pier III Footing Width Revised. E.S. 3/19/65
REVISIONS
SURVEY PLAN
NOTE: River bed contours are approximate.
NOTE: For embankment details of abutments, See Br. Sh. 5-7.
NEW HAMPSHIRE
VERMONT
Connecticut River
Present Edge of River
N.H.-Vt. State Boundary
Typical Footing outline
B.&M. R.R. Spur
C.V. Railroad
PROFILE OF EASTBOUND INTERSTATE 89
PROFILE OF WESTBOUND INTERSTATE 89
LOCATION OF THE STATE LINE AND BOUNDARY MARKERS AT CURB WALKS
Scale: 1" = 20'
STATE LINE MARKER
NOTE: For details of the State Line Monument and State Line Markers see descriptions included in Item Numbers 813 and 813.1, respectively. Space curb reinforcement to avoid drill hole of State Line Markers.
STATE BOUNDARY LINE
Sheet Scale: 1" = 40'

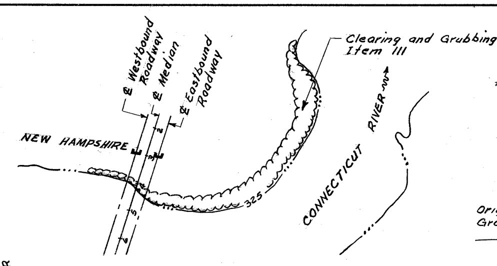

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION
TOWN LEBANON, N.H. WHITE RIVER JUNCTION, VT.
BRIDGE NO. 044/103 E.B. 044/104 W.B.
FEDERAL PROJECT I89-1(41)59
STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER
WESTBOUND ROADWAY BORINGS
DESIGNED / DRAWN LRT 10/63 / TRACED LRT " / QUANTITIES JWM 4/64
CHECKED JWM 2/64 / CHECKED JWM " / CHECKED CLW 4/64
BRIDGE SHEET NO. 3 OF 25
FILE NUMBER 17-4-1
REVIEWED BY
PROJ. NO. I89-1(41)59
SHEET NO. 4
TOTAL SHEETS 26
FED. ROAD DIV. NO. 1
STATE N.H.
REVISIONS
Sheet Scale as noted
NOTE: T.F. = top of footing. B.F. = bottom of footing. B.S. = bottom of seal.
BORING NO. | REFUSAL ELEVATION
11A | El. 289.2
11B | El. 281.2 Cored
12B | El. 293.0
13A | El. 294.0
13B | El. 299.2
LOG OF BORINGS
Vertical Scale 1/8" = 1'-0"
PLAN OF BORING LAYOUT
Scale: 1" = 50'
Note: Borings made by the N.H. Department of Public Works and Highways, July thru October 1963. Borings shown thus ● indicate bed rock was drilled. Figures in the right hand column indicate the number of blows required to drive a 1 3/8" O.D. A-rod one foot using a 140 lb. weight falling 2 feet 6 inches. Borings are for design and show conditions at boring point only and do not necessarily indicate materials to be encountered during construction.
℄ Roadway Westbound I89
℄ Brg. Abut. A
℄ Pier I
℄ Pier II
℄ Pier III
℄ Pier IV
℄ Pier V
℄ Brg. Abut. B
Connecticut River Flow
Ground El. 342.3
Bottom of Hole @ El. 292.3
Ground El. 337.4
Bottom of Hole @ El. 287.4
Ground El. 340.4
Refusal on Bldr. or Bed Rock @ El. 258.4
Ground El. 339.9
Bottom of Hole @ El. 257.9
Top of Water El. 326.2
Bottom of Hole @ El. 231.2
Top of Water El. 327.3
Refusal on Bldr. or Bed Rock @ El. 240.3
Stream Bed El. 324.2
Bottom of Hole @ El. 240.2
Stream Bed El. 324.2
Refusal on Bldr. or Bed Rock @ El. 247.2
Top of Water El. 324.6
Refusal on Bldr. or Bed Rock @ El. 246.6
Top of Water El. 327.5
Refusal on Bldr. or Bed Rock @ El. 250.5
Top of Water El. 324.6
Refusal on Bldr. or Bed Rock @ El. 286.6
Top of Water El. 324.6
Refusal on Bldr. or Bed Rock @ El. 294.6
Stream Bed El. 310.7
Bottom of Hole @ El. 278.7
Top of Water El. 324.6
Refusal on Bldr. or Bed Rock @ El. 295.6
Ground El. 357.3
Refusal on Bldr. or Bed Rock @ El. 331.3
Ground El. 340.4
Refusal on Bldr. or Bed Rock @ El. 326.4
Ground El. 359.8
Refusal on Bldr. or Bed Rock @ El. 337.8
Ground El. 353.1
Bottom of Hole @ El. 309.1
Ground El. 353.1
Refusal on Bldr. or Bed Rock @ El. 338.1
Ground El. 363.9
Bottom of Hole @ El. 316.9
Ground El. 352.8
Refusal on Bldr. or Bed Rock @ El. 337.8


STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION
TOWN LEBANON, N.H. WHITE RIVER JUNCTION, VT.
BRIDGE NO. 044/103 E.B. 044/104 W.B.
FEDERAL PROJECT I89-1(41)59
STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER
EASTBOUND ROADWAY BORINGS
DESIGNED
DRAWN LRT 10/63
TRACED LRT "
QUANTITIES JWM 4/64
CHECKED JWM 2/64
CHECKED JWM "
CHECKED CLW 4/64
BRIDGE SHEET NO. 4 OF 25
FILE NUMBER 17-4-1
REVIEWED BY
PROJ. NO. I89-1(41)59
SHEET NO. 5
TOTAL SHEETS 26
REVISIONS
LOG OF BORINGS
Vertical Scale: 1/8" = 1'-0"
PLAN OF BORING LAYOUT
Scale: 1" = 50'
Sheet Scale as noted
NOTE: T.F. = top of footing. B.F. = bottom of footing. B.S. = bottom of seal.
BORING NO. | REFUSAL ELEVATION
30A | El. 292.2
30B | El. 292.2
31A | El. 285.2
32A | El. 285.2 Cored
32B | El. 288.2
Connecticut River Flow
Pier I
Pier II
Pier III
Pier IV
Pier V
Brg. Abut. A
Brg. Abut. B
Roadway Eastbound I89


APPROACH ROADWAY DETAILS
ABUTMENT A- NEW HAMPSHIRE
Edge of Roadway Pavement
G.R.-3 (multi-cable)
Granite Curb Type D
B.C.C.M.P.
Paved Shoulder
Normal Edge of Pavement
Drop Inlet
⟸ DIRECTION OF TRAFFIC
℄ Roadway
℄ Median
Granite Curb Type D
G.R.-6 (Beam)
DIRECTION OF TRAFFIC ⟹
El. 363.0
BERM SECTION B-B
Scale : 3/16" = 1'-0"
Slope to match end of wings
NOTE: The approach roadway shall be constructed to subgrade and the finished side slopes. Roadway curbing, railing, pavement, base, and drainage structures shown on this sheet are not a part of this Contract.
TYPICAL APPROACH ROADWAY SECTION
AWAY FROM BRIDGE
TYPICAL APPROACH ROADWAY SECTION
ADJACENT TO BRIDGE
℄ Median
Varies 12'-6" (max.) to 6'-6" (min.)
Varies 6'-6" (max.) to 5'-0" (min.)
LOG OF BORINGS
Vertical Scale : 1/8" = 1'-0"
For additional information on borings See Br. Sh. #3 & 4.
Ground El. 342.3
Bottom of Hole @ El. 312.3
Ground El. 345.5
Bottom of Hole @ El. 315.5
Ground El. 343.8
Bottom of Hole @ El. 303.8
Top Soil
Fine Sand
Gravel
PLAN OF CHANNEL EXCAVATION LIMITS
Scale : 1" = 200'
MASCOMA RIVER
NEW HAMPSHIRE
CONNECTICUT RIVER
VERMONT
Channel Excavation
Service Road
℄ Westbound Roadway
℄ Eastbound Roadway
Boston & Maine Railroad Spur
Central Vermont Railroad
NOTE: Widen river bed as shown on PLAN OF CHANNEL EXCAVATION LIMITS and as directed by Engineer. To be paid for as Unclassified Channel Excavation, Item 163. This Channel Excavation shall be used to form the embankment at Abutment A, only.
Ground Line
El. 340 ±
Water El. 329.4 5/13/63
El. 325.0
El. 323.0
Slope to match river bottom as directed
CHANNEL SECTION A-A
Sheet Scale : 1" = 20' or as noted
STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION
TOWN LEBANON, N.H. WHITE RIVER JUNCTION, VT.
BRIDGE NO. 044/103 E.B. 044/104 W.B.
FEDERAL PROJECT I89-1(41) 59
STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER
APPROACH ROADWAY DETAILS & CHANNEL EXCAVATION
DESIGNED E.S. 3/64 CHECKED L.R.T. 3/64
DRAWN R.T.F. 3/64 CHECKED E.S. 3/64
TRACED L.R.T. 3/64 CHECKED E.S. 3/64
QUANTITIES J.W.M. 4/64 CHECKED C.L.W. 4/64
BRIDGE SHEET NO. 5 OF 25
FILE NUMBER 17-4-1
REVIEWED BY
PROJ. NO. I89-1(41) 59
SHEET NO. 6
TOTAL SHEETS 26
REVISIONS
FED. ROAD DIV. NO. 1
STATE N. H.



PLAN OF ABUTMENT A
NEW HAMPSHIRE
Scale: 1" = 40'



CLEARING & GRUBBING LIMITS
Scale: 1" = 200'

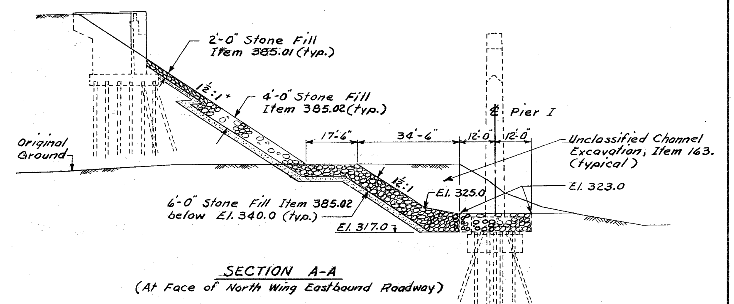
NOTES:

1. The upper limit of Earth Structure Exc. (River Piers), Item 171.2 shall be the original ground or the lower limit of Unclassified Channel Excavation; using the lower value.
2. The excavation required for placing the Stone Fill shall be paid for as Unclassified Channel Excavation, Item 163.
3. Gravel for Special Purposes may be omitted for the portion below original ground at Abutment A if the natural material is found suitable as a filter against intrusion failure.
4. All Stone Fill at Abutment A below El. 363.0 shall be composed of Class A stone.
5. All dimensions and fill slopes shown in Section A-A and B-B are normal to ℄ Pier I.
6. For planting requirements for channel bank treatment see "SPECIAL ATTENTION" in SPECIAL PROVISIONS.
7. Gravel for Special Purposes used as fill behind abutments, and base for stone fill shall be paid for as Item 214.1 and Item 214.2, respectively.

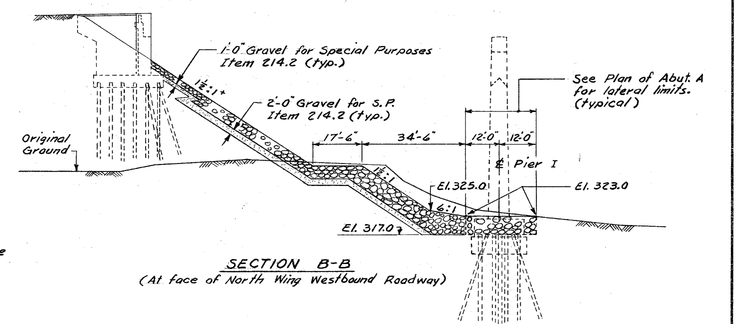
ABUTMENT A QUANTITIES

ITEM NO.	DESCRIPTION	ABUT. A WESTBOUND	ABUT. A EASTBOUND	
163	Unclassified Channel Excavation	4,200	70,000	c.y.
214.2	Gravel for S.P.	1,678 *	1,668 *	c.y.
385.02	Stone Fill (Class A)	4,610	5,120	c.y.

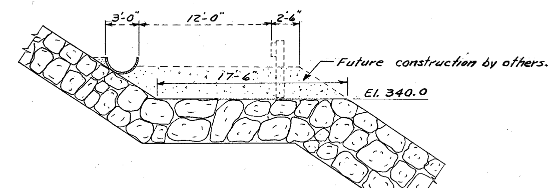
Quantity marked thus * is the amount below El. 363.0.



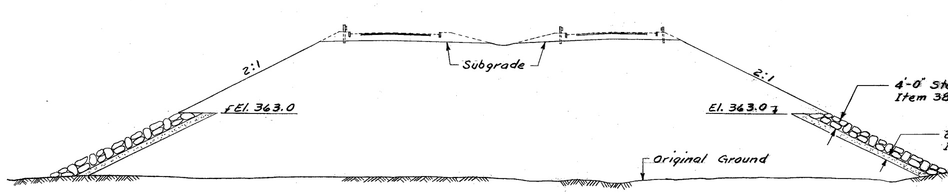
SECTION A-A
(At Face of North Wing Eastbound Roadway)



SECTION B-B
(At face of North Wing Westbound Roadway)



SECTION C-C
(Future Service Road and Sluice)
Scale: 3/16" = 1'-0"



SECTION D-D
TYPICAL APPROACH ROADWAY SECTION

Sheet Scale: 1" = 20' or as noted

FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N.H.				

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION

TOWN LEBANON, N.H. / WHITE RIVER JUNCTION, VT. — BRIDGE NO. 044/103 E.B. / 044/104 W.B.
FEDERAL PROJECT I89-1(41)59 — STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

ABUTMENT A - N.H. EARTHWORK DETAILS

	BY	DATE		BY	DATE
DESIGNED	E.S.	3/64	CHECKED	L.R.T.	3/64
DRAWN	R.K.F.	3/64	CHECKED	E.S.	3/64
TRACED	L.R.T.	3/64	CHECKED	E.S.	3/64
QUANTITIES	J.W.M.	4/64	CHECKED	C.L.W.	4/64

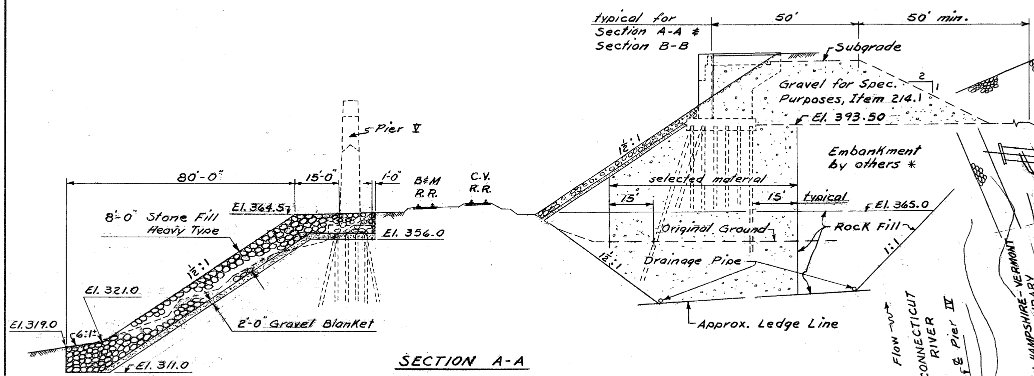
BRIDGE SHEET NO. 6 OF 25
FILE NUMBER 17-4-1

Δ	DESCRIPTION	BY	DATE

REVISIONS

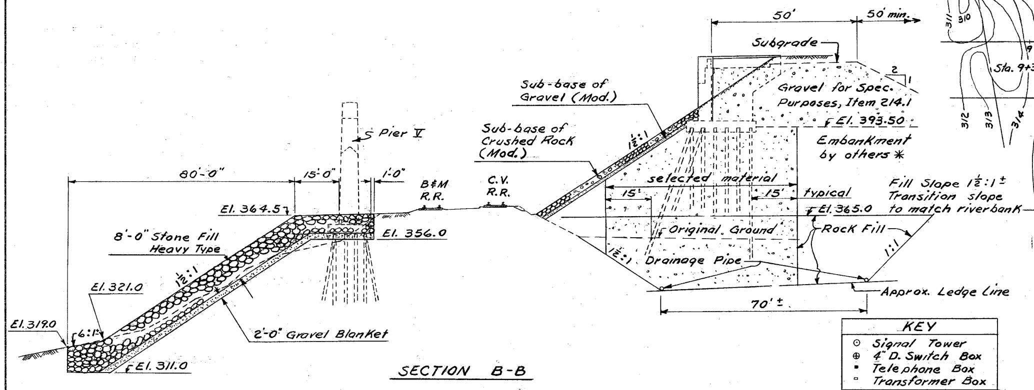
REVIEWED BY	PROJ. NO.	SHEET NO.	TOTAL SHEETS
	I89-1(41)59	7	26

FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.				



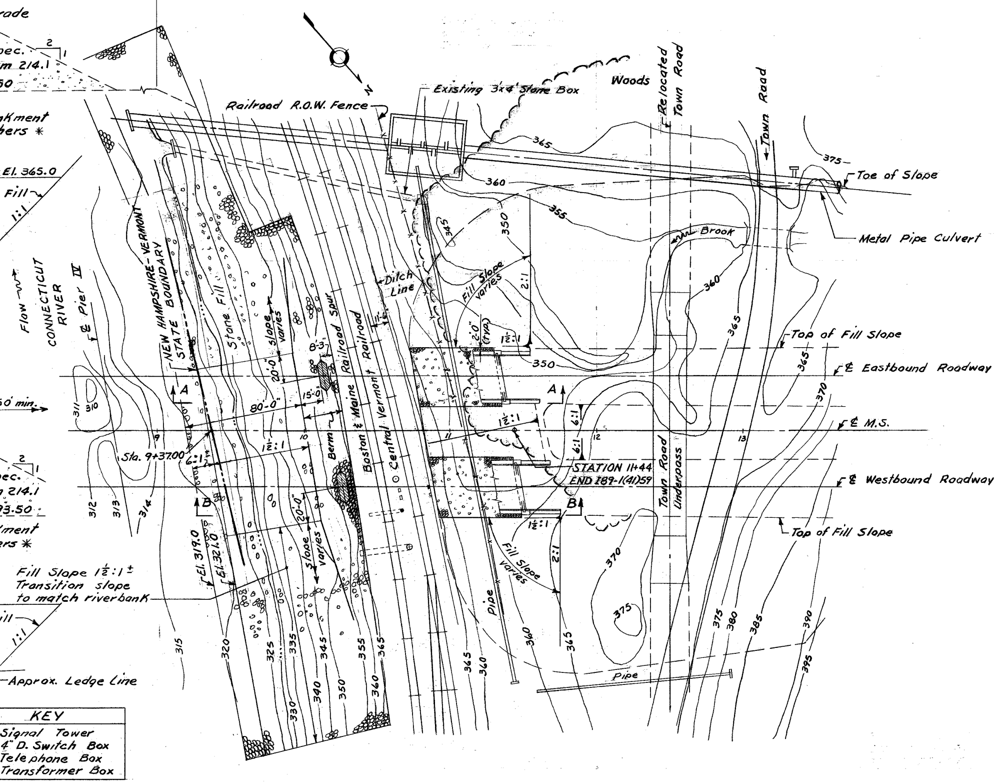
SECTION A-A

NOTE: All dimensions and fill slopes shown in Section A-A & B-B are normal to ℄ Pier V.



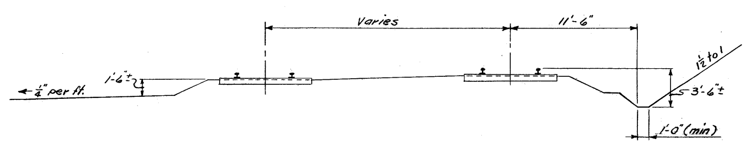
SECTION B-B

NOTE: Placing of embankment above El. 356.00 in the vicinity of Pier V footings shall be interrupted until the pier shaft masonry is completed. The river embankment, except as noted above, shall be in place before December 15, 1964.



PLAN OF ABUTMENT B
VERMONT
Scale 1" = 40'

NOTE: Embankment, Stone Fill, Gravel base for Stone Fill, Town Road Underpass and drainage structures will be constructed under the Vermont Contract I89-1(3). Embankment marked thus * is to be in place before December 15, 1964. Any subsequent excavation necessary at Abutment B shall be subsidiary. No work shall be permitted on Pier V and Abutment B, before April 1, 1965.



TYPICAL SECTION OF RAILROAD
Scale: 3/16" = 1'-0"

Sheet Scale: 1" = 20' or as noted

△	DESCRIPTION	BY	DATE
	REVISIONS		

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION

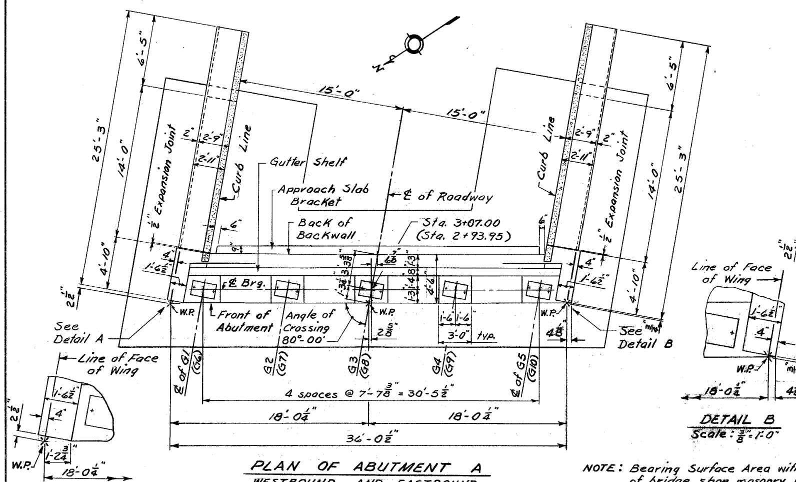
TOWN LEBANON, N.H. WHITE RIVER JUNCTION, VT. BRIDGE NO. 044/103 E.B. 044/104 W.B.
FEDERAL PROJECT I89-1(41)59 STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

ABUTMENT B - VT. EARTHWORK & DRAINAGE

	BY	DATE		BY	DATE	
DESIGNED	E.S.	3/64	CHECKED	L.R.T.	3/64	BRIDGE SHEET NO. 7 OF 25
DRAWN	R.T.F.	4/64	CHECKED	E.S.	4/64	
TRACED	L.R.T.	4/64	CHECKED	E.S.	4/64	FILE NUMBER
QUANTITIES	J.W.M.	4/64	CHECKED	C.L.W.	4/64	17-4-1

REVIEWED BY	PROJ. NO.	SHEET NO.	TOTAL SHEETS
	I89-1(41)59	8	26

FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.				



PLAN OF ABUTMENT A

WESTBOUND AND EASTBOUND

For detail of galv. channel gutter See Br. Sh. # 9.

DETAIL A

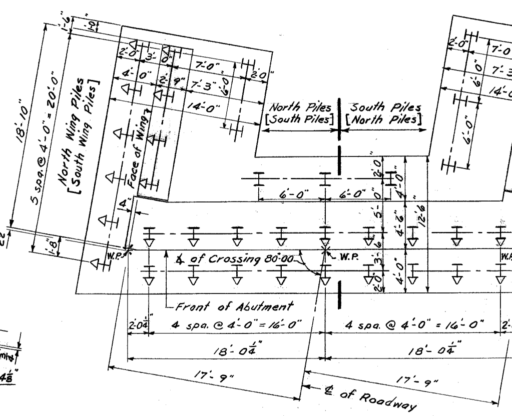
Scale: 3/8" = 1'-0"

DETAIL B

Scale: 3/8" = 1'-0"

NOTE: Bearing Surface Area within 3" outside of bridge shoe masonry plate shall be formed & poured slightly higher and bush hammered to exact elevation as shown on plan. (Typical for abutments & piers).

Bearing Surface Elevations				
G1 El. 383.94	G2 El. 384.04	G3 El. 384.18	G4 El. 383.98	G5 El. 383.78
(G6 El. 383.55)	(G7 El. 383.67)	(G8 El. 383.79)	(G9 El. 383.59)	(G10 El. 383.39)



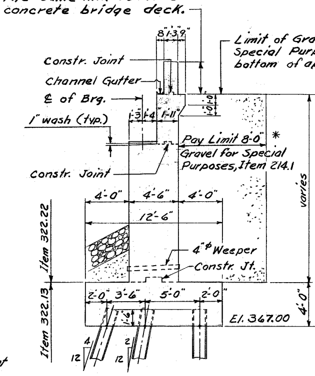
ABUTMENT FOOTING & PILE LAYOUT

Typical for all abutments

NOTE: Pile Dimensions shown are horizontal and at bottom of footing.

NOTE: Location of piles marked thus [ ] apply to Abutment B only.

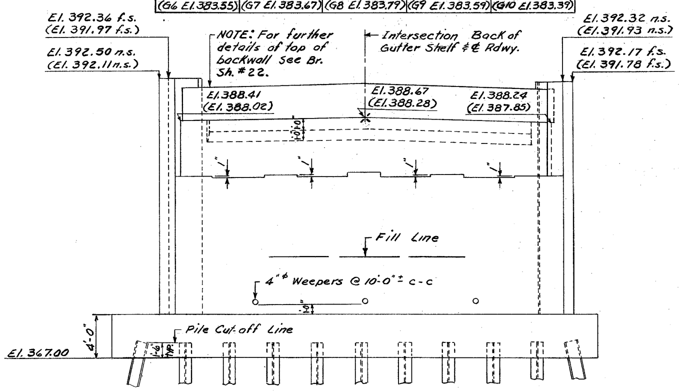
NOTE: Concrete in the upper backwall shall be of the same mix as in the concrete bridge deck.



TYPICAL ABUTMENT SECTION

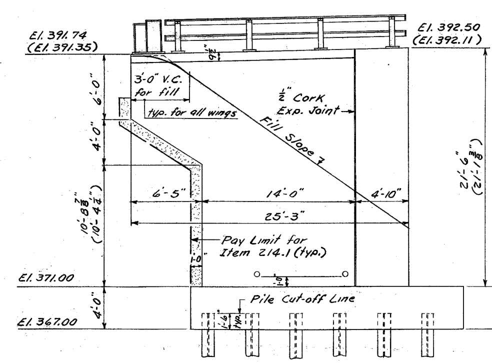
(Abutment A & B)

NOTE: Epoxy Coating for Concrete, Item 336, shall be applied to the following surfaces, only, of all abutments: Face of upper & lower backwalls, bridge seat masonry shelf, and the inside face of the curtain walls. The color of epoxy shall match that of concrete, as nearly as practicable. Apply a single coat of 15 mil thickness.

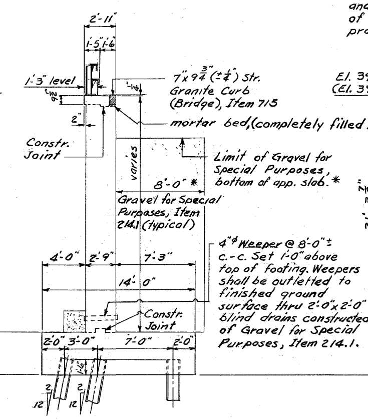


ELEVATION OF ABUTMENT A

WESTBOUND AND EASTBOUND

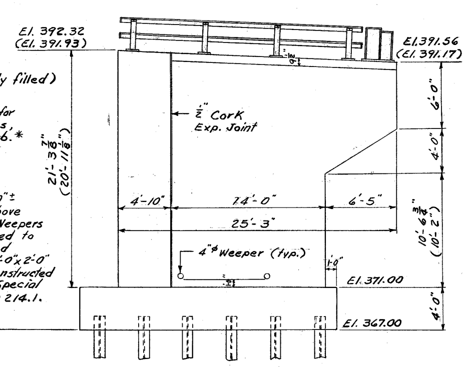


ELEVATION OF NORTH WING



TYPICAL WING SECTION

(Abutment A & B Wings)



ELEVATION OF SOUTH WING

NOTE: Elevations & Dimensions marked thus ( ) apply to Eastbound Abutment only.

NOTE: Details of Abutment A and Abutment B are alike.

NOTE: All Abutment piles 12BP53. Design Load = 45 Tons per pile. All piles shown thus ⊢▷ shall be battered in the direction of the arrow as shown in Sections. For further information see "GENERAL PILE NOTES" on Bridge Sheet # 12.

ESTIMATED LENGTH OF ABUTMENT & WING PILES

LOCATION	ABUTMENT A WESTBOUND	ABUTMENT A EASTBOUND	ABUTMENT B WESTBOUND	ABUTMENT B EASTBOUND
Vertical Piles	115	115	65	65
~~Abutment~~-North Batter Piles	130	130	65	70
~~Abutment~~-South Batter Piles	130	125	70	70
North Wing Batter Piles	120	120	65	70
South Wing Batter Piles	120	115	70	65

* At Abutment A only. For limits of Abutment B see Br. Sh. # 7 of 25.

Sheet Scale: 3/16" = 1'-0" or as noted

Δ	DESCRIPTION	BY	DATE
	REVISIONS		

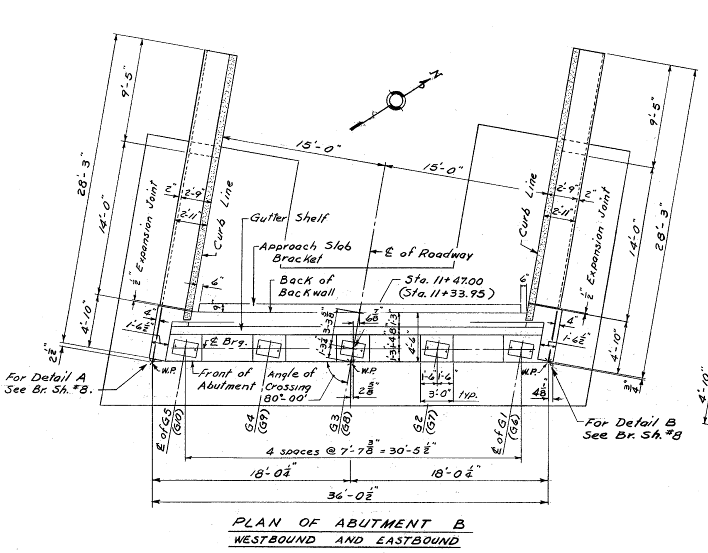
STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION

TOWN LEBANON, N.H. / WHITE RIVER JUNCTION, VT. BRIDGE NO. 044/103 E.B. / 044/104 W.B.
FEDERAL PROJECT I89-1(41)59 STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

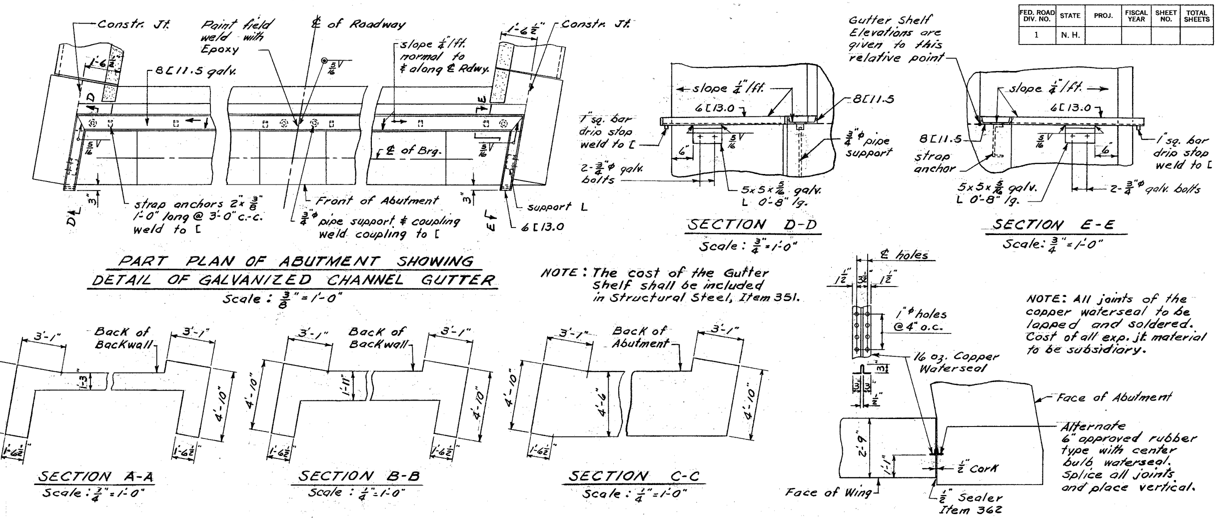
ABUT. A MASONRY & ABUT. PILE LAYOUT

	BY	DATE		BY	DATE	
DESIGNED	E.S.	12/63	CHECKED	L.R.T.	12/63	BRIDGE SHEET NO. 8 OF 25
DRAWN	L.R.T.	2/64	CHECKED	E.S.	2/64	FILE NUMBER
TRACED	L.R.T.	3/64	CHECKED	E.S.	3/64	17-4-1
QUANTITIES	J.W.M.	4/64	CHECKED	C.C.W.	4/64	

REVIEWED BY	PROJ. NO.	SHEET NO.	TOTAL SHEETS
	I89-1(41)59	9	26



PLAN OF ABUTMENT B
WESTBOUND AND EASTBOUND



PART PLAN OF ABUTMENT SHOWING DETAIL OF GALVANIZED CHANNEL GUTTER
Scale: 3/8" = 1'-0"

NOTE: The cost of the Gutter Shelf shall be included in Structural Steel, Item 351.

SECTION A-A Scale: 1/4" = 1'-0"

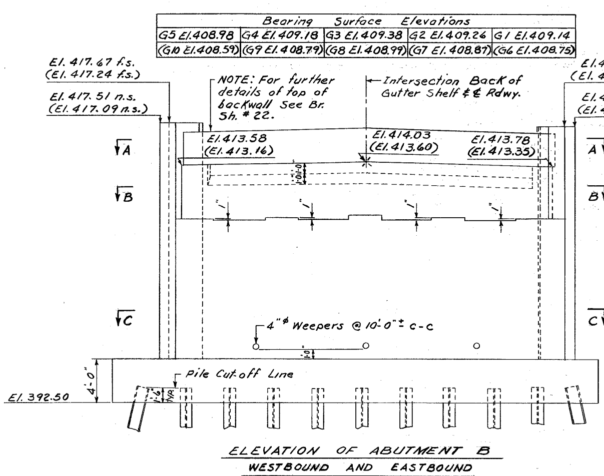
SECTION B-B Scale: 1/4" = 1'-0"

SECTION C-C Scale: 1/4" = 1'-0"

SECTION D-D Scale: 3/4" = 1'-0"

SECTION E-E Scale: 3/4" = 1'-0"

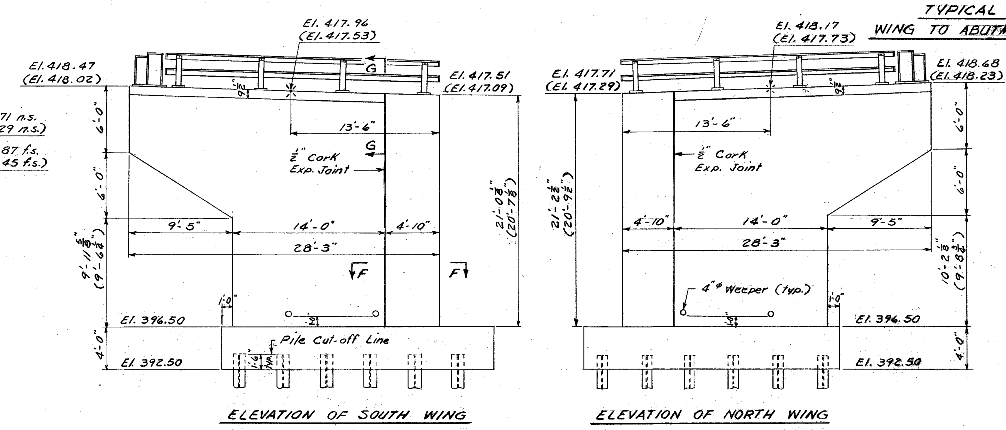
NOTE: All joints of the copper waterseal to be lapped and soldered. Cost of all exp. jt. material to be subsidiary.



ELEVATION OF ABUTMENT B
WESTBOUND AND EASTBOUND

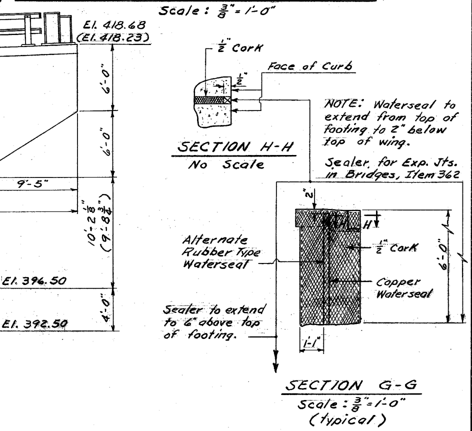
NOTE: Elevations & Dimensions marked thus ( ) apply to Eastbound Abutment only.

NOTE: Details of Abutment A & Abutment B are alike.



ELEVATION OF SOUTH WING

ELEVATION OF NORTH WING



TYPICAL SECTION F-F
WING TO ABUTMENT EXPANSION JOINT
Scale: 3/8" = 1'-0"

SECTION H-H No Scale

NOTE: Waterseal to extend from top of footing to 2" below top of wing.

Sealer for Exp. Jts. in Bridges, Item 362

SECTION G-G Scale: 3/8" = 1'-0" (typical)

ABUTMENT QUANTITIES

ITEM NO.	DESCRIPTION	ABUT. A WESTBOUND	ABUT. A EASTBOUND	ABUT. B WESTBOUND	ABUT. B EASTBOUND	
214.1	Gravel for Special Purposes	250	240	3,490	3,420	c.y.
214.2	Gravel for Special Purposes	42 *	42 *	—	—	c.y.
310.2	Pile Loading Tests	1	1	1	1	ea.
316	Furnishing Steel Brg. Piles	299,980	295,210	163,770	165,890	lb.
317	Driving Steel Brg. Piles	299,980	295,210	163,770	165,890	lb.
319	Pile Splices	4	4	4	4	ea.
322.13	Conc. Class A (Land Pier + Abut. Footing)	128.2	128.2	128.2	128.2	c.y.
322.22	Conc. Class A (Land Pier - Abut. Abv. Ftgs.)	172.3	169.0	178.7	175.0	c.y.
334	Water Repellent	6	6	7	7	gal.
336	Epoxy Coating for Concrete	4	4	4	4	gal.
344	Reinforcing Steel	16,880	16,880	17,842	17,842	lb.
362	Sealer for Expansion Joints in Bridges	179	176	179	176	c.i.
385.01	Stone Fill	75	75	—	—	c.y.

Quantity marked thus * is the amount above El. 363.0.
Quantities shown include Abutment & Wings

NOTE: Apply Water Repellent, Item 334 to the Abutment curb walk and front face of Abutment.

Sheet Scale: 3/16" = 1'-0" or as noted

FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.				

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION

TOWN: LEBANON, N.H. / WHITE RIVER JUNCTION, VT. — BRIDGE NO. 044/103 E.B. / 044/104 W.B.
FEDERAL PROJECT: I89-1(41)59 — STATE PROJECT: P3821F
LOCATION: INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

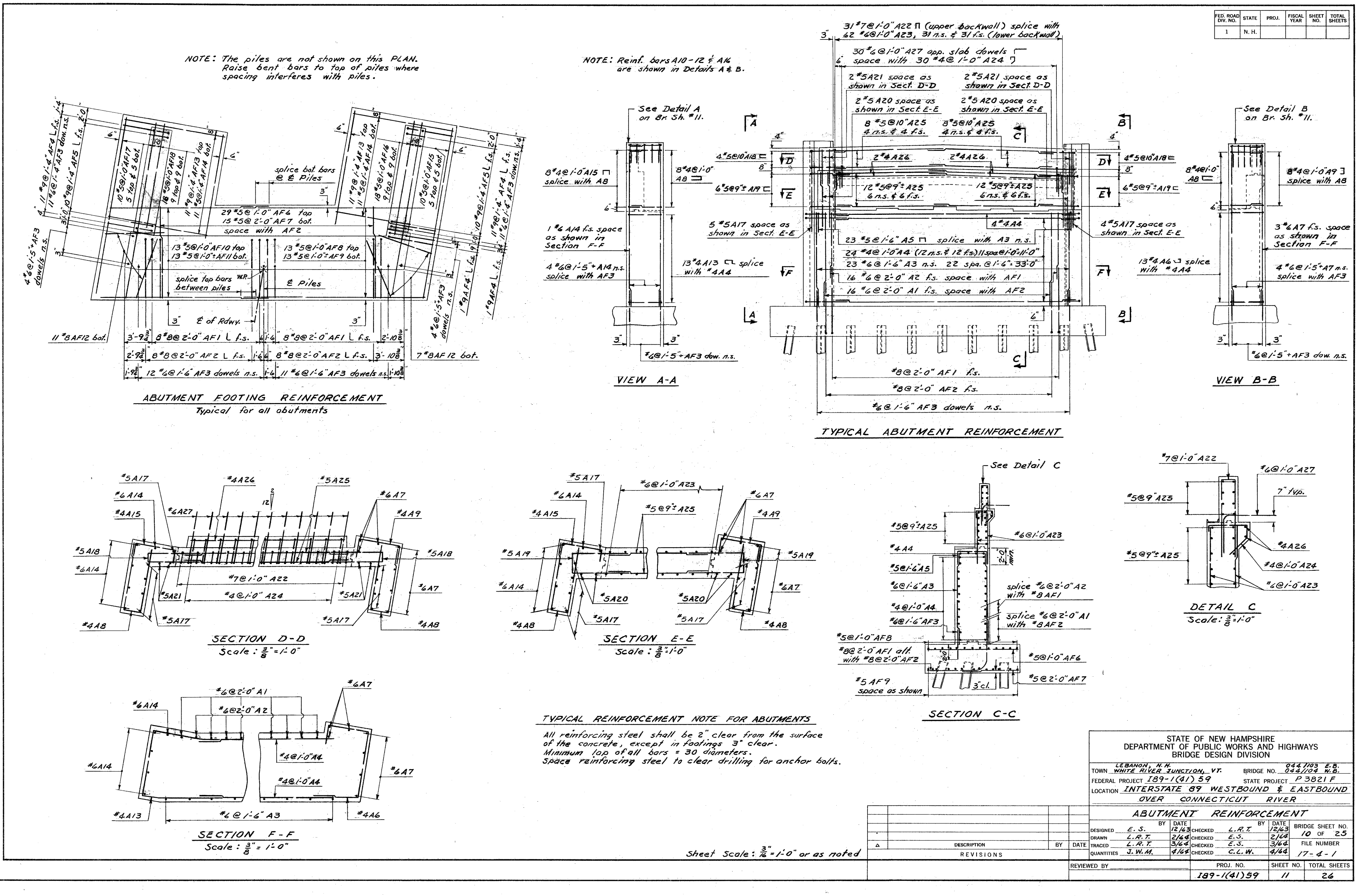
ABUTMENT B MASONRY & ABUT. DETAILS

	BY	DATE		BY	DATE
DESIGNED	E. S.	12/63	CHECKED	L.R.T.	12/63
DRAWN	L.R.T.	2/64	CHECKED	E.S.	2/64
TRACED	L.R.T.	3/64	CHECKED	E.S.	3/64
QUANTITIES	J.W.M.	4/64	CHECKED	C.L.W.	4/64

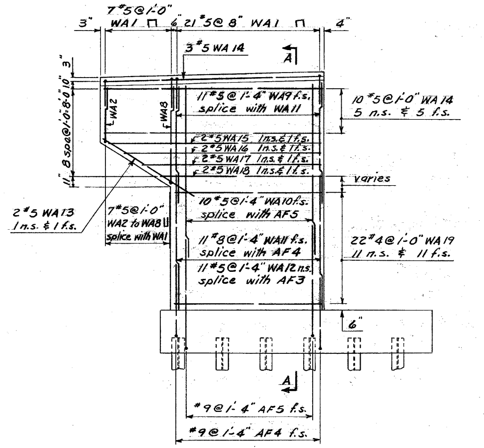
BRIDGE SHEET NO. 9 OF 25
FILE NUMBER 17-4-1

REVISIONS: DESCRIPTION / BY / DATE

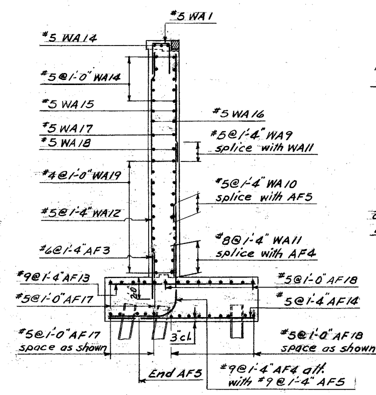
REVIEWED BY — PROJ. NO. I89-1(41)59 — SHEET NO. 10 — TOTAL SHEETS 26


NOTE: The piles are not shown on this PLAN. Raise bent bars to top of piles where spacing interferes with piles.
ABUTMENT FOOTING REINFORCEMENT
Typical for all abutments
NOTE: Reinf. bars A10-12 & A16 are shown in Details A & B.
See Detail A on Br. Sh. #11.
VIEW A-A
31 #7@1'-0" A22 ⊓ (upper backwall) splice with 62 #6@1'-0" A23, 31 n.s. & 31 f.s. (lower backwall)
30 #6@1'-0" A27 app. slab dowels space with 30 #4@1'-0" A24
TYPICAL ABUTMENT REINFORCEMENT
See Detail B on Br. Sh. #11.
VIEW B-B
SECTION D-D
Scale: 3/8" = 1'-0"
SECTION E-E
Scale: 3/8" = 1'-0"
SECTION C-C
See Detail C
DETAIL C
Scale: 3/8" = 1'-0"
SECTION F-F
Scale: 3/8" = 1'-0"
TYPICAL REINFORCEMENT NOTE FOR ABUTMENTS
All reinforcing steel shall be 2" clear from the surface of the concrete, except in footings 3" clear.
Minimum lap of all bars = 30 diameters.
Space reinforcing steel to clear drilling for anchor bolts.
Sheet Scale: 3/16" = 1'-0" or as noted
FED. ROAD DIV. NO. 1
STATE N. H.
STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION
TOWN LEBANON, N.H. WHITE RIVER JUNCTION, VT.
BRIDGE NO. 044/103 E.B. 044/104 W.B.
FEDERAL PROJECT I89-1(41) 59
STATE PROJECT P 3821 F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER
ABUTMENT REINFORCEMENT
DESIGNED E. S. 12/63 CHECKED L.R.T. 12/63
DRAWN L.R.T. 2/64 CHECKED E.S. 2/64
TRACED L.R.T. 3/64 CHECKED E.S. 3/64
QUANTITIES J.W.M. 4/64 CHECKED C.L.W. 4/64
BRIDGE SHEET NO. 10 OF 25
FILE NUMBER 17-4-1
REVISIONS
PROJ. NO. I89-1(41)59
SHEET NO. 11
TOTAL SHEETS 26

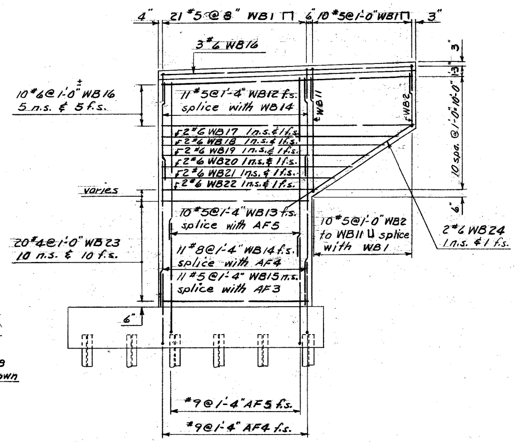
FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.				



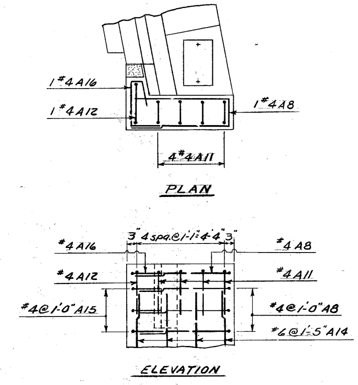
REINFORCEMENT OF NORTH WING AT ABUT. A
(reinforcement of south wing at abut. A is opposite hand)



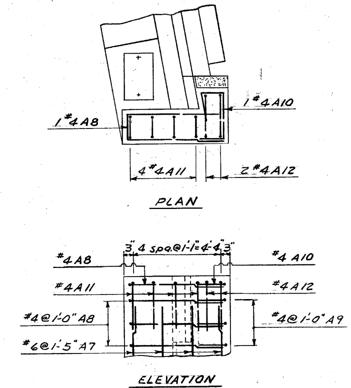
SECTION A-A
(Section Thru Abut. B Wing is Similar)



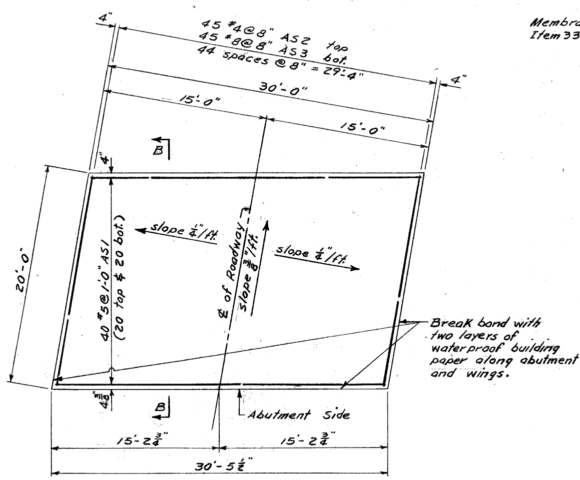
REINFORCEMENT OF NORTH WING AT ABUT. B
(reinforcement of south wing at abut. B is opposite hand)



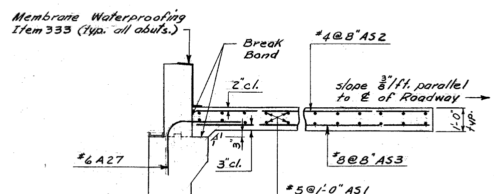
DETAIL A
Scale: 3/8" = 1'-0"



DETAIL B
Scale: 3/8" = 1'-0"



REINFORCEMENT OF APPROACH SLAB



SECTION B-B
Scale: 3/8" = 1'-0"

APPROACH SLAB QUANTITIES				
ITEM NO.	DESCRIPTION	WESTBOUND	EASTBOUND	
322.3	Concrete Class A (Approach Slab)	44.9	44.9	c.y.
333	Membrane Waterproofing *	23	23	sq. yd.
344	Reinforcing Steel	8,361	8,361	lb.

* Includes Abutment Quantities

Sheet Scale: 3/16" = 1'-0" or as noted

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DIVISION

TOWN LEBANON, N.H. / WHITE RIVER JUNCTION, VT. BRIDGE NO. 044/103 E.B. / 044/104 W.B.
FEDERAL PROJECT I89-1(41)59 STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

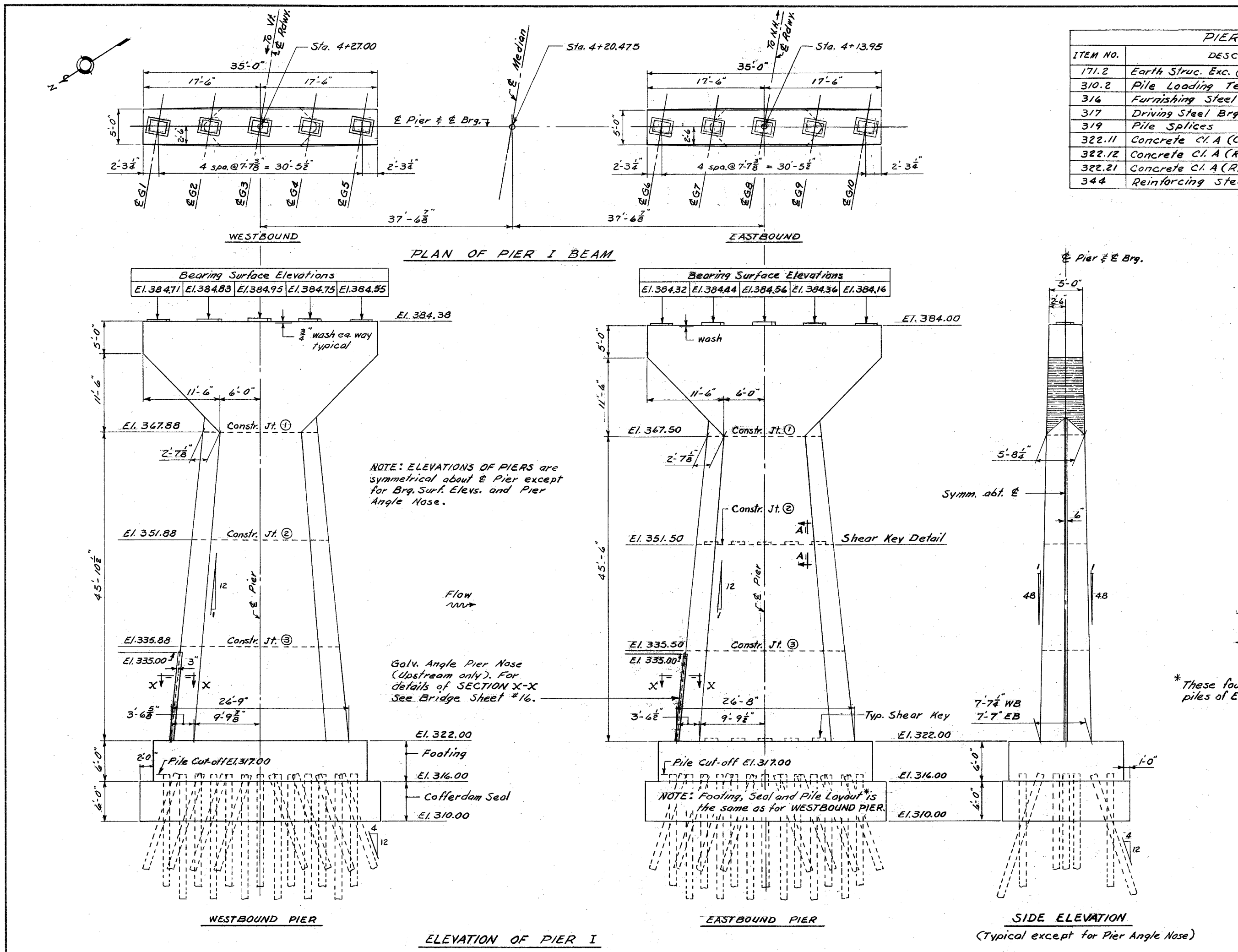
WING & APP. SLAB REINFORCEMENT

	BY	DATE		BY	DATE
DESIGNED	E. S.	12/63	CHECKED	L.R.T.	12/63
DRAWN	L. R. T.	2/64	CHECKED	E. S.	2/64
TRACED	L. R. T.	3/64	CHECKED	E. S.	3/64
QUANTITIES	J. W. M.	4/64	CHECKED	C. L. W.	4/64

BRIDGE SHEET NO. 11 OF 25
FILE NUMBER 17-4-1

Δ	DESCRIPTION	BY	DATE
	REVISIONS		

REVIEWED BY	PROJ. NO.	SHEET NO.	TOTAL SHEETS
	I89-1(41)59	12	26



PIER I QUANTITIES

ITEM NO.	DESCRIPTION	PIER I WESTBOUND	PIER I EASTBOUND	
171.2	Earth Struc. Exc. (River Piers)	180	180	c.y.
310.2	Pile Loading Tests	1	1	ea.
316	Furnishing Steel Brg. Piles	262,435	240,900	lbs.
317	Driving Steel Brg. Piles	262,435	240,900	lbs.
319	Pile Splices	4	4	ea.
322.11	Concrete Cl. A (Cofferdam Seal)	152	152	c.y.
322.12	Concrete Cl. A (River Pier - Footings)	120.9	120.9	c.y.
322.21	Concrete Cl. A (River Pier - Abv. Ftgs.)	304.4	303.9	c.y.
344	Reinforcing Steel	29,400	29,400	lbs.

ESTIMATED LENGTH OF PIER I PILES

See Plan	WESTBOUND PIER		EASTBOUND PIER	
Row	Upstream	Downstream	Upstream	Downstream
③ Ⓐ ④	100'	85'	90'	80'
① ⑥	90'	85'	80'	80'
⑤	90'	85'	85'	80'
②	95'	90'	85'	80'

GENERAL PILE NOTES

1. All piles shall be driven to refusal or as directed by the Engineer.
2. All piles shall be driven to the required penetration.
3. Pile Loading Tests, Item 310.2, shall be made, only, if directed by the Engineer.
4. If the Contractor so elects, he may splice each pile once at approximately mid-length. This splice shall be at his expense. (Except do not splice at Pier V)
5. At abutments, place and compact as much rock free fill as is practicable before driving the piles.
6. All earth excavation within the cofferdams shall be completed before driving the piles.
7. The required penetration of the river piles shall be not less than the estimated pile length less 15'-0", unless permitted otherwise by the Engineer. Any pile tip reinforcement or other aid to reach the required penetration shall be subsidiary in cost.

PIER I, II & III NOTES (RIVER PIERS ON PILES)

1. All piles 14 BP73. Design load = 60 tons per pile.
2. All piles indicated thus ↦ shall be battered 4 horizontal to 12 vertical in the direction of the arrow.
3. The depth of the cofferdam seal is satisfactory for a water level at Elev. 335.0 and the cofferdam shall be vented for flooding at this level. Higher vent elevations may be permitted subject to the approval of the Engineer.
4. See "GENERAL PILE NOTES" on this sheet and additional information titled "GENERAL RIVER PIER CONSTRUCTION NOTES" on Bridge Sheet #15.

Sheet Scale: 1/8" = 1'-0"

FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.				

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION

TOWN: LEBANON, N.H. / WHITE RIVER JUNCTION, VT. — BRIDGE NO. 044/103 E.B. / 044/104 W.B.
FEDERAL PROJECT I89-1(41)59 — STATE PROJECT P3821F
LOCATION: INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

PIER I - MASONRY

	BY	DATE		BY	DATE
DESIGNED	E. S.	11/63	CHECKED	L.R.T.	11/63
DRAWN	E. S.	12/63	CHECKED	L.R.T.	12/63
TRACED	L.R.T.	2/64	CHECKED	E. S.	3/64
QUANTITIES	J. W. M.	4/64	CHECKED	C. L. W.	4/64

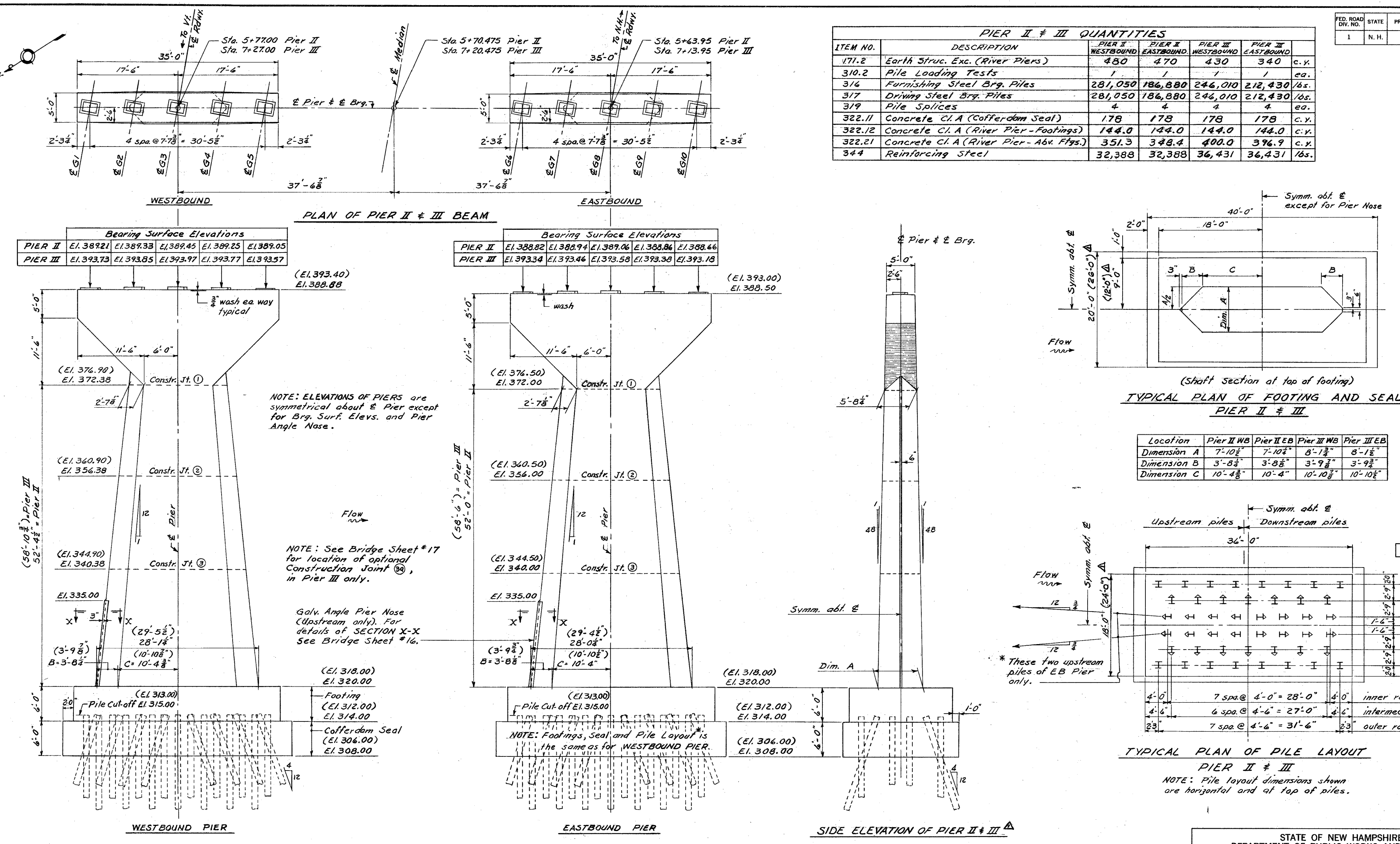
BRIDGE SHEET NO. 12 OF 25
FILE NUMBER 17-4-1

Δ	DESCRIPTION	BY	DATE

REVISIONS

REVIEWED BY

PROJ. NO.	SHEET NO.	TOTAL SHEETS
I89-1(41)59	13	26



NOTE: Elevations, Dimensions, and Pile Lengths marked thus ( ) apply to Pier III only. See Br. Sh. #12 for "Pier I, II & III Notes", (River Piers on Piles).

FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.				

PIER II & III QUANTITIES

ITEM NO.	DESCRIPTION	PIER II WESTBOUND	PIER II EASTBOUND	PIER III WESTBOUND	PIER III EASTBOUND	
171.2	Earth Struc. Exc. (River Piers)	480	470	430	340	c.y.
310.2	Pile Loading Tests	1	1	1	1	ea.
316	Furnishing Steel Brg. Piles	281,050	186,880	246,010	212,430	lbs.
317	Driving Steel Brg. Piles	281,050	186,880	246,010	212,430	lbs.
319	Pile Splices	4	4	4	4	ea.
322.11	Concrete Cl. A (Cofferdam Seal)	178	178	178	178	c.y.
322.12	Concrete Cl. A (River Pier - Footings)	144.0	144.0	144.0	144.0	c.y.
322.21	Concrete Cl. A (River Pier - Abv. Ftgs.)	351.3	348.4	400.0	396.9	c.y.
344	Reinforcing Steel	32,388	32,388	36,431	36,431	lbs.

Bearing Surface Elevations (Westbound)

PIER II	El. 389.21	El. 389.33	El. 389.45	El. 389.25	El. 389.05
PIER III	El. 393.73	El. 393.85	El. 393.97	El. 393.77	El. 393.57

Bearing Surface Elevations (Eastbound)

PIER II	El. 388.82	El. 388.94	El. 389.06	El. 388.86	El. 388.66
PIER III	El. 393.34	El. 393.46	El. 393.58	El. 393.38	El. 393.18

Location	Pier II WB	Pier II EB	Pier III WB	Pier III EB
Dimension A	7'-10½"	7'-10¼"	8'-1¾"	8'-1½"
Dimension B	3'-8¼"	3'-8⅛"	3'-9⅞"	3'-9¾"
Dimension C	10'-4⅜"	10'-4"	10'-10⅞"	10'-10½"

ESTIMATED LENGTH OF PIER II & PIER III PILES

See Plan Row	WESTBOUND PIER Upstream		WESTBOUND PIER Downstream		EASTBOUND PIER Upstream		EASTBOUND PIER Downstream	
③,④	90'	(80')	75'	(70')	65'	(70')	50'	(60')
①,⑥	80'	(75')	75'	(70')	55'	(65)	50'	(60')
⑤	95'	(80')	90'	(75')	60'	(65')	55'	(60')
②	95'	(70')	90'	(65)	60'	(65')	55'	(60')

Sheet Scale: ⅛" = 1'-0"

REVISIONS

	DESCRIPTION	BY	DATE
⚠2	Pier III Piles respaced along width.	E.S.	9/14/65
⚠1	Pier III Footing Width Revised.	E.S.	9/14/65

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION

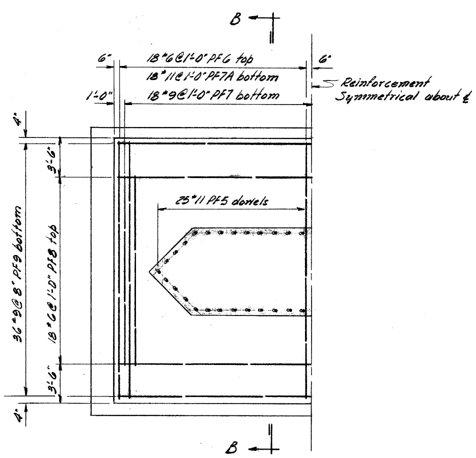
TOWN LEBANON, N.H. / WHITE RIVER JUNCTION, VT. — BRIDGE NO. 044/103 E.B. / 044/104 W.B.
FEDERAL PROJECT I89-1(41)59 — STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

PIERS II & III - MASONRY

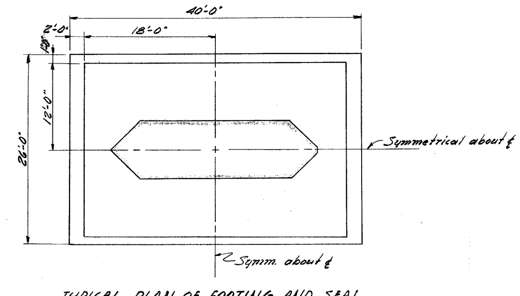
	BY	DATE		BY	DATE
DESIGNED	E.S.	11/63	CHECKED	L.R.T.	11/63
DRAWN	E.S.	12/63	CHECKED	L.R.T.	12/63
TRACED	L.R.T.	2/64	CHECKED	E.S.	2/64
QUANTITIES	J.W.M.	4/64	CHECKED	C.L.W.	4/64

BRIDGE SHEET NO. 13 OF 25
FILE NUMBER 17-4-1

REVIEWED BY	PROJ. NO.	SHEET NO.	TOTAL SHEETS
	I89-1(41)59	14	26

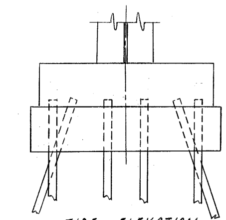


HALF PLAN OF PIER III
FOOTING REINFORCEMENT REVISED
Scale: 3/16" = 1'-0"

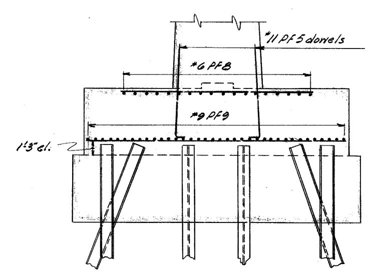


TYPICAL PLAN OF FOOTING AND SEAL
OF PIER III REVISED
Scale: 1/8" = 1'-0"

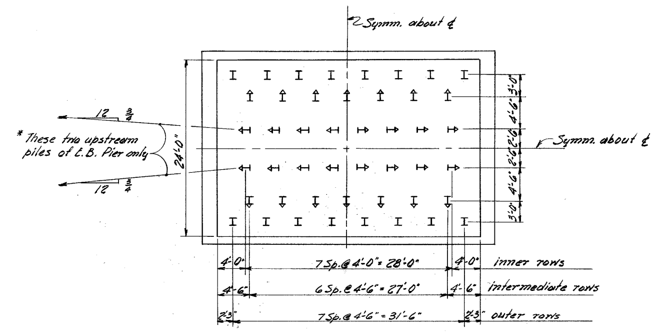
NOTE: For additional information on Pier III footings see Br. Sh. No 13 of 25.



SIDE ELEVATION
OF PIER III REVISED
Scale: 1/8" = 1'-0"



SECTION B-B
PIER III FOOTING
Scale: 3/16" = 1'-0"



TYPICAL PLAN OF PILE LAYOUT
OF PIER III REVISED
Scale: 1/8" = 1'-0"

ADDITIONAL QUANTITIES

ITEM NO.	DESCRIPTION	QUANTITY
171.2	Earth Structure Excavation (River Piers)	230 C.Y.
322.11	Concrete Class A (Cofferdam Seal)	106.6 C.Y.
322.12	Concrete Class A (River Pier Footings)	96.0 C.Y.
344	Reinforcing Steel	13,336 Lbs.

ADDITIONAL REINFORCING STEEL REQUIRED

#11 PF7A 72 × 23'-6" (Straight)
#9 PF9 36 × 35'-6" (do)

NOTE: Quantities and Schedule above includes both Pier III footings.

Sheet Scale as noted.

FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.				

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION

TOWN LEBANON, N.H. / WHITE RIVER JUNCTION, VT. — BRIDGE NO. 044/108 S.B. / 044/108 N.B.
FEDERAL PROJECT I89-1(41)59 — STATE PROJECT P 3821-F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

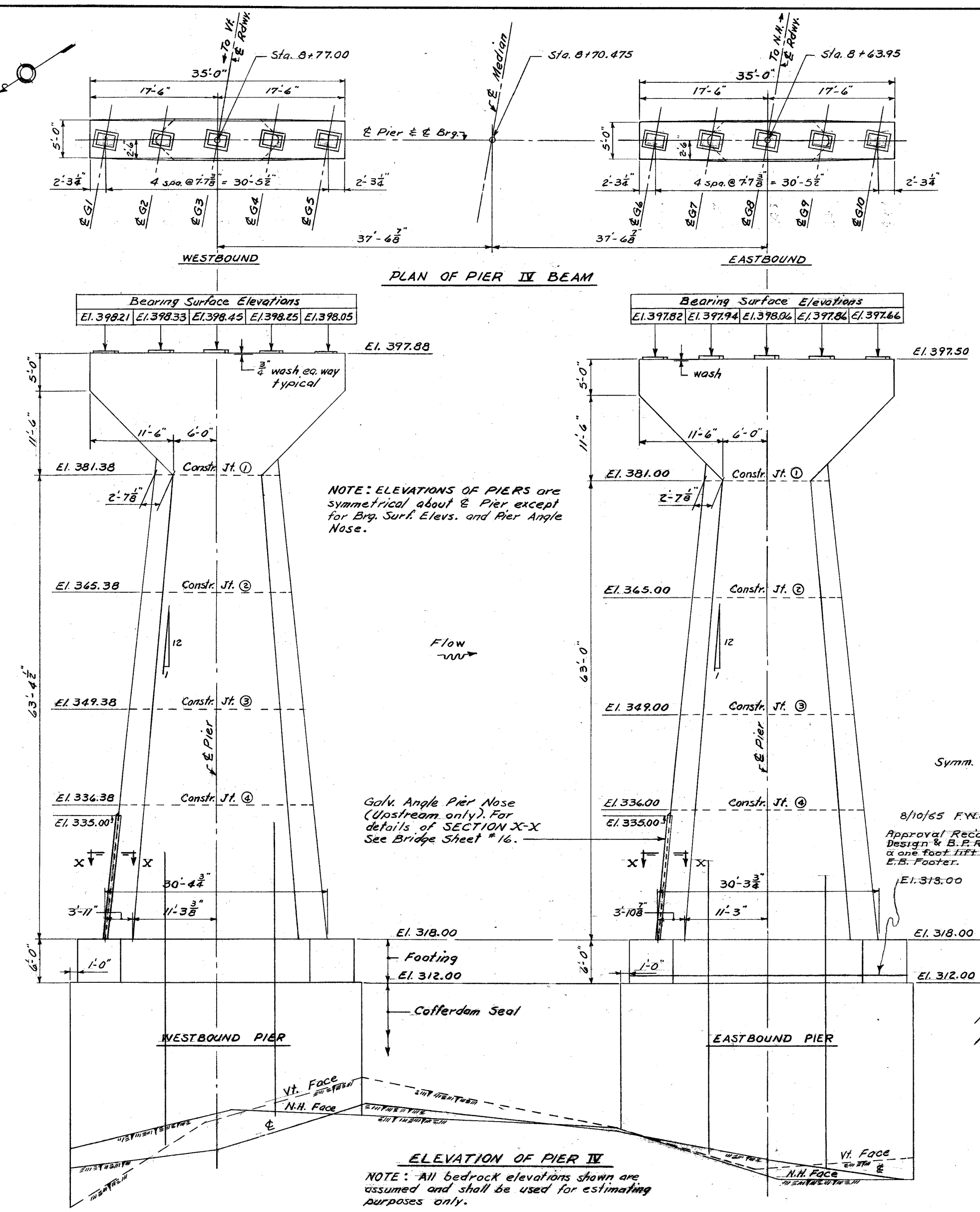
PIER III FOOTING REVISION

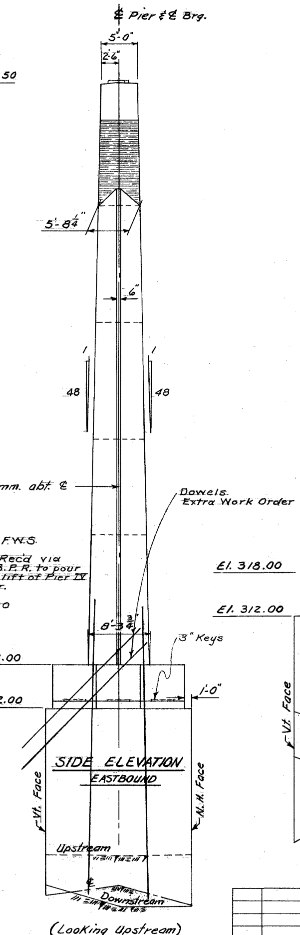
	BY	DATE		BY	DATE
DESIGNED	E.S.	3/65	CHECKED	J.P.	3/65
DRAWN	E.S. & J.P.	3/65	CHECKED		
TRACED	J.P.	3/65	CHECKED	E.S.	3/65
QUANTITIES	J.P.	3/65	CHECKED	E.S.	3/65

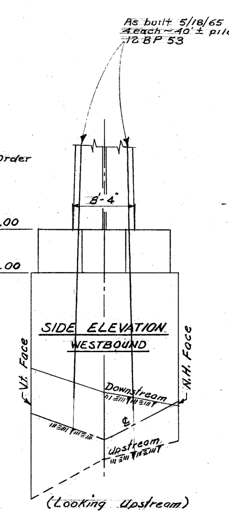
BRIDGE SHEET NO. 13A OF 25
FILE NUMBER 17-4-1

Δ	DESCRIPTION	BY	DATE
	REVISIONS		

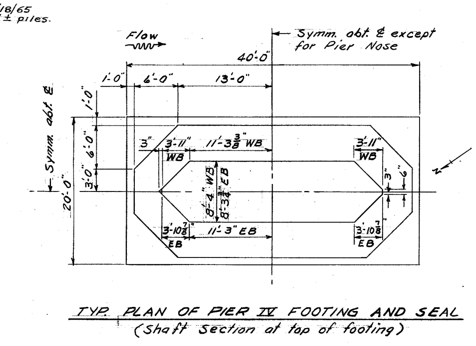
REVIEWED BY	PROJ. NO.	SHEET NO.	TOTAL SHEETS
	I89-1(41)59	14A	26







Sheet Scale: ⅛" = 1'-0"



TYP. PLAN OF PIER IV FOOTING AND SEAL
(Shaft Section at top of footing)

FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.				

PIER IV QUANTITIES

ITEM NO.	DESCRIPTION	PIER IV WESTBOUND	PIER IV EASTBOUND	
171.2	Earth Struc. Exc. (River Piers)	670	620	c.y.
172	Ledge Struc. Exc. (River Piers)	10	5	c.y.
322.11	Concrete Class A (Cofferdam Seal)	620	714	c.y.
322.12	Concrete Class A (River Pier Ftgs.)	136.0	136.0	c.y.
322.21	Concrete Class A (River Pier-Abv. Ftgs.)	436.0	432.8	c.y.
344	Reinforcing Steel	38,107	38,106	lbs.

PIER IV NOTES (RIVER PIER ON BEDROCK)

1. Pier IV shall be founded on firm bedrock. The rock surface shall be stepped or serrated, as directed by the Engineer.
2. The ledge structure excavation pay limit shall be measured from existing firm ledge as uncovered in the field.
3. The depth of the cofferdam seal has been designed for a maximum water level of Elev. 330.0 for the Westbound Pier and Elev. 335.0 for the Eastbound Pier. Before placing the pier footing, the particular cofferdam tremie seal must be flooded when water reaches its design elevation. After placing the pier footing, the cofferdam must be flooded when water rises an additional 10'-0" above the seal design.
4. If the minimum thickness of cofferdam seal at any point is less than 13'-0" at the Westbound Pier and 17'-0" at the Eastbound Pier the seal must be submitted for a redesign.
5. See Bridge Sheet #15 for additional information titled "GENERAL RIVER PIER CONSTRUCTION NOTES".

△	DESCRIPTION	BY.	DATE
	REVISIONS		

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION

TOWN: LEBANON, N.H. / WHITE RIVER JUNCTION, VT. — BRIDGE NO. 044/103 E.B. / 044/106 W.B.
FEDERAL PROJECT: I89-1(41)59 — STATE PROJECT: P3821F
LOCATION: INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

PIER IV - MASONRY

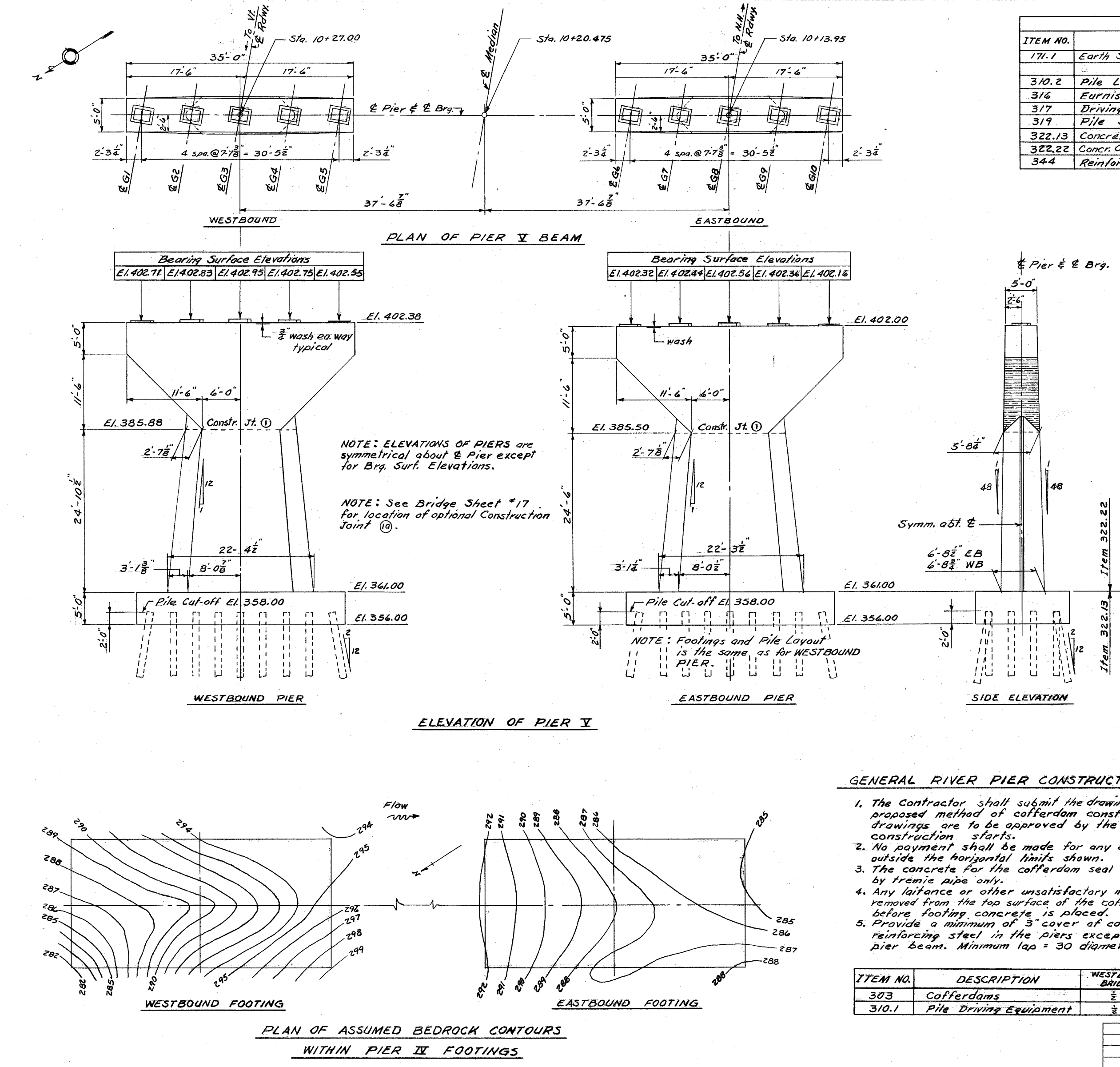
	BY	DATE		BY	DATE
DESIGNED	E. S.	12/63	CHECKED	L. R. T.	12/63
DRAWN	E. S.	12/63	CHECKED	L. R. T.	12/63
TRACED	L. R. T.	2/64	CHECKED	E. S.	2/64
QUANTITIES	J. W. M.	4/64	CHECKED	C. L. W.	4/64

BRIDGE SHEET NO. 14 OF 25
FILE NUMBER 17-4-1

REVIEWED BY

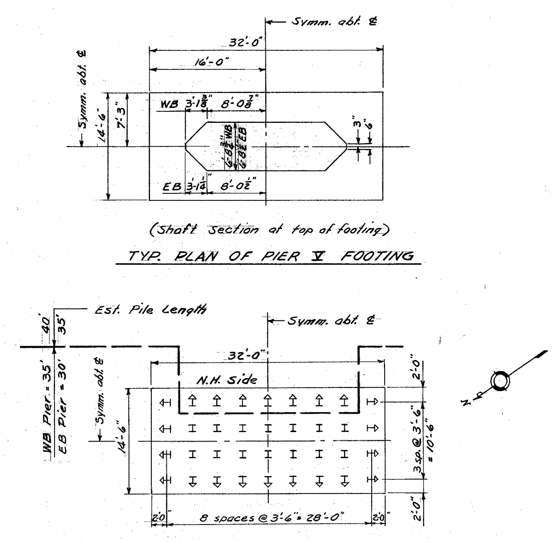
PROJ. NO.	SHEET NO.	TOTAL SHEETS
I89-1(41)59	15	26

FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.				



PIER V QUANTITIES

ITEM NO.	DESCRIPTION	PIER V WESTBOUND	PIER V EASTBOUND	
171.1	Earth Struc. Exc. (Land Piers)	80	120	c.y.
310.2	Pile Loading Tests	1	1	ea.
316	Furnishing Steel Brg. Piles	68,635	59,095	lbs.
317	Driving Steel Brg. Piles	68,635	59,095	lbs.
319	Pile Splices	4	4	ea.
322.13	Concrete Cl. A (Land Pier - Abut. Footing)	85.9	85.9	c.y.
322.22	Concr. Cl. A (Land Pier - Abut. Above Ftg.)	186.7	184.8	c.y.
344	Reinforcing Steel	23,411	23,411	lbs.



NOTE: Pile layout dimensions shown are horizontal and at top of piles.

PIER V NOTES (LAND PIER ON PILES)

1. All piles 12 BP53 Design load = 45 tons per pile.
2. All piles indicated thus ↦ shall be battered 2 horizontal to 12 vertical in the direction of the arrow.
3. For "GENERAL PILE NOTES" See Bridge Sheet #12.
4. Provide a 3" minimum cover of concrete over the reinforcing steel, except 2" cover at pier beam. Minimum lap = 30 diameters.

GENERAL RIVER PIER CONSTRUCTION NOTES

1. The Contractor shall submit the drawings showing his proposed method of cofferdam construction. These drawings are to be approved by the Engineer before construction starts.
2. No payment shall be made for any concrete placed outside the horizontal limits shown.
3. The concrete for the cofferdam seal shall be placed by tremie pipe only.
4. Any laitance or other unsatisfactory material shall be removed from the top surface of the cofferdam seal concrete before footing concrete is placed.
5. Provide a minimum of 3" cover of concrete over the reinforcing steel in the piers except 2" cover of pier beam. Minimum lap = 30 diameters

ITEM NO.	DESCRIPTION	WESTBOUND BRIDGE	EASTBOUND BRIDGE	
303	Cofferdams	½	½	Unit
310.1	Pile Driving Equipment	½	½	Unit

Sheet Scale: 1/8" = 1'-0"

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION

TOWN LEBANON, N.H. / WHITE RIVER JUNCTION, VT. — BRIDGE NO. 044/103 E.B. / 044/104 W.B.
FEDERAL PROJECT I89-1(41)59 — STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

PIER V MASONRY & PIER IV BEDROCK CONTOURS

	BY	DATE		BY	DATE
DESIGNED	E. S.	11/63	CHECKED	L. R. T.	11/63
DRAWN	E. S.	12/63	CHECKED	L. R. T.	12/63
TRACED	L. R. T.	2/64	CHECKED	E. S.	2/64
QUANTITIES	J. W. M.	4/64	CHECKED	C. L. W.	4/64

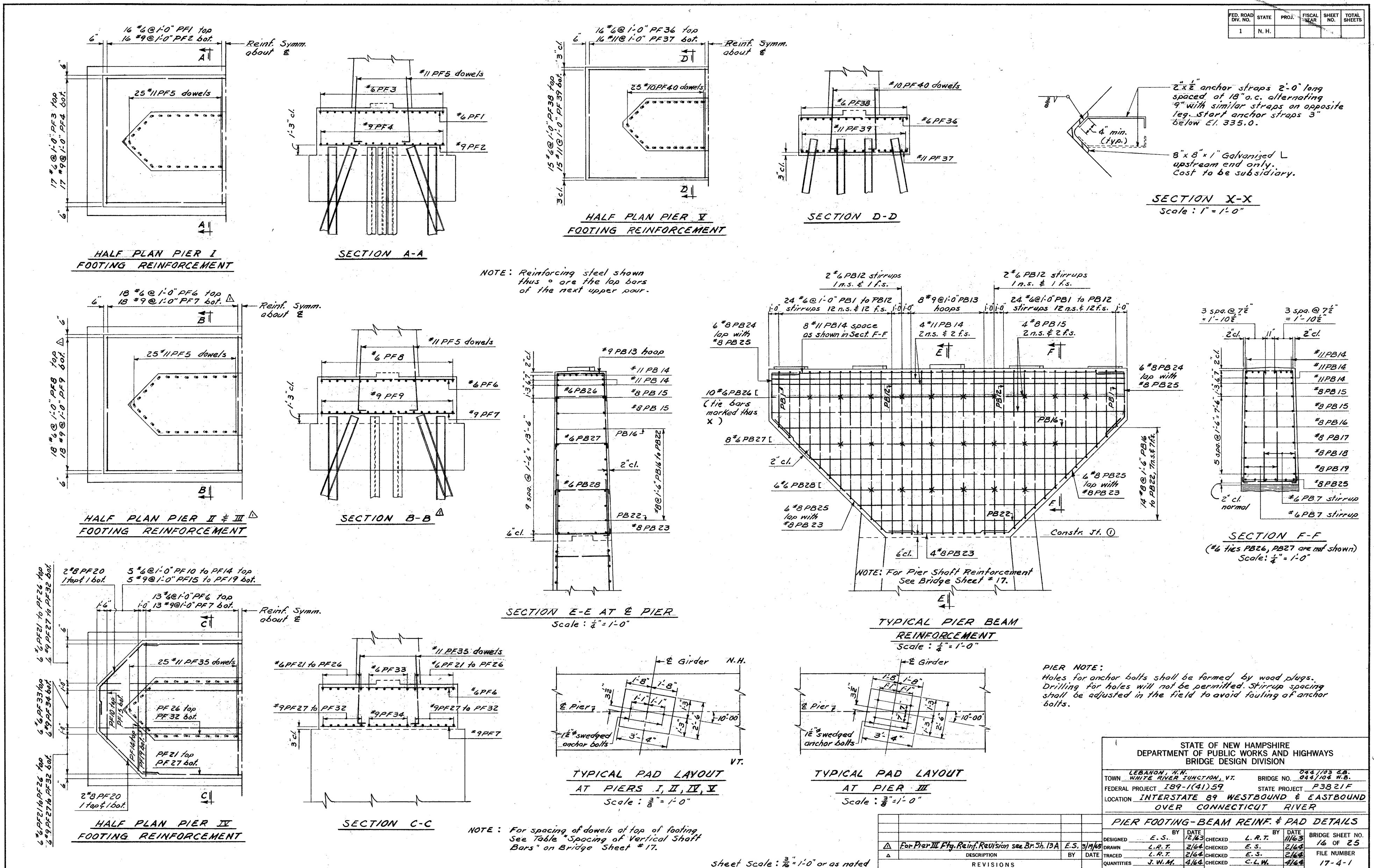
BRIDGE SHEET NO. 15 OF 25
FILE NUMBER 17-4-1

△	DESCRIPTION	BY	DATE

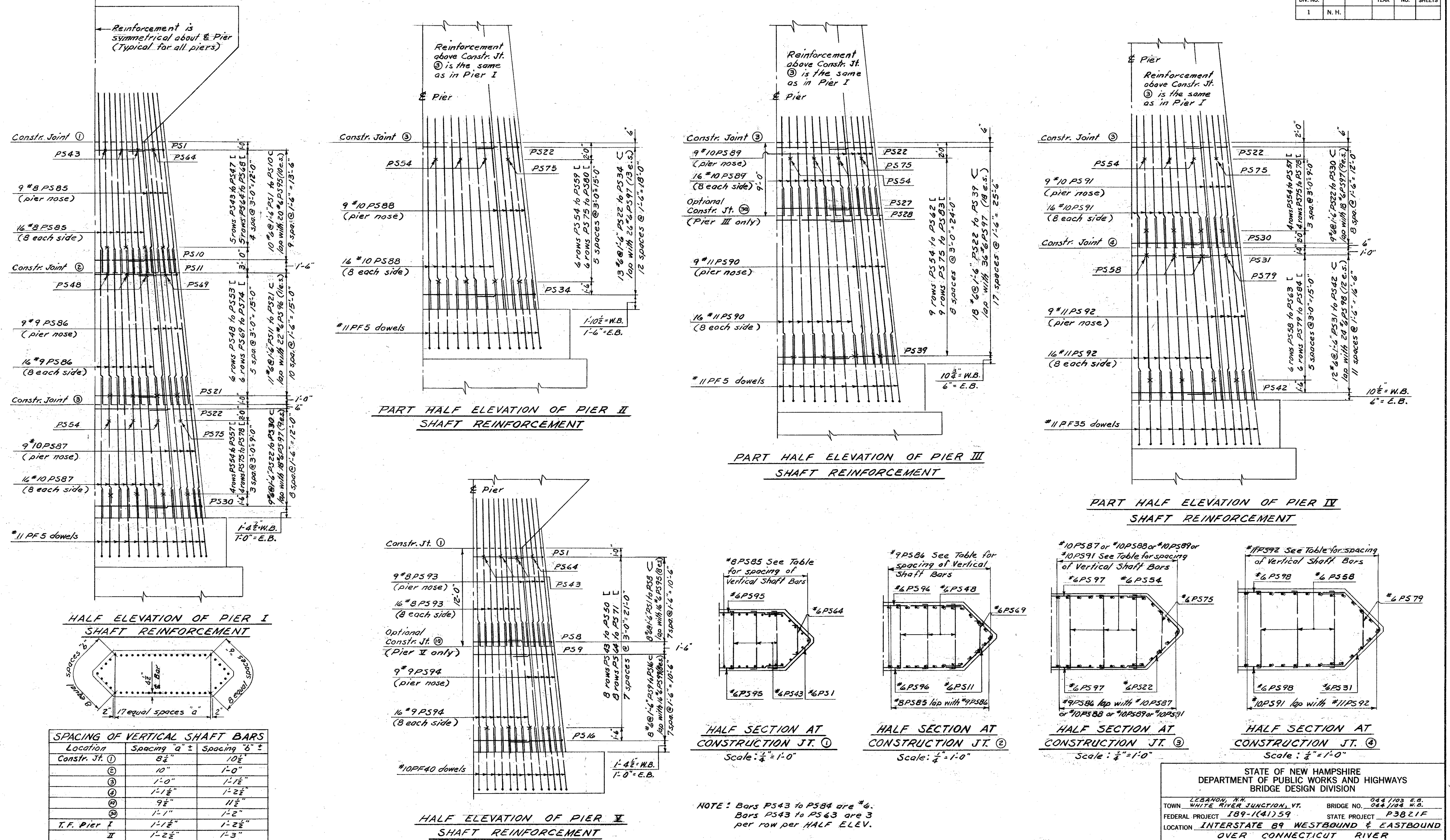
REVISIONS

REVIEWED BY

PROJ. NO.	SHEET NO.	TOTAL SHEETS
I89-1(41)59	16	26


HALF PLAN PIER I
FOOTING REINFORCEMENT
SECTION A-A
HALF PLAN PIER V
FOOTING REINFORCEMENT
SECTION D-D
SECTION X-X
Scale: 1" = 1'-0"
2"x1/2" anchor straps 2'-0" long spaced at 18" o.c. alternating 9" with similar straps on opposite leg. Start anchor straps 3" below El. 335.0.
8"x8"x1" Galvanized L upstream end only. Cost to be subsidiary.
NOTE: Reinforcing steel shown thus ∘ are the lap bars of the next upper pour.
HALF PLAN PIER II & III
FOOTING REINFORCEMENT
SECTION B-B
SECTION E-E AT ℄ PIER
Scale: 1/4" = 1'-0"
TYPICAL PIER BEAM
REINFORCEMENT
Scale: 1/4" = 1'-0"
NOTE: For Pier Shaft Reinforcement See Bridge Sheet #17.
SECTION F-F
(#6 ties PB26, PB27 are not shown)
Scale: 1/4" = 1'-0"
HALF PLAN PIER IV
FOOTING REINFORCEMENT
SECTION C-C
TYPICAL PAD LAYOUT
AT PIERS I, II, IV, V
Scale: 3/8" = 1'-0"
TYPICAL PAD LAYOUT
AT PIER III
Scale: 3/8" = 1'-0"
PIER NOTE:
Holes for anchor bolts shall be formed by wood plugs. Drilling for holes will not be permitted. Stirrup spacing shall be adjusted in the field to avoid fouling of anchor bolts.
NOTE: For spacing of dowels at top of footing See Table "Spacing of Vertical Shaft Bars" on Bridge Sheet #17.
Sheet Scale: 3/16" = 1'-0" or as noted
For Pier III Ftg. Reinf. Revision see Br. Sh. 13A
REVISIONS
STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION
TOWN LEBANON, N.H. WHITE RIVER JUNCTION, VT.
BRIDGE NO. 044/103 E.B. 044/104 W.B.
FEDERAL PROJECT I89-1(41)59
STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER
PIER FOOTING-BEAM REINF. & PAD DETAILS
BRIDGE SHEET NO. 16 OF 25
FILE NUMBER 17-4-1
PROJ. NO. I89-1(41)59
SHEET NO. 17
TOTAL SHEETS 26

FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N.H.				



SPACING OF VERTICAL SHAFT BARS		
Location	Spacing "a" ±	Spacing "b" ±
Constr. Jt. ①	8¾"	10½"
②	10"	1'-0"
③	1'-0"	1'-1½"
④	1'-1½"	1'-2½"
③a	9½"	11½"
①a	1'-1"	1'-2"
T.F. Pier I	1'-1½"	1'-2½"
II	1'-2½"	1'-3"
III	1'-3"	1'-3½"
IV	1'-3¾"	1'-4"
V	11"	1'-0½"

T.F. = Section at top of footing.

NOTE: Bars PS43 to PS84 are #4.
Bars PS43 to PS63 are 3 per row per HALF ELEV.

Sheet Scale: 3/16"=1'-0" or as noted

△	DESCRIPTION	BY	DATE
	REVISIONS		

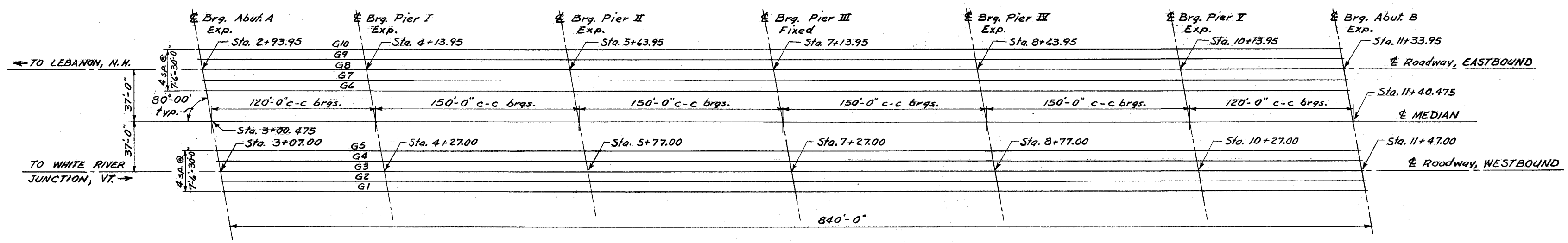
STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION

TOWN: LEBANON, N.H. / WHITE RIVER JUNCTION, VT. BRIDGE NO. 044/103 E.B. / 044/104 W.B.
FEDERAL PROJECT: I89-1(41)59 STATE PROJECT: P3821F
LOCATION: INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

PIER SHAFT REINFORCEMENT

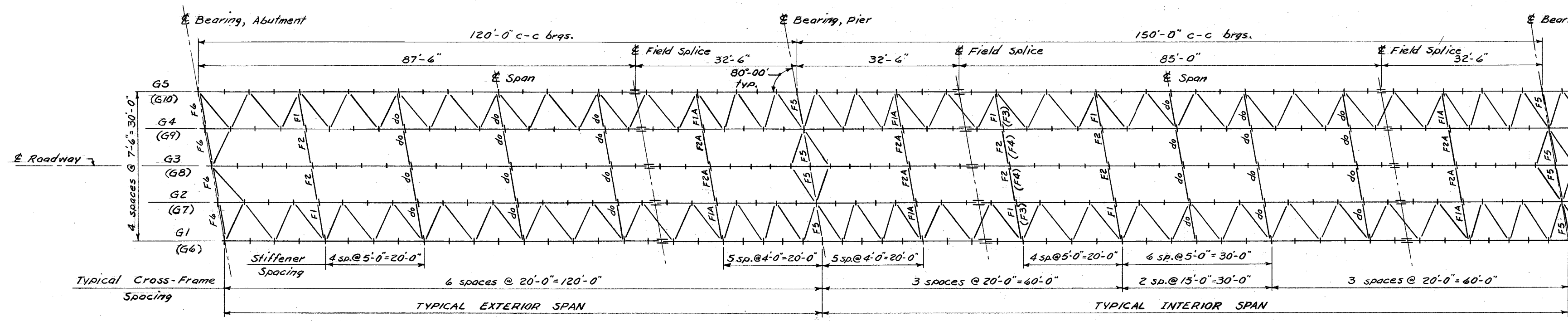
	BY	DATE		BY	DATE	
DESIGNED	E.S.	11/63	CHECKED	L.R.T.	11/63	BRIDGE SHEET NO. 17 OF 25
DRAWN	L.R.T.	2/64	CHECKED	E.S.	2/64	
TRACED	L.R.T.	2/64	CHECKED	E.S.	2/64	FILE NUMBER 17-4-1
QUANTITIES	J.W.M.	4/64	CHECKED	C.L.W.	4/64	

REVIEWED BY	PROJ. NO.	SHEET NO.	TOTAL SHEETS
	I89-1(41)59	18	26



GIRDER LOCATION PLAN

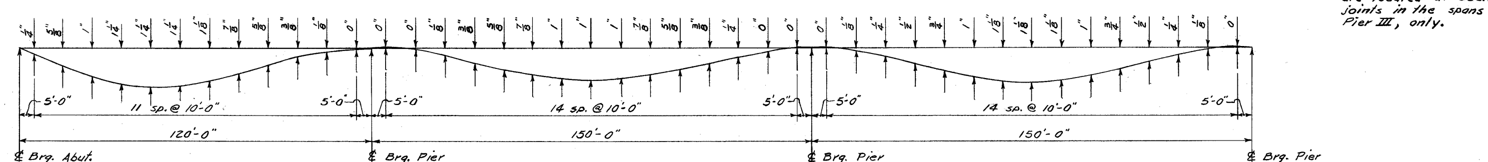
Scale: 1" = 40'-0"



PART PLAN OF STEEL FRAMING

Scale: $\frac{3}{32}$" = 1'-0"

NOTE: Cross-frames marked thus ( ) are located at deck expansion joints in the spans adjacent to Pier III, only.



DEAD LOAD DEFLECTION CURVE

Horiz. Scale: 1" = 20'-0"
Vert. Scale: Half Size

SUPERSTRUCTURE QUANTITIES

ITEM NO.	DESCRIPTION	WESTBOUND	EASTBOUND	
259	Type I-1 Hot Asph. Concr. W.C. for Br.	315.0	315.0	Ton
327	Concrete Bridge Deck (1,750 Cu.Yds.)*	½	½	Unit
333	Membrane Waterproofing	2,817	2,817	Sq.Yd.
334	Water Repellent	94	94	Gal.
344	Reinforcing Steel	229,818	229,818	Lbs.
351	Structural Steel (2,540,000 Lbs.)*	½	½	Unit
352	Bridge Shoes	½	½	Unit
362	Sealer for Exp. Joints in Bridges	225	225	Cu. In.
363.5	Bridge Railing E	1,781.8	1,781.8	Lin. Ft.
364	Bridge Lighting System	½	½	Unit
715	Straight Granite Curb (Bridge)	1,773	1,773	Lin. Ft.

* Approximate quantity for estimating only. Quantity shown includes the combined WB & EB bridge totals.

STRUCTURAL STEEL NOTES

1. All structural steel shall conform to A.S.T.M. designation A36.
2. The girders shall be cambered for the total Dead Load Deflection.
3. All shop connections and splices shall be welded.
4. Shop web splices may be relocated or omitted subject to the approval of the Engineer.
5. No tension flange welds shall be permitted in the girders except as shown.
6. The shop drawings shall indicate the procedures and sequence to be followed in welding the girder components.
7. The State will shop inspect the fabrication of the structural steel.
8. The Structural Steel Fabricator shall arrange for radiographic and magnetic particle inspection of the welds. See Special Provision.
9. All field connections shall be made with ⅞"⌀ high strength steel bolts in $\frac{15}{16}$" holes.
10. Holes for field splices shall be reamed in the shop while the girders are assembled to fit bearing elevations.
11. The Contractor shall submit drawings showing the method of field erection. These drawings shall be approved by the Engineer before erection is started.

△ $1\frac{1}{16}$"⌀ holes shall be permitted in the lateral bracing field connections only.

Sheet Scale: As Noted

FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.				

△	DESCRIPTION	BY	DATE
△	Lat. Bracing holes revised to $1\frac{1}{16}$"⌀	LRT	8/18/64

REVISIONS

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION

TOWN: LEBANON, N.H. / WHITE RIVER JUNCTION, VT. — BRIDGE NO. 044/103 E.B. / 044/104 W.B.
FEDERAL PROJECT: I89-1(41)59 — STATE PROJECT: P3821 F
LOCATION: INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

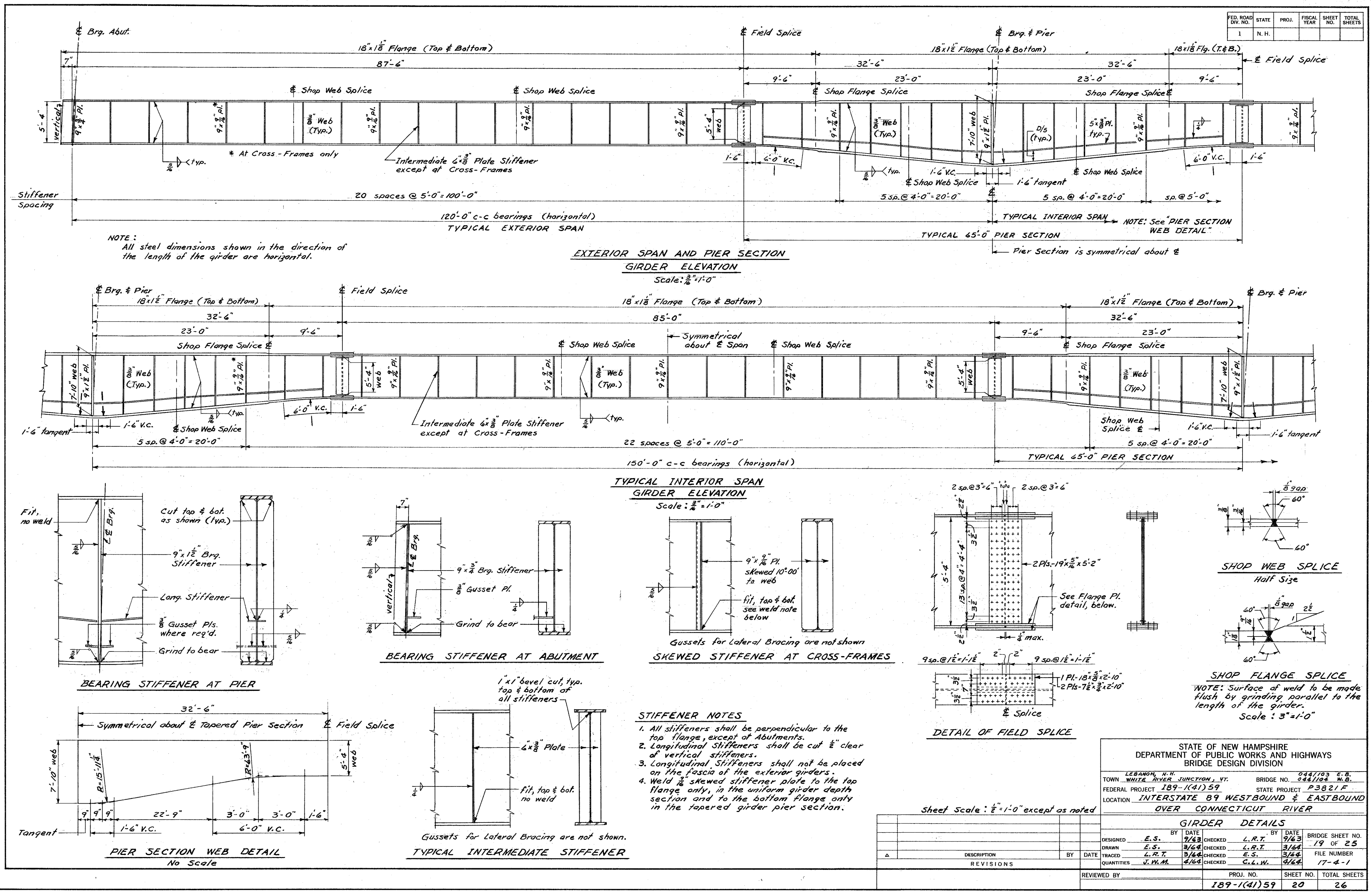
STRUCTURAL STEEL FRAMING

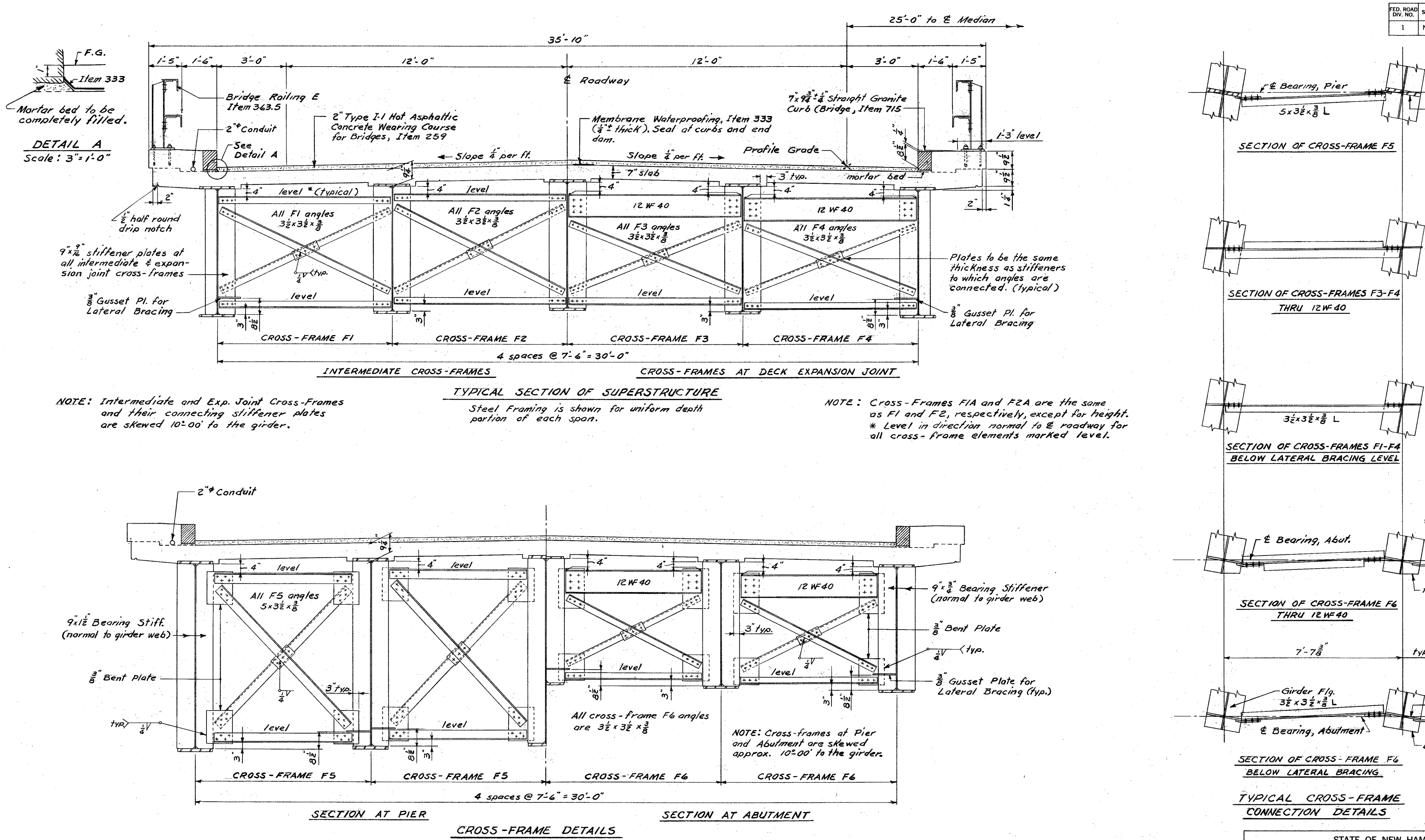
	BY	DATE		BY	DATE
DESIGNED	E.S.	9/63	CHECKED	L.R.T.	9/63
DRAWN	E.S.	3/64	CHECKED	L.R.T.	3/64
TRACED	L.R.T.	3/64	CHECKED	E.S.	3/64
QUANTITIES	J.W.M.	4/64	CHECKED	C.L.W.	4/64

BRIDGE SHEET NO. 18 OF 25
FILE NUMBER 17-4-1

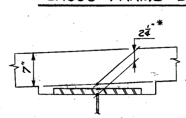
REVIEWED BY

PROJ. NO.	SHEET NO.	TOTAL SHEETS
I89-1(41)59	19	26


EXTERIOR SPAN AND PIER SECTION
GIRDER ELEVATION
Scale: 3/16" = 1'-0"
TYPICAL EXTERIOR SPAN
120'-0" c-c bearings (horizontal)
20 spaces @ 5'-0" = 100'-0"
TYPICAL 65'-0" PIER SECTION
TYPICAL INTERIOR SPAN
NOTE: See "PIER SECTION WEB DETAIL"
Pier Section is symmetrical about ℄
NOTE:
All steel dimensions shown in the direction of the length of the girder are horizontal.
* At Cross-Frames only
Intermediate 6"x3/8" Plate Stiffener except at Cross-Frames
Stiffener Spacing
TYPICAL INTERIOR SPAN
GIRDER ELEVATION
Scale: 3/16" = 1'-0"
150'-0" c-c bearings (horizontal)
22 spaces @ 5'-0" = 110'-0"
Symmetrical about ℄ Span
BEARING STIFFENER AT PIER
BEARING STIFFENER AT ABUTMENT
SKEWED STIFFENER AT CROSS-FRAMES
Gussets for Lateral Bracing are not shown
DETAIL OF FIELD SPLICE
SHOP WEB SPLICE
Half Size
SHOP FLANGE SPLICE
NOTE: Surface of weld to be made flush by grinding parallel to the length of the girder.
Scale: 3" = 1'-0"
PIER SECTION WEB DETAIL
No Scale
Symmetrical about ℄ Tapered Pier Section
TYPICAL INTERMEDIATE STIFFENER
Gussets for Lateral Bracing are not shown.
1"x1" bevel cut, typ. top & bottom of all stiffeners
STIFFENER NOTES
1. All stiffeners shall be perpendicular to the top flange, except at Abutments.
2. Longitudinal Stiffeners shall be cut 1/2" clear of vertical stiffeners.
3. Longitudinal Stiffeners shall not be placed on the fascia of the exterior girders.
4. Weld 7/16" skewed stiffener plate to the top flange only, in the uniform girder depth section and to the bottom flange only in the tapered girder pier section.
Sheet Scale: 1/2" = 1'-0" except as noted
STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION
TOWN LEBANON, N.H. WHITE RIVER JUNCTION, VT.
BRIDGE NO. 044/103 E.B. 044/104 W.B.
FEDERAL PROJECT I89-1(41)59
STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER
GIRDER DETAILS
DESIGNED E.S. 9/63 CHECKED L.R.T. 9/63
DRAWN E.S. 3/64 CHECKED L.R.T. 3/64
TRACED L.R.T. 3/64 CHECKED E.S. 3/64
QUANTITIES J.W.M. 4/64 CHECKED C.L.W. 4/64
BRIDGE SHEET NO. 19 OF 25
FILE NUMBER 17-4-1
PROJ. NO. I89-1(41)59
SHEET NO. 20
TOTAL SHEETS 26
FED. ROAD DIV. NO. 1
STATE N.H.



ABUTMENT B HAUNCH VARIATION DUE TO VERTICAL CURVE										
LOCATION	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
Sta. 11+00	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/4"
Mid Point	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 3/8"	2 3/8"	2 3/8"	2 3/8"	2 3/8"
℄ Brg. Abut. B	3 1/4"	3 1/8"	3 1/8"	3 1/8"	3"	2 3/4"	2 3/4"	2 3/4"	2 5/8"	2 5/8"



HAUNCH DETAIL
Scale: 1"=1'-0"

Sheet Scale: 1/2"=1'-0" or as noted.

FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.				

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION

TOWN LEBANON, N.H. WHITE RIVER JUNCTION, VT. BRIDGE NO. 044/103 E.B. 044/104 W.B.
FEDERAL PROJECT I89-1(41)59 STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

TYP. SECTION OF DECK & CROSS-FRAME DETAILS

	BY	DATE		BY	DATE
DESIGNED	E.S.	9/63	CHECKED	L.R.T.	9/63
DRAWN	E.S.	3/64	CHECKED	L.R.T.	3/64
TRACED	L.R.T.	3/64	CHECKED	E.S.	3/64
QUANTITIES	J.W.M.	4/64	CHECKED	C.L.W.	4/64

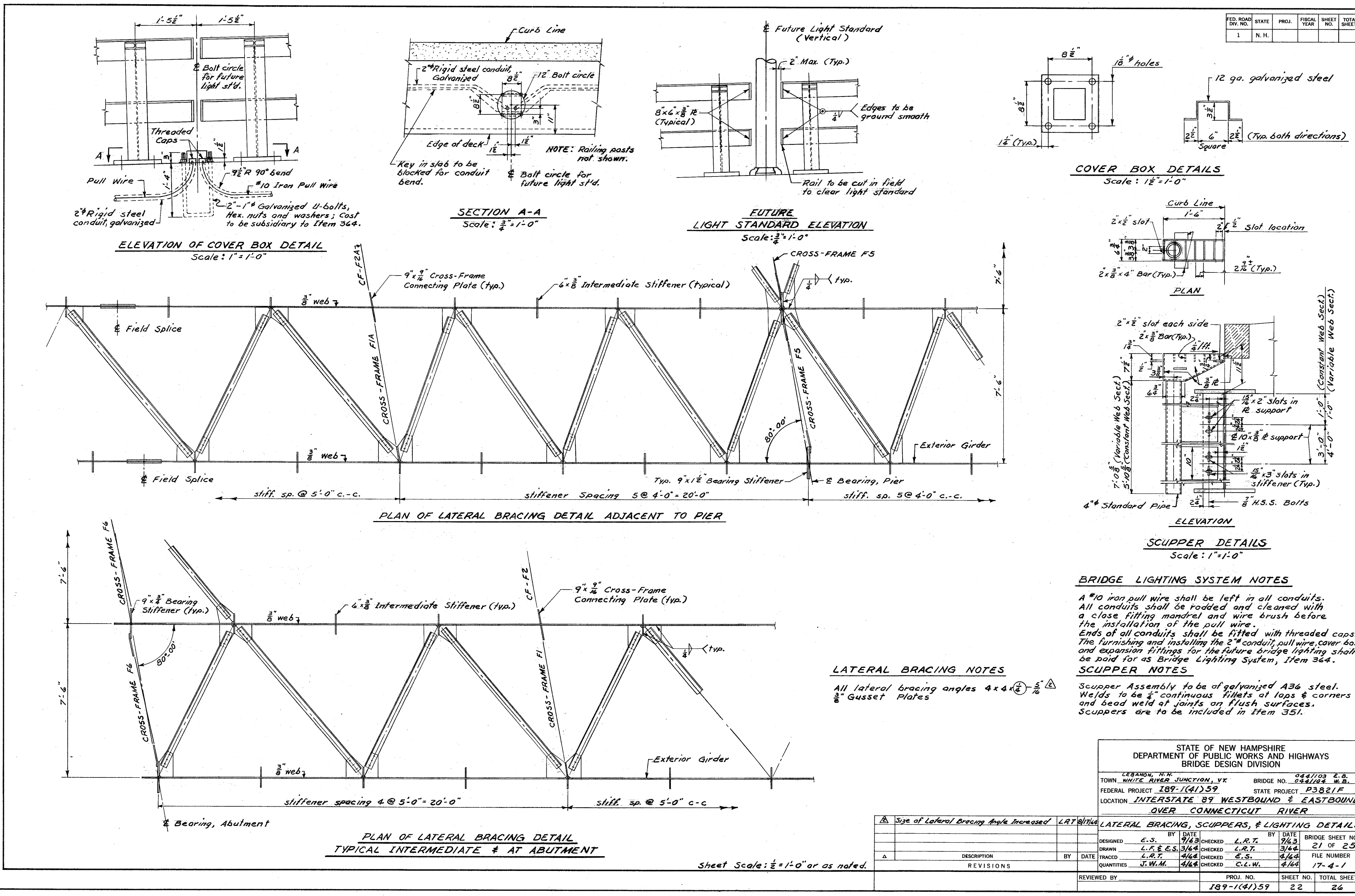
BRIDGE SHEET NO. 20 OF 25
FILE NUMBER 17-4-1

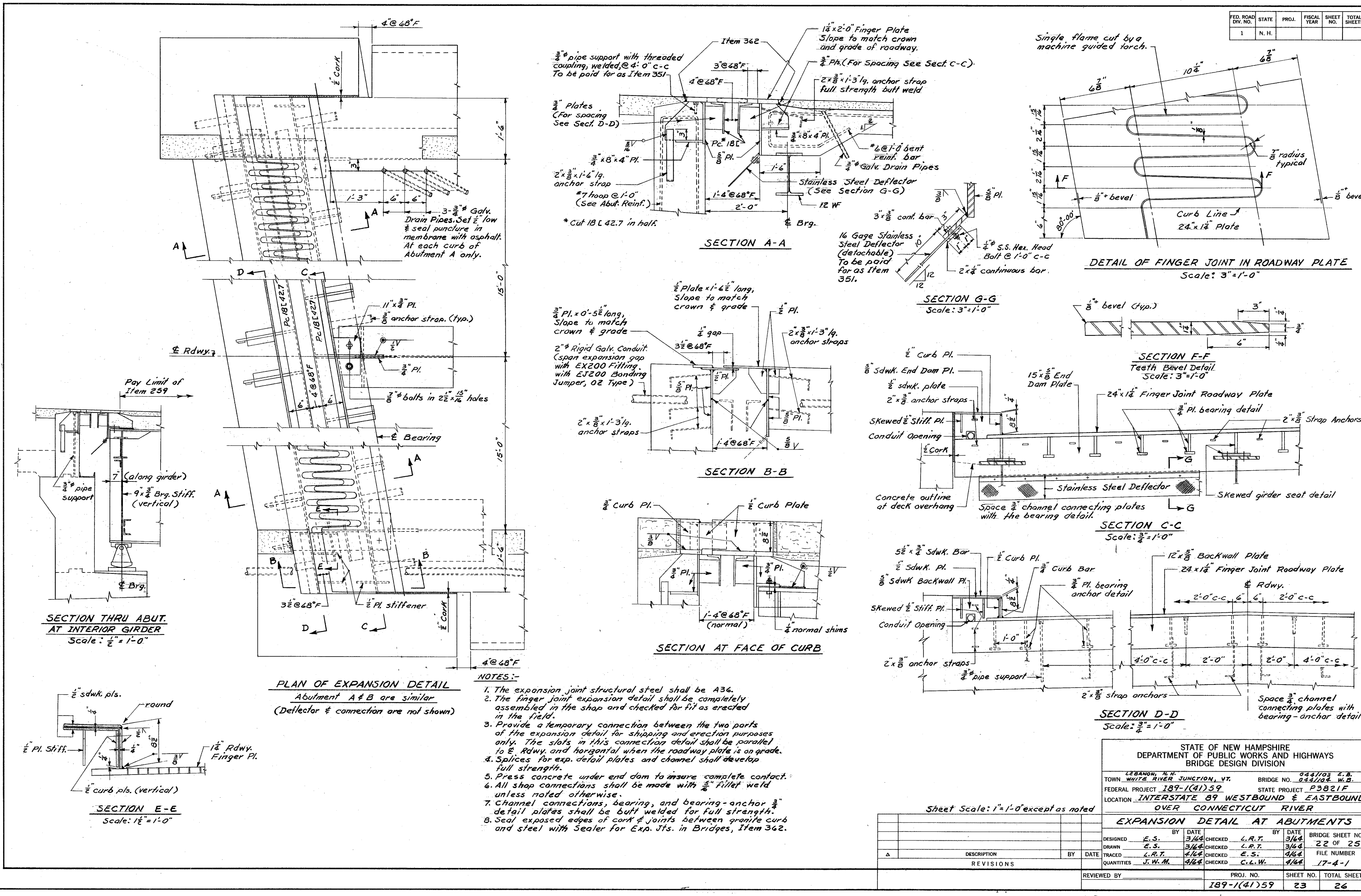
Δ	DESCRIPTION	BY	DATE

REVISIONS

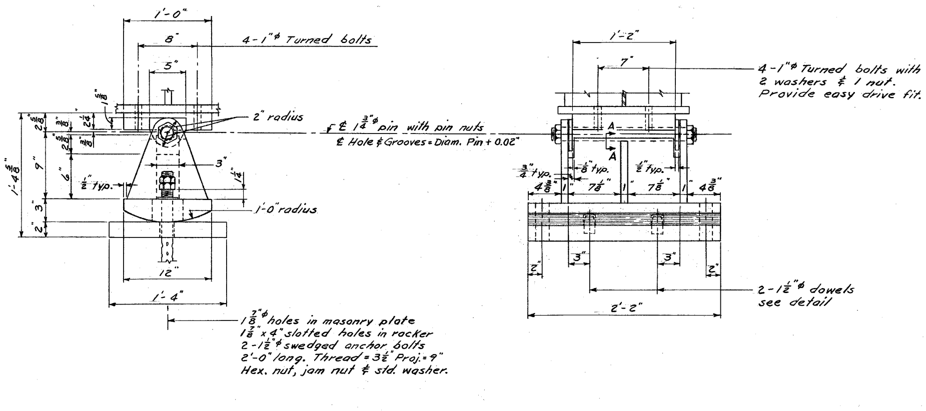
REVIEWED BY

PROJ. NO.	SHEET NO.	TOTAL SHEETS
I89-1(41)59	21	26

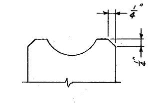

ELEVATION OF COVER BOX DETAIL
Scale: 1" = 1'-0"
SECTION A-A
Scale: 3/4" = 1'-0"
FUTURE LIGHT STANDARD ELEVATION
Scale: 3/4" = 1'-0"
COVER BOX DETAILS
Scale: 1 1/2" = 1'-0"
12 ga. galvanized steel
SCUPPER DETAILS
Scale: 1" = 1'-0"
PLAN
ELEVATION
PLAN OF LATERAL BRACING DETAIL ADJACENT TO PIER
PLAN OF LATERAL BRACING DETAIL TYPICAL INTERMEDIATE & AT ABUTMENT
LATERAL BRACING NOTES
All lateral bracing angles 4 x 4 x 1/2 - 5/16
3/8" Gusset Plates
BRIDGE LIGHTING SYSTEM NOTES
A #10 iron pull wire shall be left in all conduits.
All conduits shall be rodded and cleaned with a close fitting mandrel and wire brush before the installation of the pull wire.
Ends of all conduits shall be fitted with threaded caps.
The furnishing and installing the 2"φ conduit, pull wire, cover box, and expansion fittings for the future bridge lighting shall be paid for as Bridge Lighting System, Item 364.
SCUPPER NOTES
Scupper Assembly to be of galvanized A36 steel.
Welds to be 1/4" continuous fillets at laps & corners and bead weld at joints on flush surfaces.
Scuppers are to be included in Item 351.
Sheet Scale: 1/2" = 1'-0" or as noted.
STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION
TOWN LEBANON, N.H. WHITE RIVER JUNCTION, VT.
BRIDGE NO. 044/103 E.B. 044/104 W.B.
FEDERAL PROJECT I89-1(41)59
STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER
LATERAL BRACING, SCUPPERS, & LIGHTING DETAILS
Size of Lateral Bracing Angle Increased LRT 8/17/66
BRIDGE SHEET NO. 21 OF 25
FILE NUMBER 17-4-1
PROJ. NO. I89-1(41)59
SHEET NO. 22
TOTAL SHEETS 26


PLAN OF EXPANSION DETAIL
Abutment A & B are similar
(Deflector & connection are not shown)
SECTION THRU ABUT. AT INTERIOR GIRDER
Scale: 1/2" = 1'-0"
SECTION E-E
Scale: 1 1/2" = 1'-0"
SECTION A-A
* Cut 18 [42.7 in half.
SECTION B-B
SECTION AT FACE OF CURB
SECTION G-G
Scale: 3" = 1'-0"
DETAIL OF FINGER JOINT IN ROADWAY PLATE
Scale: 3" = 1'-0"
Single flame cut by a machine guided torch.
SECTION F-F
Teeth Bevel Detail
Scale: 3" = 1'-0"
SECTION C-C
Scale: 3/4" = 1'-0"
SECTION D-D
Scale: 3/4" = 1'-0"
NOTES:-
1. The expansion joint structural steel shall be A36.
2. The finger joint expansion detail shall be completely assembled in the shop and checked for fit as erected in the field.
3. Provide a temporary connection between the two parts of the expansion detail for shipping and erection purposes only. The slots in this connection detail shall be parallel to ℄ Rdwy. and horizontal when the roadway plate is on grade.
4. Splices for exp. detail plates and channel shall develop full strength.
5. Press concrete under end dam to insure complete contact.
6. All shop connections shall be made with 5/16" fillet weld unless noted otherwise.
7. Channel connections, bearing, and bearing-anchor 3/4" detail plates shall be butt welded for full strength.
8. Seal exposed edges of cork & joints between granite curb and steel with Sealer for Exp. Jts. in Bridges, Item 362.
Sheet Scale: 1" = 1'-0" except as noted
STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION
TOWN LEBANON, N.H. / WHITE RIVER JUNCTION, VT.
BRIDGE NO. 044/103 E.B. / 044/104 W.B.
FEDERAL PROJECT I89-1(41)59
STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER
EXPANSION DETAIL AT ABUTMENTS
DESIGNED E.S. 3/64 CHECKED L.R.T. 3/64
DRAWN E.S. 3/64 CHECKED L.R.T. 3/64
TRACED L.R.T. 4/64 CHECKED E.S. 4/64
QUANTITIES J.W.M. 4/64 CHECKED C.L.W. 4/64
BRIDGE SHEET NO. 22 OF 25
FILE NUMBER 17-4-1
REVISIONS
REVIEWED BY
PROJ. NO. I89-1(41)59
SHEET NO. 23
TOTAL SHEETS 26
FED. ROAD DIV. NO. 1
STATE N.H.

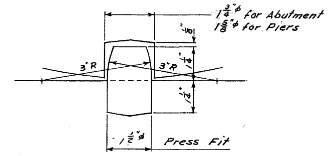
FED. ROAD DIV. NO.	STATE	PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N.H.				



EXPANSION SHOE - ABUTMENT



SECTION A-A
(Typical)

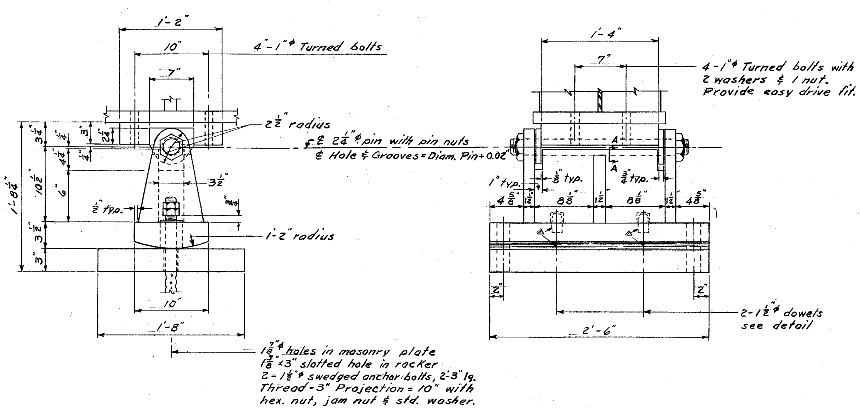


DOWEL DETAIL
Half Size

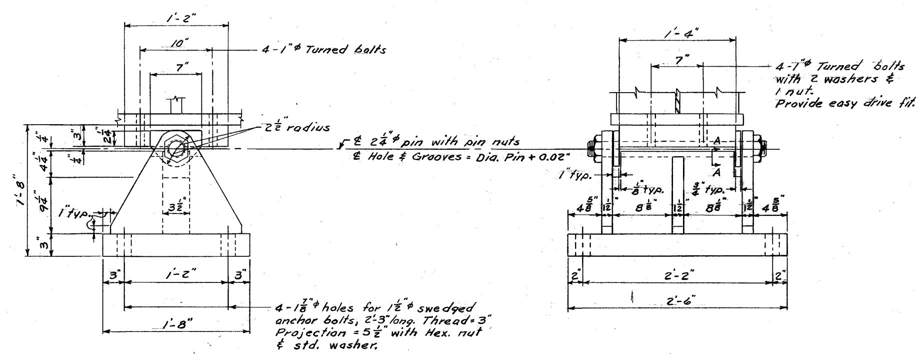
Note: Bearing Shoes shall be fabricated from plates and assembled with ⅜" continuous fillet weld, except that ½" fillet weld shall be used to connect parts thicker than 2¼".
Surface finish of bearings shall be as follows:

Pins, pin holes & pin grooves	ASA 125
Contact surface at rockers	ASA 250
Surface at plates in contact and welded	ASA 1000
Other Surface	ASA 2000

All bridge shoe steel shall conform to A.S.T.M. designation A36.
The bridge shoes shall be plumb at 68° F. During steel erection, the bridge shoes shall be adjusted to tip in accordance with the ambient temperature.
Allow ⅛" for a prefabricated bearing pad between the masonry and the masonry plate.
All expansion and fixed bearing assemblies including anchor bolts will be paid for as Item 352, Bridge Shoes.

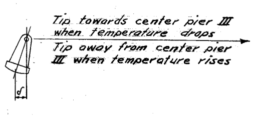


EXPANSION SHOE - PIERS



FIXED SHOE

Tip per 1° Fahrenheit
δ_1 = .0117 in. per 150'
δ_2 = .0234 in. per 300'
δ_3 = .03276 in. per 420'



ROCKER TIP DETAIL

Sheet Scale: 1½" = 1'-0" or as noted

Δ	DESCRIPTION	BY	DATE
Δ	Pintle location in error	E.S.	2/18/65

REVISIONS

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION

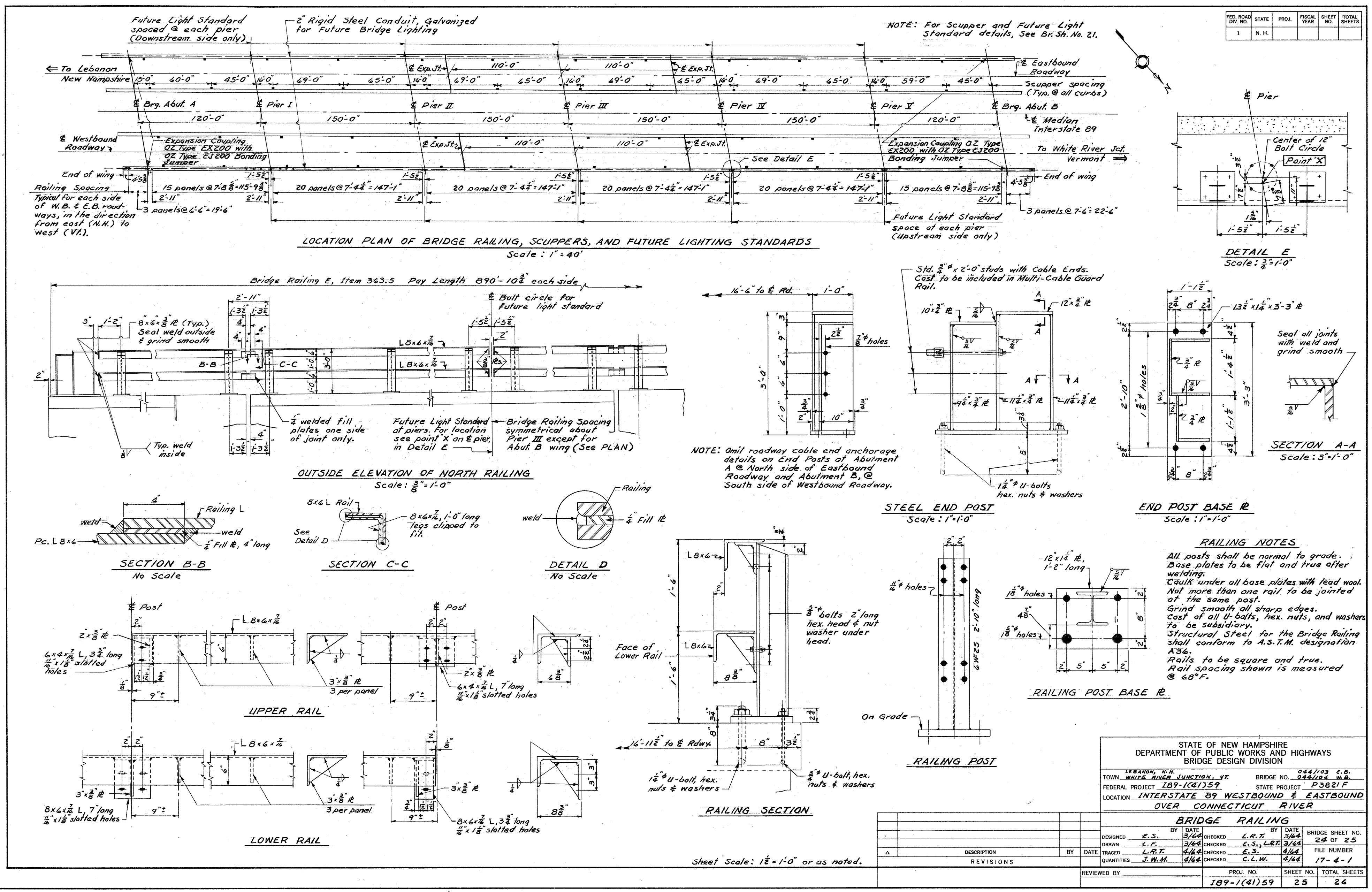
TOWN LEBANON, N.H. / WHITE RIVER JUNCTION, VT. — BRIDGE NO. 044/103 E.B. / 044/102 W.B.
FEDERAL PROJECT I89-1(41)59 — STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER

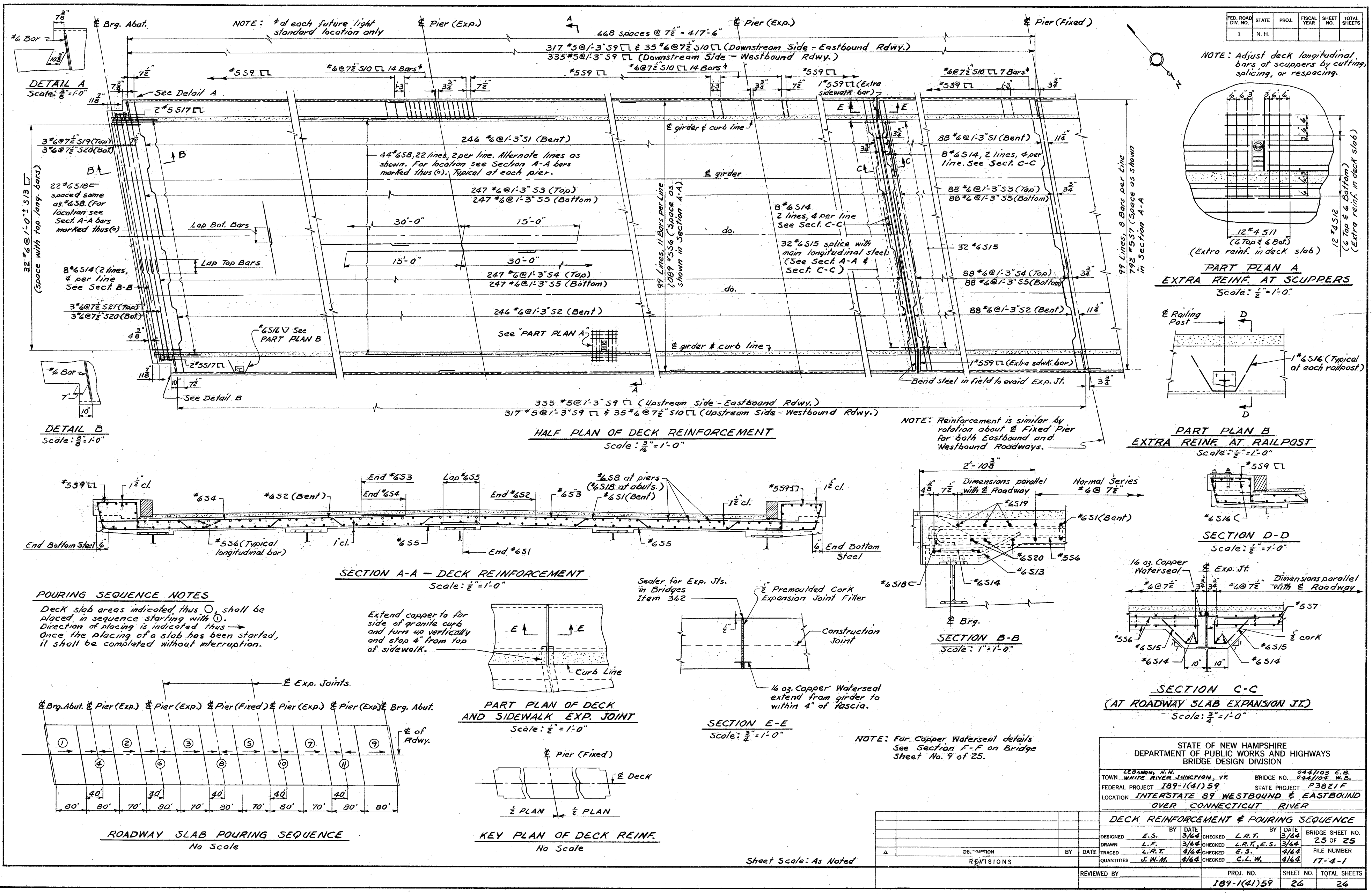
BRIDGE SHOES

	BY	DATE		BY	DATE
DESIGNED	E.S.	11/63	CHECKED	L.R.T.	11/63
DRAWN	E.S.	11/63	CHECKED	L.R.T.	11/63
TRACED	L.R.T.	11/63	CHECKED	E.S.	11/63
QUANTITIES	J.W.M.	4/64	CHECKED	C.L.W.	4/64

BRIDGE SHEET NO. 23 OF 25
FILE NUMBER 17-4-1

REVIEWED BY	PROJ. NO.	SHEET NO.	TOTAL SHEETS
	I89-1(41)59	24	26


LOCATION PLAN OF BRIDGE RAILING, SCUPPERS, AND FUTURE LIGHTING STANDARDS
Scale : 1" = 40'
NOTE: For Scupper and Future Light Standard details, See Br. Sh. No. 21.
Future Light Standard spaced @ each pier (Downstream side only)
2" Rigid Steel Conduit, Galvanized for Future Bridge Lighting
To Lebanon New Hampshire
To White River Jct. Vermont
Future Light Standard space at each pier (upstream side only)
Railing Spacing Typical for each side of W.B. & E.B. roadways, in the direction from east (N.H.) to west (Vt.).
OUTSIDE ELEVATION OF NORTH RAILING
Scale : 3/8" = 1'-0"
Bridge Railing E, Item 363.5 Pay Length 890'-10 3/4" each side
Future Light Standard at piers. For location see point "X" on ℄ pier, in Detail E
Bridge Railing Spacing symmetrical about Pier III except for Abut. B wing (See PLAN)
SECTION B-B
No Scale
SECTION C-C
DETAIL D
No Scale
UPPER RAIL
LOWER RAIL
RAILING SECTION
NOTE: Omit roadway cable end anchorage details on End Posts of Abutment A @ North side of Eastbound Roadway and Abutment B, @ South side of Westbound Roadway.
STEEL END POST
Scale : 1" = 1'-0"
RAILING POST
DETAIL E
Scale : 3/4" = 1'-0"
SECTION A-A
Scale : 3" = 1'-0"
END POST BASE ℞
Scale : 1" = 1'-0"
RAILING POST BASE ℞
RAILING NOTES
All posts shall be normal to grade. Base plates to be flat and true after welding.
Caulk under all base plates with lead wool.
Not more than one rail to be jointed at the same post.
Grind smooth all sharp edges.
Cost of all U-bolts, hex. nuts, and washers to be subsidiary.
Structural Steel for the Bridge Railing shall conform to A.S.T.M. designation A36.
Rails to be square and true.
Rail spacing shown is measured @ 68°F.
STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION
TOWN LEBANON, N.H. WHITE RIVER JUNCTION, VT.
BRIDGE NO. 044/103 E.B. 044/104 W.B.
FEDERAL PROJECT I89-1(41)59
STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER
BRIDGE RAILING
DESIGNED E.S. 3/64 CHECKED L.R.T. 3/64
DRAWN L.F. 3/64 CHECKED E.S., L.R.T. 3/64
TRACED L.R.T. 4/64 CHECKED E.S. 4/64
QUANTITIES J.W.M. 4/64 CHECKED C.L.W. 4/64
BRIDGE SHEET NO. 24 OF 25
FILE NUMBER 17-4-1
PROJ. NO. I89-1(41)59
SHEET NO. 25 TOTAL SHEETS 26
Sheet Scale: 1 1/2" = 1'-0" or as noted.


STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DESIGN DIVISION
TOWN LEBANON, N.H. WHITE RIVER JUNCTION, VT.
BRIDGE NO. 044/103 E.B. 044/104 W.B.
FEDERAL PROJECT I89-1(41)59
STATE PROJECT P3821F
LOCATION INTERSTATE 89 WESTBOUND & EASTBOUND OVER CONNECTICUT RIVER
DECK REINFORCEMENT & POURING SEQUENCE
BRIDGE SHEET NO. 25 OF 25
FILE NUMBER 17-4-1
PROJ. NO. I89-1(41)59
SHEET NO. 26
TOTAL SHEETS 26
HALF PLAN OF DECK REINFORCEMENT
Scale: 3/16" = 1'-0"
NOTE: Reinforcement is similar by rotation about ℄ Fixed Pier for both Eastbound and Westbound Roadways.
NOTE: ℄ of each future light standard location only
DETAIL A
Scale: 3/8" = 1'-0"
DETAIL B
Scale: 3/8" = 1'-0"
PART PLAN A
EXTRA REINF. AT SCUPPERS
Scale: 1/2" = 1'-0"
NOTE: Adjust deck longitudinal bars at scuppers by cutting, splicing, or respacing.
PART PLAN B
EXTRA REINF. AT RAILPOST
Scale: 1/2" = 1'-0"
SECTION A-A – DECK REINFORCEMENT
Scale: 1/2" = 1'-0"
SECTION B-B
Scale: 1" = 1'-0"
SECTION D-D
Scale: 1/2" = 1'-0"
SECTION C-C
(AT ROADWAY SLAB EXPANSION JT.)
Scale: 3/4" = 1'-0"
SECTION E-E
Scale: 3/4" = 1'-0"
NOTE: For Copper Waterseal details See Section F-F on Bridge Sheet No. 9 of 25.
PART PLAN OF DECK AND SIDEWALK EXP. JOINT
Scale: 1/2" = 1'-0"
KEY PLAN OF DECK REINF.
No Scale
POURING SEQUENCE NOTES
Deck slab areas indicated thus ○ shall be placed in sequence starting with ①. Direction of placing is indicated thus →. Once the placing of a slab has been started, it shall be completed without interruption.
ROADWAY SLAB POURING SEQUENCE
No Scale
Sheet Scale: As Noted

APPENDIX B – NORTHBOUND OCTOBER 2013 AND SOUTHBOUND JANUARY 2014 BRIDGE INSPECTION REPORTS

Bridge Inspection Report

Lebanon 044/104

Date of Inspection: 07/31/2013
Date Report Sent: 10/9/2013
☐ Picture taken during inspection
Owner: NHDOT
Bridge also in: Hartford , Vermont

I-89 NB
Over
CONNECTICUT RIVER,NECRR
Vietnam Veteran Memorial
Interstate Bridge Number: 071

Recommended Postings:

Weight: No Posting Required — ☑ Weight Sign OK

Width: Not Required — ☑ Width Sign OK

Primary Height Sign Recommendation: *None*
Optional Centerline Height Sign Rec: *None*

Clearances: (Feet) Over: Under: 38.98 Route:

☑ Height Signs OK

Condition: State Redlist
Deck: 4 Poor
Superstructure: 5 Fair
Substructure: 6 Satisfactory
Culvert: N N/A (NBI)

Structure Type and Materials:
Number of Spans Main Unit: 6
Number of Approach Spans: 0

Main Span Material and Design Type
Steel Continuous Multiple Beam

Sufficiency Rating: 61.7%
NBI Status: Structurally Deficient

Bridge Rail: Substandard
Rail Transition: Substandard
Bridge Approach Rail: Substandard
Approach Rail Ends: Substandard

NH Bridge Type: I Beams w/ Concrete Deck
Deck Type: Concrete, Cast in Place
Wearing Surface: Bituminous
Membrane: Other
Deck Protection: None
Pavement thickness: Not Applicable
Curb Reveal: 8.5 in
Plan Location: 17-4-1

Bridge Dimensions:
Length Maximum Span: 150.0 ft
Left Curb/Sidewalk Width: 0.7 ft
Width Curb to Curb: 30.0 ft
Approach Roadway Width (W/ Shoulders): 40.0 ft

Total Bridge Length: 847.0 ft
Right Curb/Sidewalk Width: 0.7 ft
Total Bridge Width: 35.8 ft
Median: No median
Bridge Skew: 10.00 °

Bridge Service:
Type of Service on Bridge: Highway
Type of Service under: Railroad-waterway
Lanes on bridge: 2
Lanes Under: NA

Year Built: 1966
Year Rebuilt: Not Rebuilt
Detour Length: 1.0 mi

AADT: 19500 Percent Trucks: 6 % Year of AADT: 2012
Future AADT: 28860 Year of Future AADT: 2032

Bridge Inspection Report

Federal or State Definition Bridge:	Fed. Definition Bridge
Roadway Functional Class:	Urban Interstate
New Hampshire Highway System and Class:	Interstate Highway
Eligibility for the National Register of Historic Places:	Not Eligible
Traffic Direction:	One-way traffic

National Bridge Inventory (NBI) Appraisal Ratings:

Deck Geometry:	Minimum Tolerable
Underclearances:	Equal Minimum Criteria
Approach Alignment:	Equal Desirable Criteria
Structural Evaluation:	Above Min. Tolerable
Channel/Channel Protection:	Bank Slumping
Waterway Adequacy:	Above Desirable Criteria
Bridge Scour Critical Status:	Critical during floods
Riprap Condition:	Good Condition
Debris Present:	Debris Present

HEAVY BANK EROSION UPSTREAM. MINOR SCOUR AND DRIFT.
Scour Critical by CHa study, possible pile study?

Date of Underwater Inspection: Nov. 2012

AASHTO CoRe Element Condition State Data:

No.	Description	Env.	Material Notes and Condition Notes
14	Concrete Deck - Protected w/ Membrane and Pavement	Severe	*ASPHALT- CRACKED OVER RELIEF JOINT #1. FEW CRACKS IN PAVEMENT OVER DELAMINATIONS. CURBS- CRACKS AND LIGHT TO MODERATE SPALLS WITH SEVERAL GRANITE SECTIONS LOOSENED. CURB STONES LOOSE AND ONE MISSING AT NORTH.*
107	Painted Steel Beam or Girder (Open Web)	Moderate	*WF-BEAMS WITH WEB STIFFENERS, HAUNCHED AT PIERS* *MINOR TO LIGHT RUST. SOME HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND ON EXTERIOR GIRDERS IN NORTH SPAN. PAINT CRACKED AND PEELING.*
210	Reinforced Concrete Pier Wall	Moderate	*FEW FINE CRACKS. TREE DEBRIS AT PIER # 4.*
215	Reinforced Concrete Abutment	Moderate	*LIGHT TO MODERATE CRACKS ANDDELAMINATIONS. MODERATE SPALLS IN NORTHWEST WINS. LIGHT SPALLS IN TOP OF BACKWALLS. MODERATE SPALLS IN SOUTH FOOTER.*
234	Reinforced Concrete Cap	Low	*HAMMERHEADS* *LIGHT CRACK IN WEST END OF #5. MINOR SPALLS IN TOP #4.*
304	Open Expansion Joint	Severe	*** Finger Joint *** *12 MISSING OR BROKEN FINGERS ON NORTH JOINT, ONE CRACKED.*

No.	Description	Env.	Material Notes and Condition Notes
311	Moveable Bearing (roller, sliding, etc.)	Moderate	*ROCKERS* *DEBRIS BUILD-UP AT ABUTMENTS WITH SECTION LOSS ON ANCHOR BOLTS. INTERIOR ROCKERS AT NORTH LIFTED SLIGHTLY DUE TO PACK RUST AND DEBRIS. ROCKERS TIPPED BACK TO NEAR FULL EXPANSION AT NORTH AND TIPPED SLIGHTLY TO SOUTH AT PIERS #1 #2 #4 AND #5.*
313	Fixed Bearing	Low	*AT PIER #3* *PAINT PEELING AND LIGHT RUST ON EXTERIORS.*
334	Coated Metal Bridge Railing	Severe	*** Steel Angle Rail** TRANSITION RAILS GALVANIZED* *RUSTED, PAINT FLAKED AND PEELED. MINOR SECTION LOSS. LIGHT TRANSITION RAIL DAMAGE.BOTTOM RAIL ANGLE BRACE BROKEN AT SOUTHEAST.*
359	Soffit of Conc Deck or Slab Condition Warning Flag	Severe	*CRACKS, LIGHT EFFLORESCENCE AND STAINS. MODERATE TO HEAVY DELAMINATIONS AT BAYS 2, 3 AND 4 THROUGH MOST SPANS. SPALLS WITH REBAR EXPOSED IN AREAS. SOME LIGHT LEAKING EVIDENT AT CURBLINE, RELIEF JOINTS AND IN FEW AREAS IN NORTH SPAN. SEVERAL FORMS IN PLACE FROM DECK REPAIRS.*
363	Section Loss Condition Warning Flag	Moderate	*Element record added 2011-12-29.* *LIGHT TO MODERATE SECTION LOSS IN SPAN # 3 AND SPAN # 4 UNDER RELIEF JOINTS TO ANGLE BRACING, STIFFNERS, GUSSET PLATES AND BOTTOMS OF WEB. MINOR SECTION LOSS TO UPPER AND LOWER FLANGES. SPAN # 3, GIRDER # 4, PITTED FULL LENGTH ALONG STIFFNER, UNDER RELIEF JOINT.*

No.	Description	Env.	Quantity	Units	State 1	State 2	State 3	State 4	State 5
14	Concrete Deck - Protected w/ Membran	Severe	30,107	(SF)	0 %	0 %	100 %	0 %	0 %
107	Painted Steel Beam or Girder (Open We	Moderate	4,209	(LF)	0 %	77 %	20 %	3 %	0 %
210	Reinforced Concrete Pier Wall	Moderate	131	(LF)	95 %	5 %	0 %	0 %	
215	Reinforced Concrete Abutment	Moderate	180	(LF)	13 %	80 %	7 %	0 %	
234	Reinforced Concrete Cap	Low	171	(LF)	94 %	6 %	0 %	0 %	
304	Open Expansion Joint	Severe	69	(LF)	68 %	20 %	12 %		
311	Moveable Bearing (roller, sliding, etc.)	Moderate	30	(EA)	67 %	33 %	0 %		
313	Fixed Bearing	Low	5	(EA)	60 %	40 %	0 %		
334	Coated Metal Bridge Railing	Severe	1,873	(LF)	0 %	0 %	100 %	0 %	0 %
359	Soffit of Conc Deck or Slab Condition W	Severe	1	(EA)	0 %	0 %	100 %	0 %	0 %
363	Section Loss Condition Warning Flag	Moderate	1	(EA)	0 %	100 %	0 %	0 %	

Bridge Notes:

Vietnam Veterans Memorial Bridge (1983, Chapter 362)
LIFT INSPECTION 5/07
LIFT INSPECTION 12/11
LIFT INSPECTION 12/29/2011.
REPAIRS TO RELIEF JOINTS,RUST REMOVED PRIMED AND PAINTED IN JUNE 2012.
POST FLOOD INSPECTION 7/31/2013.

Approach and Roadway Notes: *PAVEMENT CRACKED, RUTTED , SETTLED AND POTHOLED AT NORTH APPROACH.*
CURBS STONES SETTLED LOOSE AND MISSING.
W-BEAM APPROACH RAIL.

Inspection History:

Inspection Date: 07/31/2013 **Inspector:** MHC

Deck: 4 Poor
Super: 5 Fair
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MHC inspection comments -
POST FLOOD INSPECTION - TREE DEBRIS AT PIER # 4. ALL ELEMENTS APPEAR STABLE.
DECK: ASPHALT- CRACKED IN AREAS. NORTH APPROACH POTHOLED. CURBS- CRACKS AND LIGHT TO MODERATE SPALLS WITH SEVERAL STONES LOOSENED.
JOINT- TWELVE MISSING OR BROKEN FINGERS AT NORTH EXPANSION JOINT.
CRACKS,DELAMINATION,AND SPALLS IN BAYS 2, 3, AND 4 IN ALL SPANS.
SUPERSTRUCTURE: MINOR TO LIGHT RUST. SOME HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND ON EXTERIOR GIRDERS IN NORTH SPAN. HEAVY SECTION LOSS IN ANGLE BRACING AND LATERAL BRACING CONNECTION PLATES TO GIRDERS UNDER RELIEF JOINT IN SPAN #3 AND SPAN #4.REPAIRS MADE TO RELIEF JOINT,RUST REMOVED PRIMED AND PAINTED,JUNE 2012.
SUBSTRUCTURE: FINE AND LIGHT CRACKS. LIGHT DELAMINATIONS. LIGHT SPALLS IN TOP OF BACKWALL'S. HEAVY DEBRIS ON SEATS.
PIERS: FEW FINE CRACKS. LIGHT CRACK IN DOWNSTREAM END OF CAP #5. MINOR SPALLS IN TOP OF #4.

Inspection Date: 06/13/2013 **Inspector:** MHC

Deck: 4 Poor
Super: 5 Fair
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MHC - inspection comments -
DECK: ASPHALT- CRACKED IN AREAS. NORTH APPROACH POTHOLED. CURBS- CRACKS AND LIGHT TO MODERATE SPALLS WITH SEVERAL STONES LOOSENED.
JOINT- TWELVE MISSING OR BROKEN FINGERS AT NORTH EXPANSION JOINT. CRACKS, DELAMINATION, SPALLS, AREAS OF LEAKING AND RUST STAINING AT SOFFIT.
SUPERSTRUCTURE: MINOR TO LIGHT RUST. SOME HEAVY RUST UNDER EXPANSION JOINTS, AND GIRDER FLANGES IN NORTH SPAN. REPAIRS MADE TO RELIEF JOINT, RUST REMOVED PRIMED AND PAINTED, LIGHT RUST LEACHING THROUGH. BEARINGS AT BOTH ABUTMENTS HEAVILY RUSTED.
SUBSTRUCTURE: FINE AND LIGHT CRACKS, DELAMINATIONS, AND SPALLS IN BACKWALLS. HEAVY DEBRIS ON SEATS. FEW FINE CRACKS, LIGHT SPALLS AND MINOR DELAMINATIONS AT PIERS.

PICTURES: B467 # 15 - 32
SEE PIC LIST FOR DESCRIPTIONS.

Inspection Date: 03/18/2013 **Inspector:** MTC

Deck: 4 Poor
Super: 5 Fair
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MTC inspection comments -
DECK: ASPHALT- CRAKED IN AREAS. NORTH APPROACH POTHOLED. CURBS- CRACKS AND LIGHT TO MODERATE SPALLS WITH SEVERAL STONES LOOSENED. JOINT- TWELVE MISSING OR BROKEN FINGERS AT NORTH EXPANSION JOINT.
CRACKS,DELAMINATION,AND SPALLS IN BAYS 2, 3, AND 4 IN ALL SPANS.
SUPERSTRUCTURE: MINOR TO LIGHT RUST. SOME HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND ON EXTERIOR GIRDERS IN NORTH SPAN.HEAVY SECTION LOSS IN ANGLE BRACING AND LATERAL BRACING CONNECTION PLATES TO GIRDERS UNDER RELIEF JOINT IN SPAN #3 AND SPAN #4.REPAIRS MADE TO RELIEF JOINT,RUST REMOVED PRIMED AND PAINTED,JUNE 2012.
SUBSTRUCTURE: FINE AND LIGHT CRACKS. LIGHT DELAMINATIONS. LIGHT SPALLS IN TOP OF BACKWALLS. HEAVY DEBRIS ON SEATS.
PIERS: FEW FINE CRACKS. LIGHT CRACK IN DOWNSTREAM END OF CAP #5. MINOR SPALLS IN TOP OF #4.

PICTURES: B454.
94. POTHOLED AT NORTH APPROACH.
95. PATCHED AREA OVER RELIEF JOINT CRACKED.

Inspection History:

Inspection Date: 11/27/2012 **Inspector:** JEL

Deck: 4 Poor
Super: 5 Fair
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

NJL inspection comments -
REFER TO STEARNS ENGINEERING UNDERWATER INSPECTION REPORT 11/27/2012

Inspection Date: 11/16/2012 **Inspector:** MTC

Deck: 4 Poor
Super: 5 Fair
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MTC inspection comments -
DECK: ASPHALT- CRAKED IN AREAS CURBS- CRACKS AND LIGHT TO MODERATE SPALLS WITH SEVERAL STONES LOOSENED. JOINT- TWELVE MISSING OR BROKEN FINGERS AT NORTH EXPANSION JOINT. CRACKS,DELAMINATION,AND SPALLS IN BAYS 3,4 IN ALL SPANS.(SEE 5/21/12 INSPECTION REPORT.)
SUPERSTRUCTURE: MINOR TO LIGHT RUST. SOME HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND ON EXTERIOR GIRDERS IN NORTH SPAN.HEAVY SECTION LOSS IN ANGLE BRACING AND LATERAL BRACING CONNECTION PLATES TO GIRDERS UNDER RELIEF JOINT IN SPAN #3 AND SPAN #4.REPAIRS MADE TO RELIEF JOINT,RUST REMOVED PRIMED AND PAINTED,JUNE 2012.
SUBSTRUCTURE: FINE AND LIGHT CRACKS. LIGHT DELAMINATIONS. LIGHT SPALLS IN TOP OF BACKWALLS. HEAVY DEBRIS ON SEATS.
PIERS: FEW FINE CRACKS. LIGHT CRACK IN DOWNSTREAM END OF CAP #5. MINOR SPALLS IN TOP OF #4.

PICTURES: B446.
72. PATCHED AREA OVER RELIEF JOINT.

Inspection Date: 05/21/2012 **Inspector:** NJL

Deck: 4 Poor
Super: 5 Fair
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

NJL inspection comments -
DECK: ASPHALT- CRACKED OVER RELIEF JOINTS. FEW CRACKS IN PAVEMENT OVER DELAMINATIONS. CURBS- CRACKS AND LIGHT TO MODERATE SPALLS WITH SEVERAL GRANITE SECTIONS LOOSENED. CURB STONES LOOSE AT NORTH. RAIL- RUSTED, MINOR SECTION LOSS. PAINT FLAKED AND PEELED. LIGHT TRANSITION RAIL DAMAGE. BOTTOM ANGLE BRACE BROKEN. JOINT- TWELVE BROKEN FINGERS AT NORTH EXPANSION JOINT, WITH ONE CRACKED. SOFFIT- CRACKS, LIGHT EFFLORESCENCE AND STAINS. MODERATE TO HEAVY DELAMINATIONS AT BAYS 2,3 AND 4 THROUGH MOST SPANS. SPALLS WITH REBAR EXPOSED IN AREAS. SOME LIGHT LEAKING EVIDENT AT CURBLINE, RELIEF JOINTS AND IN FEW AREAS IN NORTH SPAN. SEVERAL FORMS IN PLACE FROM DECK REPAIRS.
SUPERSTRUCTURE: MINOR TO LIGHT RUST. SOME HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND ON EXTERIOR GIRDERS IN NORTH SPAN. PAINT CRACKED AND PEELING. SEVERAL LOOSE BRACING FRAME BOLTS. HEAVY SECTION LOSS IN ANGLE BRACING AND LATERAL BRACING CONNECTION PLATES TO GIRDERS UNDER RELIEF JOINT IN SPAN #3 AND SPAN #4. DEBRIS BUILD-UP AT ABUTMENT BEARINGS WITH SECTION LOSS ON ANCHOR BOLTS. INTERIOR ROCKERS AT NORTH LIFTED SLIGHTLY DUE TO PACK RUST AND DEBRIS. ROCKERS TIPPED BACK TO NEAR FULL EXPANSION AT NORTH AND TIPPED SLIGHTLY TO SOUTH AT PIERS #1 #2 #4 AND #5.
SUBSTRUCTURE: FINE AND LIGHT CRACKS. LIGHT DELAMINATIONS. LIGHT SPALLS IN TOP OF BACKWALLS. MODERATE SPALLS IN SOUTH FOOTER. HEAVY DEBRIS ON SEATS.
PIERS: FEW FINE CRACKS. LIGHT CRACK IN DOWNSTREAM END OF CAP #5. MINOR SPALLS IN TOP OF #4.

PICTURE DESCRIPTION IN STRUCTURE NOTES.

Inspection History:

Inspection Date: 12/29/2011 **Inspector:** NJL

Deck: 5 Fair
Super: 5 Fair
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

NJL inspection comments -
DECK: ASPHALT- NEW. CURBS- CRACKS AND LIGHT TO MODERATE SPALLS WITH SEVERAL STONES LOOSENED. RAIL- RUSTED, MINOR SECTION LOSS. PAINT FLAKED AND PEELED. LIGHT TRANSITION RAIL DAMAGE. BOTTOM ANGLE BRACE BROKEN. JOINT- TWELVE MISSING OR BROKEN FINGERS AT NORTH EXPANSION JOINT. SOFFIT-CRACKS, LIGHT EFFLORESCENCE AND STAINS. MODERATE TO HEAVY DELAMINATIONS. SOME LIGHT LEAKING EVIDENT AT CURBLINE AND RELIEF JOINTS AND IN FEW AREAS IN NORTH SPAN. SEVERAL FORMS IN PLACE FROM DECK REPAIRS.
SUPERSTRUCTURE: MINOR TO LIGHT RUST. SOME HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND ON EXTERIOR GIRDERS IN NORTH SPAN. PAINT CRACKED AND PEELING. SEVERAL LOOSE BRACING FRAME BOLTS. HEAVY SECTION LOSS IN ANGLE BRACING AND LATERAL BRACING CONNECTION PLATES TO GIRDERS UNDER RELIEF JOINT IN SPAN #3 AND SPAN #4. DEBRIS BUILD-UP AT ABUTMENT BEARINGS WITH SECTION LOSS ON ANCHOR BOLTS. INTERIOR ROCKERS AT NORTH LIFTED SLIGHTLY DUE TO PACK RUST AND DEBRIS. ROCKERS TIPPED BACK TO NEAR FULL EXPANSION AT NORTH AND TIPPED SLIGHTLY TO SOUTH AT PIERS #1 #2 #4 AND #5.
SUBSTRUCTURE: FINE AND LIGHT CRACKS. LIGHT DELAMINATIONS. LIGHT SPALLS IN TOP OF BACKWALLS. MODERATE SPALLS IN SOUTH FOOTER. HEAVY DEBRIS ON SEATS.
PIERS: FEW FINE CRACKS. LIGHT CRACK IN DOWNSTREAM END OF CAP #5. MINOR SPALLS IN TOP OF #4.

PICTURES: B417.
53 THRU 72 OF ANGLE BRACING, LATERAL BRACING CONNECTIONS, STIFFNERS, SCALE ON LOWER WEBS IN SPAN # 3 AND SPAN # 4 UNDER RELIEF JOINTS.

Inspection Date: 12/12/2011 **Inspector:** MTC

Deck: 5 Fair
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MTC: inspection comments -
RAIL: RUSTED, MINOR SECTION LOSS. PAINT FLAKED AND PEELED. LIGHT TRANSITION RAIL DAMAGE.BOTTOM ANGLE BRACE BROKEN.
DECK: CRACKS, LIGHT EFFLORESCENCE AND STAINS. MODERATE TO HEAVY DELAMINATIONS. SOME LIGHT LEAKING EVIDENT AT CURBLINE AND RELIEF JOINTS, AND IN FEW AREAS IN NORTH SPAN. SEVERAL FORMS IN PLACE FROM DECK REPAIRS. ASPHALT-NEW. CRACKS AND LIGHT TO MODERATE SPALLS IN CURBS WITH SEVERAL STONES LOOSENED. TWELVE MISSING OR BROKEN FINGERS AT NORTH EXPANSION JOINT.
SUPERSTRUCTURE: MINOR TO LIGHT RUST. SOME HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND ON EXTERIOR GIRDERS IN NORTH SPAN. PAINT CRACKED AND PEELING. SEVERAL LOOSE BRACING FRAME BOLTS. HEAVY SECTION LOSS IN ANGLE BRACING AND GUSSET AT EXTERIOR GIRDERS UNDER RELIEF JOINT IN SPAN #3 AND SPAN #4. DEBRIS BUILD-UP AT ABUTMENT BEARINGS WITH SECTION LOSS ON ANCHOR BOLTS. INTERIOR ROCKERS AT NORTH LIFTED SLIGHTLY DUE TO PACK RUST AND DEBRIS. ROCKERS TIPPED BACK TO NEAR FULL EXPANSION AT NORTH AND TIPPED SLIGHTLY TO SOUTH AT PIERS #1 #2 #4 AND #5.
SUBSTRUCTURE: FINE AND LIGHT CRACKS. LIGHT DELAMINATIONS. LIGHT SPALLS IN TOP OF BACKWALLS. MODERATE SPALLS IN SOUTH FOOTER. HEAVY DEBRIS ON SEATS.
PIERS: FEW FINE CRACKS. LIGHT CRACK IN DOWNSTREAM END OF CAP #5. MINOR SPALLS IN TOP OF #4.HEAVY DEBRIS BUILD-UP AT PIER #4.

PICTURES: B416.
52.SOUTH ABUTMENT DEBRIS BUILD-UP.
53.SPALL WITH REBAR EXPOSED AT SPAN 1 BAY 2.
54.CROSS BRACING RUSTED AT SPAN #1 BAY #1
55.DELAMINATION AND SPALL AT SPAN 2 BAY 3
56.CROSS BRACING RUSTED AT SPAN #3 BAY #4
57.DELAMINATION AND SPALL AT SPAN #5 BAY #4.

Inspection History:

Inspection Date: 08/29/2011 **Inspector:** MTC

Deck: 5 Fair
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

*MTC: inspection comments - * HIGH WATER INSPECTION:8/29/11 DEBRIS AT #4 PIER.**
RAIL: RUSTED, MINOR SECTION LOSS. PAINT FLAKED AND PEELED. LIGHT TRANSITION RAIL DAMAGE.
DECK: CRACKS, LIGHT EFFLORESCENCE AND STAINS. MODERATE TO HEAVY DELAMINATIONS. SOME LIGHT LEAKING EVIDENT AT CURBLINE AND RELIEF JOINTS, AND IN FEW AREAS IN NORTH SPAN. SEVERAL FORMS IN PLACE FROM DECK REPAIRS. ASPHALT- WHEEL RUTS AND SHORT, LIGHT CRACKS IN PAVEMENT WITH SEVERAL SMALL AREAS DELAMINATING. ONE QUICK SET PATCH BREAKING UP OVER SPAN 3. CRACKS AND LIGHT TO MODERATE SPALLS IN CURBS WITH SEVERAL STONES LOOSENED. TWELVE MISSING OR BROKEN FINGERS AT NORTH EXPANSION JOINT. FEW DRAINS PLUGGED.
SUPERSTRUCTURE: MINOR TO LIGHT RUST. SOME HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND ON EXTERIOR GIRDERS IN NORTH SPAN. PAINT CRACKED AND PEELING. SEVERAL LOOSE BRACING FRAME BOLTS. HEAVY SECTION LOSS IN ANGLE BRACING AND GUSSET AT EXTERIOR GIRDERS UNDER RELIEF JOINT IN SPAN #3. DEBRIS BUILD-UP AT ABUTMENT BEARINGS WITH SECTION LOSS ON ANCHOR BOLTS. INTERIOR ROCKERS AT NORTH LIFTED SLIGHTLY DUE TO PACK RUST AND DEBRIS. ROCKERS TIPPED BACK TO NEAR FULL EXPANSION AT NORTH AND TIPPED SLIGHTLY TO SOUTH AT PIERS #4 AND #5.
SUBSTRUCTURE: FINE AND LIGHT CRACKS. LIGHT DELAMINATIONS. LIGHT SPALLS IN TOP OF BACKWALLS. MODERATE SPALLS IN SOUTH FOOTER. HEAVY DEBRIS ON SEATS.
PIERS: FEW FINE CRACKS. LIGHT CRACK IN DOWNSTREAM END OF CAP #5. MINOR SPALLS IN TOP OF #4.

PICTURES: B408.
1.DEBRIS AT PIER #4.
2.NORTH VIEW OF HIGH WATER.

Inspection Date: 06/13/2011 **Inspector:** MTC

Deck: 5 Fair
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MTC: inspection comments -
RAIL: RUSTED, MINOR SECTION LOSS. PAINT FLAKED AND PEELED. LIGHT TRANSITION RAIL DAMAGE.
DECK: CRACKS, LIGHT EFFLORESCENCE AND STAINS. MODERATE TO HEAVY DELAMINATIONS. SOME LIGHT LEAKING EVIDENT AT CURBLINE AND RELIEF JOINTS, AND IN FEW AREAS IN NORTH SPAN. SEVERAL FORMS IN PLACE FROM DECK REPAIRS. ASPHALT- WHEEL RUTS AND SHORT, LIGHT CRACKS IN PAVEMENT WITH SEVERAL SMALL AREAS DELAMINATING. ONE QUICK SET PATCH BREAKING UP OVER SPAN 3. CRACKS AND LIGHT TO MODERATE SPALLS IN CURBS WITH SEVERAL STONES LOOSENED. TWELVE MISSING OR BROKEN FINGERS AT NORTH EXPANSION JOINT. FEW DRAINS PLUGGED.
SUPERSTRUCTURE: MINOR TO LIGHT RUST. SOME HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND ON EXTERIOR GIRDERS IN NORTH SPAN. PAINT CRACKED AND PEELING. SEVERAL LOOSE BRACING FRAME BOLTS. HEAVY SECTION LOSS IN ANGLE BRACING AND GUSSET AT EXTERIOR GIRDERS UNDER RELIEF JOINT IN SPAN #3. DEBRIS BUILD-UP AT ABUTMENT BEARINGS WITH SECTION LOSS ON ANCHOR BOLTS. INTERIOR ROCKERS AT NORTH LIFTED SLIGHTLY DUE TO PACK RUST AND DEBRIS. ROCKERS TIPPED BACK TO NEAR FULL EXPANSION AT NORTH AND TIPPED SLIGHTLY TO SOUTH AT PIERS #4 AND #5.
SUBSTRUCTURE: FINE AND LIGHT CRACKS. LIGHT DELAMINATIONS. LIGHT SPALLS IN TOP OF BACKWALLS. MODERATE SPALLS IN SOUTH FOOTER. HEAVY DEBRIS ON SEATS.
PIERS: FEW FINE CRACKS. LIGHT CRACK IN DOWNSTREAM END OF CAP #5. MINOR SPALLS IN TOP OF #4.

PICTURES: B399-3.
3.MODERATE DELAMINATIONS AT NORTH NEAR FINGER JOINT TPYICAL OF SEVERAL AREAS.

Inspection History:

Inspection Date: 03/19/2009 **Inspector:** FNM

Deck: 5 Fair
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

FNM inspection comments -
RAIL: RUSTED, MINOR SECTION LOSS. PAINT FLAKED AND PEELED. LIGHT TRANSITION RAIL DAMAGE.
DECK: CRACKS, LIGHT EFFLORESCENCE AND STAINS. MODERATE TO HEAVY DELAMINATIONS. SOME LIGHT LEAKING EVIDENT AT CURBLINE AND RELIEF JOINTS, AND IN FEW AREAS IN NORTH SPAN. SEVERAL FORMS IN PLACE FROM DECK REPAIRS.
ASPHALT- WHEEL RUTS AND SHORT, LIGHT CRACKS IN PAVEMENT WITH SEVERAL SMALL AREAS DELAMINATING. ONE QUICK SET PATCH BREAKING UP OVER SPAN 3.
CRACKS AND LIGHT TO MODERATE SPALLS IN CURBS WITH SEVERAL STONES LOOSENED. SIX BROKEN FINGERS AT NORTH EXPANSION JOINT. FEW DRAINS PLUGGED.
SUPER: MINOR TO LIGHT RUST. SOME HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND ON EXTERIOR GIRDERS IN NORTH SPAN. PAINT CRACKED AND PEELING. SEVERAL LOOSE BRACING FRAME BOLTS. HEAVY SECTION LOSS IN ANGLE BRACING AND GUSSET AT EXTERIOR GIRDERS UNDER RELIEF JOINT IN SPAN #3.
DEBRIS BUILD-UP AT ABUTMENT BEARINGS WITH SECTION LOSS ON ANCHOR BOLTS.
INTERIOR ROCKERS AT NORTH LIFTED SLIGHTLY DUE TO PACK RUST AND DEBRIS.
ROCKERS TIPPED BACK TO NEAR FULL EXPANSION AT NORTH AND TIPPED SLIGHTLY TO SOUTH AT PIERS #4 AND #5.
SUB: FINE AND LIGHT CRACKS. LIGHT DELAMINATIONS. LIGHT SPALLS IN TOP OF BACKWALLS. MODERATE SPALLS IN SOUTH FOOTER. HEAVY DEBRIS ON SEATS.
PIERS: FEW FINE CRACKS. LIGHT CRACK IN DOWNSTREAM END OF CAP #5. MINOR SPALLS IN TOP OF #4.

PICTURES: B360-
12. QUICK SET PATCH BREAKING UP OVER SPAN 3.
13. FINGER CRACKED AT NORTH EXPANSION JOINT. (SIX MISSING)

Inspection Date: 05/08/2007 **Inspector:** BEP

Deck: 5 Fair
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

BEP inspection comments -
RAIL: RUSTED, PAINT FLAKED AND PEELED. LIGHT TRANSITION RAIL DAMAGE.
DECK: CRACKS, LIGHT EFFLORESCENCE AND STAINS. MODERATE TO HEAVY DELAMINATIONS. SOME LIGHT LEAKING EVIDENT AT CURBLINE AND RELIEF JOINTS, AND IN FEW AREAS IN NORTH SPAN. SEVERAL FORMS IN PLACE FROM DECK REPAIRS.
WHEEL RUTS AND SHORT, LIGHT CRACKS IN PAVEMENT WITH SEVERAL SMALL AREAS DELAMINATING. CRACKS AND LIGHT TO MODERATE SPALLS IN CURBS WITH SEVERAL STONES LOOSENED. SIX BROKEN FINGERS AT NORTH EXPANSION JOINT. FEW DRAINS PLUGGED.
SUPER: MINOR TO LIGHT RUST. SOME HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND ON EXTERIOR GIRDERS IN NORTH SPAN. PAINT CRACKED AND PEELING. SEVERAL LOOSE BRACING FRAME BOLTS. HEAVY SECTION LOSS IN ANGLE BRACING AND GUSSET AT EXTERIOR GIRDERS UNDER RELIEF JOINT IN SPAN #3.
DEBRIS BUILD-UP AT ABUTMENT BEARINGS WITH SECTION LOSS ON ANCHOR BOLTS.
INTERIOR ROCKERS AT NORTH LIFTED SLIGHTLY DUE TO PACK RUST AND DEBRIS.
ROCKERS TIPPED BACK TO NEAR FULL EXPANSION AT NORTH AND TIPPED SLIGHTLY TO SOUTH AT PIERS #4 AND #5.
SUB: FINE AND LIGHT CRACKS. LIGHT DELAMINATIONS. LIGHT SPALLS IN TOP OF BACKWALLS. MODERATE SPALLS IN SOUTH FOOTER. HEAVY DEBRIS ON SEATS.
PIERS: FEW FINE CRACKS. LIGHT CRACK IN DOWNSTREAM END OF CAP #5. MINOR SPALLS IN TOP OF #4.

PICTURE A220-
20: HEAVY DEBRIS AT INTERIOR BEARINGS ON SOUTH ABUTMENT.
21: TYPICAL OF DECK DELAMINATIONS.
22: SPALL AND FORMWORK UNDER PATCHED AREA IN DECK.
23: TYPICAL OF HEAVY RUSTING UNDER RELIEF JOINT IN SPAN #3. BRACING GUSSET RUSTED THRU AT UPSTREAM GIRDER.
24: HEAVY DEBRIS ON INTERIOR BEARINGS AT NORTH ABUTMENT WITH ROCKERS LIFTED SLIGHTLY DUE TO PACK RUST AND DEBRIS.

Bridge Inspection Report

Inspection History:

Inspection Date: 09/17/2003 **Inspector:** BEP

Deck: 5 Fair
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:
Sufficiency Rating Calculation Accepted by DEP at 07/29/2004 09:41:20
BEP inspection comments -
RAIL: RUSTED, PAINT FLAKED AND PEELED. LIGHT TRANSITION RAIL DAMAGE.
DECK: CRACKS, LIGHT EFFLORESCENCE AND STAINS. MODERATE TO HEAVY DELAMINATIONS. SO

Inspection Date: 06/12/2001 **Inspector:** BEP

Deck: 5 Fair
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:
Sufficiency Rating Calculation Accepted by DEP at 10/15/2002 14:31:19

BEP inspection comments -
RAIL: MODERATE RUSTING. PAINT POOR. NORTH TRANSITIONS DAMAGED.
DECK: CRACKS, LIGHT EFFLORESCENCE, STAINS AND SPALLS WITH AREAS OF LIGHT TO MODERATE L

Inspection Date: 08/09/1999 **Inspector:** WBL

Deck: 5 Fair
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:
LIFT INSPECTION
STEEL ANGLE RAIL: MODERATE RUSTING. PAINT POOR. NORTH TRANSITIONS DAMAGED.
DECK: CRACKS, MEDIUM SPALLS AND DELAMINATIONS. SEVERAL FORMS IN PLACE FROM DECK REPAIRS. MODERATE LEAKING IN AREAS WITH RUST STAINING EVIDENT. FINGER JOIN

Inspection Date: 05/01/1997 **Inspector:** Not Available

Deck: 5 Fair
Super: 7 Good
Substr: 7 Good
Culvert: N N/A (NBI)

Notes:
Sufficiency Rating Calculation Accepted by DEP at 12-23-98 08:05:16

Inspection Date: 04/01/1995 **Inspector:** Not Available

Deck: 6 Satisfactory
Super: 8 Very Good
Substr: 7 Good
Culvert: N N/A (NBI)

Notes:

Inspection Date: 07/01/1993 **Inspector:** Not Available

Deck: 6 Satisfactory
Super: 8 Very Good
Substr: 7 Good
Culvert: N N/A (NBI)

Notes:

Copy Distribution:

- [ ] (2) Bureau of Municipal Hghways
- [ ] (3) Bureau of Municipal Hghways
- [ ] Bureau of Turnpikes
- [x] Border State
- [ ] Bureau of Rail and Transit
- [ ] Army Corps Of Engineers
- [ ] Railroad
- [ ] Dept. of Res. and Econ. Dev.
- [ ] Dept. of Environmental Services
- [ ] USDA Forest Service
- [ ] Bureau of Traffic

Bridge Inspection Report

Lebanon 044/103

Date of Inspection: 11/18/2013
Date Report Sent: 1/28/2014
[✓] Picture taken during inspection
Owner: NHDOT
Bridge also in: Hartford , Vermont

I-89 SB
Over
CONNECTICUT RIVER,NECRR
Vietnam Veteran Memorial
Interstate Bridge Number: 071

Recommended Postings:

Weight: No Posting Required — [✓] Weight Sign OK

Width: Not Required — [✓] Width Sign OK

Primary Height Sign Recommendation: *None*
Optional Centerline Height Sign Rec: *None*

Clearances: (Feet) Over: Under: 37.99 Route:

[✓] Height Signs OK

Condition: State Redlist
Deck: 5 Fair
Superstructure: 4 Poor
Substructure: 6 Satisfactory
Culvert: N N/A (NBI)

Structure Type and Materials:
Number of Spans Main Unit: 6
Number of Approach Spans: 0

Main Span Material and Design Type
Steel Continuous Multiple Beam

Sufficiency Rating: 49.9%
NBI Status: Structurally Deficient

Bridge Rail: Substandard
Rail Transition: Substandard
Bridge Approach Rail: Meets Standards
Approach Rail Ends: Substandard

NH Bridge Type: I Beams w/ Concrete Deck
Deck Type: Concrete, Cast in Place
Wearing Surface: Bituminous
Membrane: Other
Deck Protection: None
Pavement thickness: Not Applicable
Curb Reveal: 8.5 in
Plan Location: 17-4-1

Bridge Dimensions:

Length Maximum Span: 150.0 ft
Left Curb/Sidewalk Width: 0.7 ft
Width Curb to Curb: 30.0 ft
Approach Roadway Width (W/ Shoulders): 40.0 ft

Total Bridge Length: 846.0 ft
Right Curb/Sidewalk Width: 0.7 ft
Total Bridge Width: 35.8 ft
Median: No median
Bridge Skew: 10.00 °

Bridge Service:

Type of Service on Bridge: Highway
Type of Service under: Railroad-waterway
Lanes on bridge: 2
Lanes Under: NA

Year Built: 1966
Year Rebuilt: Not Rebuilt
Detour Length: 1.0 mi

AADT: 19500 Percent Trucks: 9% Year of AADT: 2012
Future AADT: 28860 Year of Future AADT: 2032

Federal or State Definition Bridge:	Fed. Definition Bridge
Roadway Functional Class:	Urban Interstate
New Hampshire Highway System and Class:	Interstate Highway
Eligibility for the National Register of Historic Places:	Not Eligible
Traffic Direction:	One-way traffic

National Bridge Inventory (NBI) Appraisal Ratings:

Deck Geometry:	Minimum Tolerable
Underclearances:	Equal Minimum Criteria
Approach Alignment:	Equal Desirable Criteria
Structural Evaluation:	Minimum Tolerable
Channel/Channel Protection:	Bank Slumping
Waterway Adequacy:	Above Desirable Criteria
Bridge Scour Critical Status:	Critical during floods
Riprap Condition:	Good Condition
Debris Present:	No Debris Present

LIGHT BANK EROSION. SCOUR: REFER TO MOST RECENT DIVE REPORT.
Scour Critical by CHA study. Pile study? TREE DEBRIS AT PIER # 4.

Date of Underwater Inspection: Nov. 2012

AASHTO CoRe Element Condition State Data:

No.	Description	Env.	Material Notes and Condition Notes
14	Concrete Deck - Protected w/ Membrane and Pavement	Severe	*ASPHALT- SEAM AT CENTERLINE. DEICING SYSTEM REMOVED, CRACK SEALED. LOOSENED CURBSTONES. MORTAR CRACKED AND MISSING AT MOST JOINTS. CURBSTONES CRACKED, TIPPED AND MOVED AT NORTHWEST. CONCRETE CORE SAMPLES DRILLED AT SOUTHEAST.*
107	Painted Steel Beam or Girder (Open Web)	Moderate	*PAINT CRACKED WITH LIGHT FLAKING AND PEELING. LIGHT RUST; HEAVY RUST UNDER EXPANSION AND RELIEF JOINTS AND IN AREAS ON EXTERIOR FLANGES.HEAVY RUST AND PITTING AT BEAMS #4 & #5 AT BOTTOM OF WEBS IN SPAN #3 AND BEAMS #1, #4, & #5 AT SPAN #4 UNDER EXPANSION JOINT. 16" VERTICAL CRACK ADJACENT TO 1 1/2 BY 2 1/2 HOLE IN WEB OF GIRDER #1 IN SPAN #3. REPAIRED WITH A PLATES AND BOLTED AT WEB AND BOTTOM FLANGE BY B.O.B.M.*
210	Reinforced Concrete Pier Wall	Moderate	*FEW FINE CRACKS AND MINOR POP OUT SPALLS.*
215	Reinforced Concrete Abutment	Moderate	*LIGHT TO MODERATE CRACKS, MINOR AND LIGHT DELAMINATIONS, PATCHES CRACKED. LIGHT TO MODERATE SPALLS IN BACKWALLS.*
234	Reinforced Concrete Cap	Low	*HAMMERHEADS* *FEW FINE CRACKS; MINOR DELAM IN NORTHWEST CORNER #2.*

No.	Description	Env.	Material Notes and Condition Notes
304	Open Expansion Joint	Severe	*SEVERAL WELDED REPAIRS MADE TO FINGERS ON SOUTH, SIXTEEN MISSING. SOUTH DECKEND SETTLED. HOLED AREA AT SOUTHEAST APPROACH. JOINT WELDS BROKEN, SLAPPING AND HOLLOW SOUNDING. TWO FINGER MISSING ON NORTH AND SLAPPING. RUSTED.*
311	Moveable Bearing (roller, sliding, etc.)	Moderate	*ROCKERS* *HEAVY RUST; SECTION LOSS ON ANCHOR BOLTS AT SOUTH END AND #4 AT NORTH. BEARING #3 LIFTED 1/4 INCH FROM DIRT BUILD UP AT SOUTH. SEVERAL ANCHOR BOLTS APPEAR LIFTED AT PIERS.*
313	Fixed Bearing	Low	*AT CENTER PIER* *LITTLE DETERIORATION.*
334	Coated Metal Bridge Railing	Severe	*** Steel Angle Rail ** PAINTED ANGLE / POSTS WITH GALVN. TRANSITIONS* *MODERATE RUST. LIGHT DAMAGE.*
359	Soffit of Conc Deck or Slab Condition Warning Flag	Severe	*LIGHT TO MODERATE DELAMINATIONS AND LEAKING IN ALL SPANS BAYS 1,2, AND 3. MEDIUM SPALL, REBAR EXPOSED IN SPAN #2, BAY #2. FEW TRANSVERSE CRACKS, MINOR DELAMINATIONS, MINOR SPALLS AT EXTERIORS.*
363	Section Loss Condition Warning Flag	Severe	*INTERIOR BOTTOM FLANGES RUSTED ALONG EDGES UNDER LEAKING DECK RELIEF JOINTS WITH MEASURMENTS AS FOLLOWS - 7/8 INCH GRIDER #1, SPAN #3 AND AND 15/16 INCH GIRDER #5, SPAN #4. 16" VERTICAL CRACK ADJACENT TO 1 1/2 BY 2 1/2 HOLE IN WEB OF GIRDER #1 IN SPAN #3, UNDER RELIEF JOINT.REPAIRED BY B.O.B.M. WITH PLATES AT WEB AND BOTTOM FLANGE.*

No.	Description	Env.	Quantity	Units	State 1	State 2	State 3	State 4	State 5
14	Concrete Deck - Protected w/ Membran	Severe	30,290	(SF)	0 %	100 %	0 %	0 %	0 %
107	Painted Steel Beam or Girder (Open We	Moderate	4,209	(LF)	0 %	70 %	10 %	20 %	0 %
210	Reinforced Concrete Pier Wall	Moderate	131	(LF)	96 %	4 %	0 %	0 %	
215	Reinforced Concrete Abutment	Moderate	180	(LF)	18 %	70 %	12 %	0 %	
234	Reinforced Concrete Cap	Low	171	(LF)	96 %	4 %	0 %	0 %	
304	Open Expansion Joint	Severe	69	(LF)	35 %	33 %	32 %		
311	Moveable Bearing (roller, sliding, etc.)	Moderate	30	(EA)	67 %	33 %	0 %		
313	Fixed Bearing	Low	5	(EA)	90 %	10 %	0 %		
334	Coated Metal Bridge Railing	Severe	1,873	(LF)	0 %	0 %	80 %	20 %	0 %
359	Soffit of Conc Deck or Slab Condition W	Severe	1	(EA)	0 %	0 %	100 %	0 %	0 %
363	Section Loss Condition Warning Flag	Severe	1	(EA)	0 %	100 %	0 %	0 %	

Bridge Notes:
Vietnam Veterans Memorial Bridge (1983, Chapter 362) DEICING SYSTEM INSTALLED IN WEARING SURFACE AT CENTERLINE.
LIFT INSPECTION 9/03.
LIFT INSPECTION 5/07.
LIFT INSPECTION 12/27/11 ADDED TO STATE REDLIST.
B.O.B.M MADE REPAIRS TO RELIEF JOINTS AND REMOVED RUST AND PRIMED AND PAINTED RUSTED BEAMS UNDER RELIEF JOINTS.JUNE OF 2012.

Approach and Roadway Notes: *ASPHALT- NEW 2012. W-BEAM RAIL- LIGHT DAMAGE.*

Inspection History:

Inspection Date: 11/18/2013 **Inspector:** MTC

Deck: 5 Fair
Super: 4 Poor
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MTC - inspection comments -
BRIDGE RAIL: MODERATE RUST.
DECK: ASPHALT SEALED AT CENTERLINE. GRANITE FACING CRACKED AND TIPPED AT NORTHWEST. MORTAR CRACKED, AND MISSING AT MOST JOINTS. CRACKS, DELAMINATIONS, MINOR SPALLS, AND LIGHT LEAKING AT SOFFIT.
SUPERSTRUCTURE: PAINT CRACKED AND FLAKING. HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND EXTERIOR FLANGES. HEAVY RUST AT MOVABLE BEARINGS, ANCHOR BOLTS LIFTED AT SEVERAL PIER BEARINGS.
SUBSTRUCTURE: LIGHT TO MODERATE CRACKS, DELAMINATIONS, AND SPALLS AT ABUTMENTS AND BACKWALLS. LIGHT CRACKS, MINOR SPALLS AT PIERS.

PICTURES: B486
44. CRACKS AND SPALLS AT NORTHWEST WING.

Inspection Date: 07/31/2013 **Inspector:** MHC

Deck: 5 Fair
Super: 4 Poor
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MHC - inspection comments -
POST FLOOD INSPECTION - ALL ELEMENTS APPEAR STABLE.
BRIDGE RAIL: MODERATE RUST.
DECK: ASPHALT SEALED AT CENTERLINE. GRANITE FACING CRACKED AND TIPPED AT NORTHWEST. MORTAR CRACKED, AND MISSING AT MOST JOINTS. CRACKS, DELAMINATIONS, MINOR SPALLS, AND LIGHT LEAKING AT SOFFIT.
SUPERSTRUCTURE: PAINT CRACKED AND FLAKING. HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND EXTERIOR FLANGES. HEAVY RUST AT MOVABLE BEARINGS, ANCHOR BOLTS LIFTED AT SEVERAL PIER BEARINGS.
SUBSTRUCTURE: MINOR TO LIGHT CRACKS, DELAMINATIONS, AND SPALLS AT ABUTMENTS AND BACKWALL'S. LIGHT CRACKS, MINOR SPALLS AT PIERS.

Inspection Date: 06/12/2013 **Inspector:** MTC

Deck: 5 Fair
Super: 4 Poor
Substr: 5 Fair
Culvert: N N/A (NBI)

Notes:

MTC - inspection comments -
BRIDGE RAIL: MODERATE RUST.
DECK: ASPHALT SEALED AT CENTERLINE. GRANITE FACING CRACKED AND TIPPED AT NORTHWEST. MORTAR CRACKED, AND MISSING AT MOST JOINTS. CRACKS, DELAMINATIONS, MINOR SPALLS, AND LIGHT LEAKING AT SOFFIT. LARGE SPALL IN SPAN 2 BAY 2 4' X 3'X 4" IN DEPTH WITH REBAR EXPOSED. RELIEF JOINTS SEALED, LEAKING AT JOINT 1 IN BAY 1 AND EXTERIOR AT WEST.
SUPERSTRUCTURE: PAINT CRACKED AND FLAKING. HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND EXTERIOR FLANGES. HEAVY RUST AT MOVABLE BEARINGS, ANCHOR BOLTS AT ABUTMENTS. BOLTS LIFTED AT SEVERAL PIER BEARINGS.
SUBSTRUCTURE: MINOR TO LIGHT CRACKS, DELAMINATIONS, AND SPALLS AT ABUTMENTS AND BACKWALLS. LIGHT CRACKS, MINOR SPALLS AT PIERS.

PICTURES: B467. 1-14 (SEE PICTURE LIST)

Bridge Inspection Report

Inspection History:

Inspection Date: 03/18/2013 **Inspector:** MHC

Deck: 5 Fair
Super: 4 Poor
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MHC - inspection comments -
BRIDGE RAIL: MODERATE RUST.
DECK: ASPHALT SEALED AT CENTERLINE. GRANITE FACING CRACKED AND TIPPED AT NORTHWEST. MORTAR CRACKED, AND MISSING AT MOST JOINTS. CRACKS, DELAMINATIONS, MINOR SPALLS, AND LIGHT LEAKING AT SOFFIT.
SUPERSTRUCTURE: PAINT CRACKED AND FLAKING. HEAVY RUST UNDER EXPANSION JOINTS, RELIEF JOINTS, AND EXTERIOR FLANGES. HEAVY RUST AT MOVABLE BEARINGS, ANCHOR BOLTS LIFTED AT SEVERAL PIER BEARINGS.
SUBSTRUCTURE: MINOR TO LIGHT CRACKS, DELAMINATIONS, AND SPALLS AT ABUTMENTS AND BACKWALLS. LIGHT CRACKS, MINOR SPALLS AT PIERS.

PICTURES: B454
92. SPALLS BEHIND GRANITE CURBSTONES.
93. GRANITE CURBSTONES CRACKED AND TIPPED AT NORTHWEST.

Inspection Date: 11/27/2012 **Inspector:** JEL

Deck: 5 Fair
Super: 4 Poor
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

JEL inspection comments -
REFER TO STEARNS ENGINEERING UNDERWATER INSPECTIONS 11/27/12

Inspection Date: 11/16/2012 **Inspector:** MTC

Deck: 5 Fair
Super: 4 Poor
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MTC inspection comments -
DECK: ASPHALT- NEW 2012 CURBS- LIGHT TO MODERATE SPALLS, REBAR EXPOSED. SOFFIT- FINE CRACKS, LIGHT LEAKING, MEDIUM SPALLS AND DELAMINATIONS. RELIEF JOINTS REPAIRED AND SEALED AT CURBS. FINGERS JOINT HAS SEVENTEEN MISSING ON SOUTH EXPANSION JOINT, ONE MISSING FINGER ON NORTH.
SUPERSTRUCTURE:PAINT CRACKED WITH LIGHT FLAKING AND PEELING. LIGHT RUST; HEAVY RUST UNDER EXPANSION AND RELIEF JOINTS AND IN AREAS ON EXTERIOR FLANGES REPAIRED AND PRIMED AND PAINT.HEAVY RUST AND PITTING AT BEAMS #4 & #5 AT BOTTOM OF WEBS IN SPAN #3 AND BEAMS #1, #4, & #5 AT SPAN #4 UNDER EXPANSION JOINT. 16" VERTICAL CRACK ADJACENT TO 1 1/2 BY 2 1/2 HOLE IN WEB OF GIRDER #1 IN SPAN #3. REPAIRED WITH A PLATES AND BOLTED AT WEB AND BOTTOM FLANGE BY B.O.B.M.
SUBSTRUCTURE: FINE AND LIGHT CRACKS, MINOR AND LIGHT DELAMINATIONS, PATCHES CRACKED IN ABUTMENTS, SEATS, BACKWALLS AND WINGS. LIGHT AND MEDIUM SPALLS IN BACKWALLS. VERY HEAVY DIRT AND DEBRIS BUILD-UP ON SEATS. FEW FINE CRACKS AND MINOR SCOURING AT WATERLINE AND SMALL POP OUTS AT CONSTRUCTION JOINTS ON PIERS.

Inspection History:

Inspection Date: 05/24/2012 **Inspector:** MTC

Deck: 5 Fair
Super: 4 Poor
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MTC inspection comments -
DECK:SEAM AT CENTERLINE FOR DEICING SYSTEM INSTALLED AT CENTERLINE SEALED.CURBS LIGHT TO MODERATE SPALLS, REBAR EXPOSED.SEVERAL DECK DRAINS PLUGGED WITH DEBRIS. RAIL MODERATE RUST, PAINT POOR, LIGHT DAMAGE. SOFFIT- FINE CRACKS, LIGHT LEAKING, MEDIUM DELAMINATIONS. MODERATE LEAKING AT RELIEF JOINTS. FINGER JOINT SEVERAL WELDED REPAIRS MADE TO FINGERS ON SOUTH, FIFTEEN MISSING AND ONE AT NORTH. PATCHED AREA AT SOUTHEAST APPROACH JOINT LOUD AND HOLLOW SOUNDING.
SUPERSTRUCTURE: LIGHT RUST; HEAVY UNDER RELIEF AND EXPANSION JOINTS. FEW AREAS MINOR SECTION LOSS ON EXTEROIR GIRDER FLANGES WITH HEAVY LOSS ON BRACING GUSSETS AND MEMBERS UNDER RELIEF JOINTS. SMALL AREAS OF HEAVY SECTION LOSS IN WEBS AT WELDED GUSSET PLATE BRACING ATTACHMENTS UNDER RELIEF JOINTS. 16" VERTICAL CRACK ADJACENT TO 1 1/2 BY 2 1/2 HOLE IN WEB OF GIRDER #1 IN SPAN #3 (REPAIRED BY BOBM, BOLTED WEB AND FLANGE PLATES). NEARLY HOLED THROUGH AT SPAN #3 BEAM #5 AT BOTTOM OF WEB NEAR FLANGE. INTERIOR EDGE OF BOTTOM FLANGE RUSTED TO 7/8 INCH IN SAME AREA. BEARINGS- HEAVY RUST ON SOUTH WITH SECTION LOSS ON ANCHOR BOLTS. MODERATE RUST AT NORTH. SOUTH ROCKER #3 LIFTED UP TO 1/4 INCH DUE TO DEBRIS BUILD UP.
SUBSTRUCTURE: FINE AND LIGHT CRACKS, MINOR AND LIGHT DELAMINATIONS, PATCHES CRACKED IN ABUTMENTS, SEATS, BACKWALLS AND WINGS. LIGHT AND MEDIUM SPALLS IN.VERY HEAVY DIRT AND DEBRIS BUILD-UP ON SEATS

PICTURE: B431.
18.DELAMINATION IN BAY 3 SPAN 5.
19.CURB SPALLED AT WEST.
20.DELAMINATION IN SPAN 2 BAY 1.
21SPALL WITH REBAR EXPOSED SPAN 2 BAY 2.
22.BEARINGS # 3,4 DEBRIS COVERED ON SOUTH.
23.JOINT AT SOUTH BROKEN AND SLAPPING.
24.ASPHALT POTHOLED AT SOUTH IN SPAN 3.

Inspection Date: 03/15/2012 **Inspector:** MTC

Deck: 5 Fair
Super: 4 Poor
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MTC inspection comments -
DECK: ASPHALT- SEVERAL CRACKS, LIGHT DEPRESSIONS AND HOLLOW SOUNDING IN AREAS. CRACKED AND DEPRESSED AREA IN SPAN FOUR NEAR CENTERLINE. CURBS- LIGHT TO MODERATE SPALLS, REBAR EXPOSED. HEAVY DIRT AND DEBRIS BUILD UP AT CURBS WITH LOOSENED CURBSTONES. SEVERAL DECK DRAINS PLUGGED WITH DEBRIS. DEICING SYSTEM INSTALLED AT CENTERLINE.SOFFIT- FINE CRACKS, LIGHT LEAKING, MEDIUM DELAMINATIONS. MODERATE LEAKING AT RELIEF JOINTS AT CURBLINES. FINGERS JOINT HAS SEVENTEEN MISSING ON SOUTH EXPANSION JOINT, ONE MISSING FINGER ON NORTH.
SUPERSTRUCTURE:(SEE 12/27/12 REPORT) LIGHT RUST; HEAVY UNDER RELIEF AND EXPANSION JOINTS. FEW AREAS MINOR SECTION LOSS ON EXTEROIR GIRDER FLANGES WITH HEAVY LOSS ON BRACING GUSSETS AND MEMBERS UNDER RELIEF JOINTS. SMALL AREAS OF HEAVY SECTION LOSS IN WEBS AT WELDED GUSSET PLATE BRACING ATTACHMENTS UNDER RELIEF JOINTS. ONE INCH HOLE IN WEB OF GIRDER #1, SPAN #3 AND NEARLY HOLED THROUGH IN SPAN 5 AND INTERIOR EDGES OF BOTTOM FLANGES RUSTED TO 7/8 INCH IN SAME AREA. BEARINGS- HEAVY RUST ON SOUTH WITH SECTION LOSS ON ANCHOR BOLTS. MODERATE RUST AT NORTH. SOUTH ROCKER #3 LIFTED UP TO 1/4 INCH DUE TO DIRT BUILD UP.
SUBSTRUCTURE: FINE AND LIGHT CRACKS, MINOR AND LIGHT DELAMINATIONS, PATCHES CRACKED IN ABUTMENTS, SEATS, BACKWALLS AND WINGS. LIGHT AND MEDIUM SPALLS IN BACKWALLS. VERY HEAVY DIRT AND DEBRIS BUILD-UP ON SEATS. FEW FINE CRACKS AND MINOR SCOURING AT WATERLINE AND SMALL POP OUTS AT CONSTRUCTION JOINTS ON PIERS.

PICTURE: B423.
38. TRAVEL LANE IN SOUTHBOUND LANE SETTLED.

Inspection History:

Inspection Date: 12/27/2011 **Inspector:** MTC

Deck: 5 Fair
Super: 4 Poor
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MTC inspection comments -
DECK:SEAM AT CENTERLINE FOR DEICING SYSTEM INSTALLED AT CENTERLINE SEALED.CURBS LIGHT TO MODERATE SPALLS, REBAR EXPOSED.SEVERAL DECK DRAINS PLUGGED WITH DEBRIS. RAIL MODERATE RUST, PAINT POOR, LIGHT DAMAGE. SOFFIT- FINE CRACKS, LIGHT LEAKING, MEDIUM DELAMINATIONS. MODERATE LEAKING AT RELIEF JOINTS. FINGER JOINT SEVERAL WELDED REPAIRS MADE TO FINGERS ON SOUTH, FIFTEEN MISSING AND ONE AT NORTH. PATCHED AREA AT SOUTHEAST APPROACH JOINT LOUD AND HOLLOW SOUNDING.
SUPERSTRUCTURE: LIGHT RUST; HEAVY UNDER RELIEF AND EXPANSION JOINTS. FEW AREAS MINOR SECTION LOSS ON EXTEROIR GIRDER FLANGES WITH HEAVY LOSS ON BRACING GUSSETS AND MEMBERS UNDER RELIEF JOINTS. SMALL AREAS OF HEAVY SECTION LOSS IN WEBS AT WELDED GUSSET PLATE BRACING ATTACHMENTS UNDER RELIEF JOINTS. 16" VERTICAL CRACK ADJACENT TO 1 1/2 BY 2 1/2 HOLE IN WEB OF GIRDER #1 IN SPAN #3 (REPAIRED BY BOBM, BOLTED WEB AND FLANGE PLATES). NEARLY HOLED THROUGH AT SPAN #3 BEAM #5 AT BOTTOM OF WEB NEAR FLANGE. INTERIOR EDGE OF BOTTOM FLANGE RUSTED TO 7/8 INCH IN SAME AREA. BEARINGS- HEAVY RUST ON SOUTH WITH SECTION LOSS ON ANCHOR BOLTS. MODERATE RUST AT NORTH. SOUTH ROCKER #3 LIFTED UP TO 1/4 INCH DUE TO DEBRIS BUILD UP.
SUBSTRUCTURE: FINE AND LIGHT CRACKS, MINOR AND LIGHT DELAMINATIONS, PATCHES CRACKED IN ABUTMENTS, SEATS, BACKWALLS AND WINGS. LIGHT AND MEDIUM SPALLS IN.VERY HEAVY DIRT AND DEBRIS BUILD-UP ON SEATS

PICTURE: B417.
36.BEAM #4 SPAN 3 RUST AND PITTING.
37.BEAM 5 SPAN 3 EXTERIOR SIDE.
38.BEAM 5 SPAN 3 INTERIOR RUSTED AND PITTING.
39.REPAIRS AT BEAM 1 SPAN 3 EXTERIOR WEB.
40.REPAIRS AT BEAM 1 SPAN 3 INTERIOR WEB.
41.REPAIRS AT BEAM 1 SPAN 3 INTERIOR WEB.
42.BEAM 1 SPAN 4 EXTERIOR WEB RUSTED AND PITTING.
43.BEAM 1 SPAN 3 INTERIOR WEB SCALING
44.BEAM 4 SPAN 4 SCALING.
45.BEAM 5 SPAN 4 RUSTED AND PITTING.
46.BEAM 5 SPAN 4 RUSTED AND PITTING.

Inspection History:

Inspection Date: 12/14/2011 **Inspector:** NJL

Deck: 5 Fair
Super: 5 Fair
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

NJL inspection comments -
DECK: ASPHALT- RESURFACED, SEAM AT CENTERLINE. DEICING SYSTEM INSTALLED AT CENTERLINE, CRACK SEALED. CURBS- LIGHT TO MODERATE SPALLS, REBAR EXPOSED. LOOSENED CURBSTONES FULL LENGTH AT EAST AND WEST. CONCRETE CORE SAMPLES DRILLED AT SOUTHEAST. SEVERAL DECK DRAINS PLUGGED WITH DEBRIS. STEEL ANGLE RAIL- MODERATE RUST, PAINT POOR, LIGHT DAMAGE. SOFFIT- FINE CRACKS, LIGHT LEAKING, MEDIUM DELAMINATIONS. MODERATE LEAKING AT RELIEF JOINTS AT CURBLINES. JOINTS- SEVERAL WELDED REPAIRS MADE TO FINGERS ON SOUTH, FIFTEEN MISSING. PATCHED AREA AT SOUTHEAST APPROACH; JOINT LOUD AND HOLLOW SOUNDING. ONE FINGER MISSING ON NORTH. RUSTED.
SUPERSTRUCTURE: LIGHT RUST; HEAVY UNDER RELIEF AND EXPANSION JOINTS. FEW AREAS MINOR SECTION LOSS ON EXTEROIR GIRDER FLANGES WITH HEAVY LOSS ON BRACING GUSSETS AND MEMBERS UNDER RELIEF JOINTS. SMALL AREAS OF HEAVY SECTION LOSS IN WEBS AT WELDED GUSSET PLATE BRACING ATTACHMENTS UNDER RELIEF JOINTS. 16" VERTICAL CRACK ADJACENT TO 1 1/2 BY 2 1/2 HOLE IN WEB OF GIRDER #1 IN SPAN #3, UNDER RELIEF JOINT AND NEARLY HOLED THROUGH IN SPAN #5, INTERIOR EDGES OF BOTTOM FLANGES RUSTED TO 7/8 INCH IN SAME AREA. BEARINGS- HEAVY RUST ON SOUTH WITH SECTION LOSS ON ANCHOR BOLTS. MODERATE RUST AT NORTH. SOUTH ROCKER #3 LIFTED UP TO 1/4 INCH DUE TO DIRT BUILD UP.
SUBSTRUCTURE: FINE AND LIGHT CRACKS, MINOR AND LIGHT DELAMINATIONS, PATCHES CRACKED IN ABUTMENTS, SEATS, BACKWALLS AND WINGS. LIGHT AND MEDIUM SPALLS IN BACKWALLS. VERY HEAVY DIRT AND DEBRIS BUILD-UP ON SEATS. FEW FINE CRACKS AND MINOR SCOURING AT WATERLINE AND SMALL POP OUTS AT CONSTRUCTION JOINTS ON PIERS.

PICTURE: B416.
64. BEARING #4 AT NORTH ABUTMENT, NUT RUSTED AND BOLT LIFTED.
65. CROSS BRACING RUSTED AND HOLED AT #5 GIRDER, SPAN #4 UNDER RELIEF JOINT.
66. 16" VERTICAL CRACK ADJACENT TO 1 1/2 BY 2 1/2 HOLE IN WEB OF GIRDER #1 IN SPAN #3.
67. INSIDE VIEW OF CRACK AND HOLE IN GIRDER #1, SPAN #3, UNDER RELIEF JOINT.

Bridge Inspection Report

Inspection History:

Inspection Date: 06/13/2011 **Inspector:** NJL

Deck: 5 Fair
Super: 6 Satisfactory
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

NJL inspection comments -
DECK: ASPHALT- SEVERAL CRACKS, LIGHT DEPRESSIONS AND HOLLOW SOUNDING IN AREAS. CRACKED AND DEPRESSED AREA IN SPAN FOUR NEAR CENTERLINE. CURBS- LIGHT TO MODERATE SPALLS, REBAR EXPOSED. HEAVY DIRT AND DEBRIS BUILD UP AT CURBS WITH LOOSENED CURBSTONES. SEVERAL DECK DRAINS PLUGGED WITH DEBRIS. DEICING SYSTEM INSTALLED AT CENTERLINE. STEEL ANGLE RAIL- MODERATE RUST, PAINT POOR, LIGHT DAMAGE. SOFFIT- FINE CRACKS, LIGHT LEAKING, MEDIUM DELAMINATIONS. MODERATE LEAKING AT RELIEF JOINTS AT CURBLINES. JOINTS- WELDED REPAIRS TO FINGERS WITH THIRTEEN MISSING ON SOUTH EXPANSION JOINT, ONE MISSING FINGER ON NORTH.
SUPERSTRUCTURE: LIGHT RUST; HEAVY UNDER RELIEF AND EXPANSION JOINTS. FEW AREAS MINOR SECTION LOSS ON EXTEROIR GIRDER FLANGES WITH HEAVY LOSS ON BRACING GUSSETS AND MEMBERS UNDER RELIEF JOINTS. SMALL AREAS OF HEAVY SECTION LOSS IN WEBS AT WELDED GUSSET PLATE BRACING ATTACHMENTS UNDER RELIEF JOINTS. ONE INCH HOLE IN WEB OF GIRDER #1, SPAN #3 AND NEARLY HOLED THROUGH IN SPAN 5 AND INTERIOR EDGES OF BOTTOM FLANGES RUSTED TO 7/8 INCH IN SAME AREA. BEARINGS- HEAVY RUST ON SOUTH WITH SECTION LOSS ON ANCHOR BOLTS. MODERATE RUST AT NORTH. SOUTH ROCKER #3 LIFTED UP TO 1/4 INCH DUE TO DIRT BUILD UP.
SUBSTRUCTURE: FINE AND LIGHT CRACKS, MINOR AND LIGHT DELAMINATIONS, PATCHES CRACKED IN ABUTMENTS, SEATS, BACKWALLS AND WINGS. LIGHT AND MEDIUM SPALLS IN BACKWALLS. VERY HEAVY DIRT AND DEBRIS BUILD-UP ON SEATS. FEW FINE CRACKS AND MINOR SCOURING AT WATERLINE AND SMALL POP OUTS AT CONSTRUCTION JOINTS ON PIERS.

PICTURE: B399-
02. NORTHWEST APPROACH IN SOUTHBOUND LANE, CRACKED SETTLED AND PATCHED.

Inspection Date: 03/19/2009 **Inspector:** JEL

Deck: 5 Fair
Super: 6 Satisfactory
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

JEL inspection comments -
STEEL ANGLE RAIL: MODERATE RUST; PAINT POOR; LIGHT DAMAGE.
DECK: FINE CRACKS, LIGHT LEAKING, MEDIUM DELAMINATIONS. CURBS CRACKED WITH MODERATE SPALLS AND LOOSE CURBSTONES. DIRT AND DEBRIS BUILD UP AT CURBS. MODERATE LEAKING AT RELIEF JOINTS AT CURBLINES. WELDED REPAIRS TO FINGERS WITH NINE MISSING ON SOUTH EXPANSION JOINT, ONE MISSING FINGER ON NORTH. FEW CRACKS IN PAVEMENT; SOME SEALED. SEVERAL LOOSENED CURB STONES. MANY SCUPPERS PLUGGED. CRACKED AND DEPRESSED AREA NEAR CENTERLINE SPAN FIVE.
SUPER: LIGHT RUST; HEAVY UNDER RELIEF AND EXPANSION JOINTS. FEW AREAS MINOR SECTION LOSS ON EXTEROIR GIRDER FLANGES WITH HEAVY LOSS ON BRACING GUSSETS AND MEMBERS UNDER RELIEF JOINTS. SMALL AREAS OF HEAVY SECTION LOSS IN WEBS AT WELDED GUSSET PLATE BRACING ATTACHMENTS UNDER RELIEF JOINTS; ONE INCH HOLE IN WEB OF GIRDER #1, SPAN #3 AND NEARLY HOLED THROUGH IN SPAN 5 AND INTERIOR EDGES OF BOTTOM FLANGES RUSTED TO 7/8 INCH IN SAME AREA. HEAVY RUST ON SOUTH BEARINGS WITH SECTION LOSS ON ANCHOR BOLTS; MODERATE RUST ON NORTH BEARINGS. SOUTH ROCKER #3 LIFTED UP TO 1/4 INCH DUE TO DIRT BUILD UP.
SUB: FINE AND LIGHT CRACKS, MINOR AND LIGHT DELAMINATIONS, PATCHES CRACKED IN ABUTMENTS, SEATS, BACKWALLS AND WINGS; LIGHT AND MEDIUM SPALLS IN BACKWALLS. VERY HEAVY DIRT AND DEBRIS BUILD-UP ON SEATS. FEW FINE CRACKS AND MINOR SCOURING AT WATERLINE AND SMALL POP OUTS AT CONSTRUCTION JOINTS ON PIERS.

PICTURES B360-
10: CRACKED AND DEPRESSED AREA NEAR CENTERLINE SPAN FIVE. DRIVING LANE
11: NINE FINGER JOINTS MISSING AT SOUTH DECK END.
12: DIRT AND DEBRIS BUILD UP AT CURBS, TYPICAL.

Inspection History:

Inspection Date: 05/07/2007 **Inspector:** WBL

Deck: 5 Fair
Super: 6 Satisfactory
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

WBL inspection comments -
STEEL ANGLE RAIL: MODERATE RUST; PAINT POOR; LIGHT DAMAGE.
DECK: FINE CRACKS, LIGHT LEAKING, MEDIUM DELAMINATIONS. CURBS CRACKED WITH MODERATE SPALLS AND LOOSE CURBSTONES. MODERATE LEAKING AT RELIEF JOINTS AT CURBLINES. WELDED REPAIRS TO FINGERS WITH FOUR MISSING ON SOUTH EXPANSION JOINT, CRACKED FINGER ON NORTH. FEW CRACKS IN PAVEMENT; SOME SEALED. SEVERAL LOOSENED CURB STONES. MANY SCUPPERS PLUGGED.
SUPER: LIGHT RUST; HEAVY UNDER RELIEF AND EXPANSION JOINTS. FEW AREAS MINOR SECTION LOSS ON EXTEROIR GIRDER FLANGES WITH HEAVY LOSS ON BRACING GUSSETS AND MEMBERS UNDER RELIEF JOINTS. SMALL AREAS OF HEAVY SECTION LOSS IN WEBS AT WELDED GUSSET PLATE BRACING ATTACHMENTS UNDER RELIEF JOINTS; ONE INCH HOLE IN WEB OF GIRDER #1, SPAN #3 AND NEARLY HOLED THROUGH IN SPAN 5 AND INTERIOR EDGES OF BOTTOM FLANGES RUSTED TO 7/8 INCH IN SAME AREA. HEAVY RUST ON SOUTH BEARINGS WITH SECTION LOSS ON ANCHOR BOLTS; MODERATE RUST ON NORTH BEARINGS. SOUTH ROCKER #3 LIFTED UP TO 1/4 INCH DUE TO DIRT BUILD UP.
SUB: FINE AND LIGHT CRACKS, MINOR AND LIGHT DELAMINATIONS, PATCHES CRACKED IN ABUTMENTS, SEATS, BACKWALLS AND WINGS; LIGHT AND MEDIUM SPALLS IN BACKWALLS. VERY HEAVY DIRT AND DEBRIS BUILD-UP ON SEATS. FEW FINE CRACKS AND MINOR SCOURING AT WATERLINE AND SMALL POP OUTS AT CONSTRUCTION JOINTS ON PIERS.

PICTURES A220-
10: TYPICAL HEAVY DIRT BUILD UP AT NORTH ABUTMENT BEARINGS.
11: HEAVY SECTION LOSS TO BRACING FRAME AND GUSSET PLATE, GIRDER #5, SPAN #4 UNDER RELIEF JOINT.
12: GIRDER #1 WEB HOLED AT BRACING FRAME GUSSET PLATE ATTACHMENT, SPAN #3 AT RELIEF JOINT.
13: TYPICAL MODERATE DELAMINATIONS IN UNDERSIDE OF DECK.
14: VERY HEAVY DIRT BUILD UP WITH BEARING #3 LIFTED 1/4 +/- INCH. TYPICAL MODERATE SPALLS IN BACKWALLS.

Inspection Date: 09/17/2003 **Inspector:** WBL

Deck: 5 Fair
Super: 6 Satisfactory
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

Sufficiency Rating Calculation Accepted by DEP at 07/29/2004 09:41:19
WBL inspection comments -
STEEL ANGLE RAIL: MODERATE RUST; PAINT POOR; LIGHT DAMAGE.
DECK: FINE CRACKS, LIGHT LEAKING, MEDIUM DELAMINATIONS. CURBS CRACKED WITH MODERATE SPALLS AND L

Inspection Date: 06/12/2001 **Inspector:** WBL

Deck: 5 Fair
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

Sufficiency Rating Calculation Accepted by DEP at 10/15/2002 14:31:19

WBL inspection comments - WALK AROUND INSPECTION
STEEL ANGLE RAIL: MODERATE RUST; PAINT POOR; LIGHT DAMAGE.
DECK: FINE CRACKS, LIGHT LEAKING, MEDIUM DELAMINATIONS. CURBS CRACK

Inspection Date: 08/10/1999 **Inspector:** BEP

Deck: 5 Fair
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

Sufficiency Rating Calculation Accepted by DEP at 03-24-2000 15:57:18
STEEL ANGLE RAIL: MODERATE RUST; PAINT POOR; LIGHT DAMAGE.
DECK: FINE CRACKS, LIGHT LEAKING, MEDIUM DELAMINATIONS. CURBS CRACKED WITH LIGHT SPALLS AND LOOSE CURBSTONES. MODERATE

Bridge Inspection Report

Inspection History:

Inspection Date: 05/01/1997 **Inspector:** Not Available

Deck: 5 Fair
Super: 7 Good
Substr: 7 Good
Culvert: N N/A (NBI)

Notes:
Sufficiency Rating Calculation Accepted by DEP at 12-23-98 08:05:16

Inspection Date: 04/01/1995 **Inspector:** Not Available

Deck: 6 Satisfactory
Super: 8 Very Good
Substr: 7 Good
Culvert: N N/A (NBI)

Notes:

Inspection Date: 07/01/1993 **Inspector:** Not Available

Deck: 6 Satisfactory
Super: 8 Very Good
Substr: 7 Good
Culvert: N N/A (NBI)

Notes:

Bridge Lighting and Utilities: *DEICING SYSTEM INSTALLED IN PAVEMENT AT CENTERLINE.*

Copy Distribution:

- [ ] (2) Bureau of Municipal Hghways
- [ ] (3) Bureau of Municipal Hghways
- [ ] Bureau of Turnpikes
- [x] Border State
- [ ] Bureau of Rail and Transit
- [ ] Army Corps Of Engineers
- [ ] Railroad
- [ ] Dept. of Res. and Econ. Dev.
- [ ] Dept. of Environmental Services
- [ ] USDA Forest Service
- [ ] Bureau of Traffic

Form 4

N.H. D.O.T.

BRIDGE CAPACITY SUMMARY

TOWN: LEBANON

BRIDGE NUMBER: 044/103

DESIGN LOAD: H20-S16 | DESIGN METHOD: WORKING STRESS | RATED BY: F.S.& T., INC. | DATE: MAY '96

RATING METHOD: LOAD FACTOR DESIGN | PLAN FILE: 39-4-3 / 17-4-1 | CHECKED BY: | DATE:

ROUTE: I-89SB OVER CONNECTICUT RIVER

RATED MEMBER	LONGITUDINAL EFFECTIVE SPAN LENGTH	REQUIRED CAPACITY			AVAILABLE CAPACITY					
		CURRENT	CERTIFIED VEHICLES		MULTIPLE LANES LOADED			SINGLE LANE LOADED		
		LEGAL LOADS	SINGLE UNIT	MULTIPLE UNIT	INVENTORY	OPERATING	POSTING	INVENTORY	OPERATING	POSTING
SPAN 1										
DECK	1'-0"	HS 14.0	HS 15.4	HS 15.4	HS 20.7	HS 34.6	HS 31.1	HS 20.7	HS 34.6	HS 31.1
GIRDER (Flexure)	120'-0"	HS 20.2	HS 22.6	HS 26.4	HS 24.6	HS 41.1	HS 37.0	HS 31.3	HS 52.3	HS 47.1
~~GIRDER (Bearing)~~	~~120'-0"~~	~~HS 20.2~~	~~HS 22.6~~	~~HS 26.4~~	~~HS 23.7~~	~~HS 29.5~~	~~HS 28.1~~	~~HS 32.9~~	~~HS 41.0~~	~~HS 39.0~~
SPAN 3										
DECK	1'-0"	HS 14.0	HS 15.4	HS 15.4	HS 20.7	HS 34.6	HS 31.1	HS 20.7	HS 34.6	HS 31.1
GIRDER (Flexure)	150'-0"	HS 19.8	HS 21.8	HS 26.2	HS 25.1	HS 41.9	HS 37.7	HS 31.9	HS 53.3	HS 48.0
~~GIRDER (Bearing)~~	~~150'-0"~~	~~HS 19.8~~	~~HS 21.8~~	~~HS 26.2~~	~~HS 23.3~~	~~HS 29.0~~	~~HS 27.6~~	~~HS 32.3~~	~~HS 40.3~~	~~HS 38.3~~

RECOMMENDED POSTING: NO POSTING REQUIRED

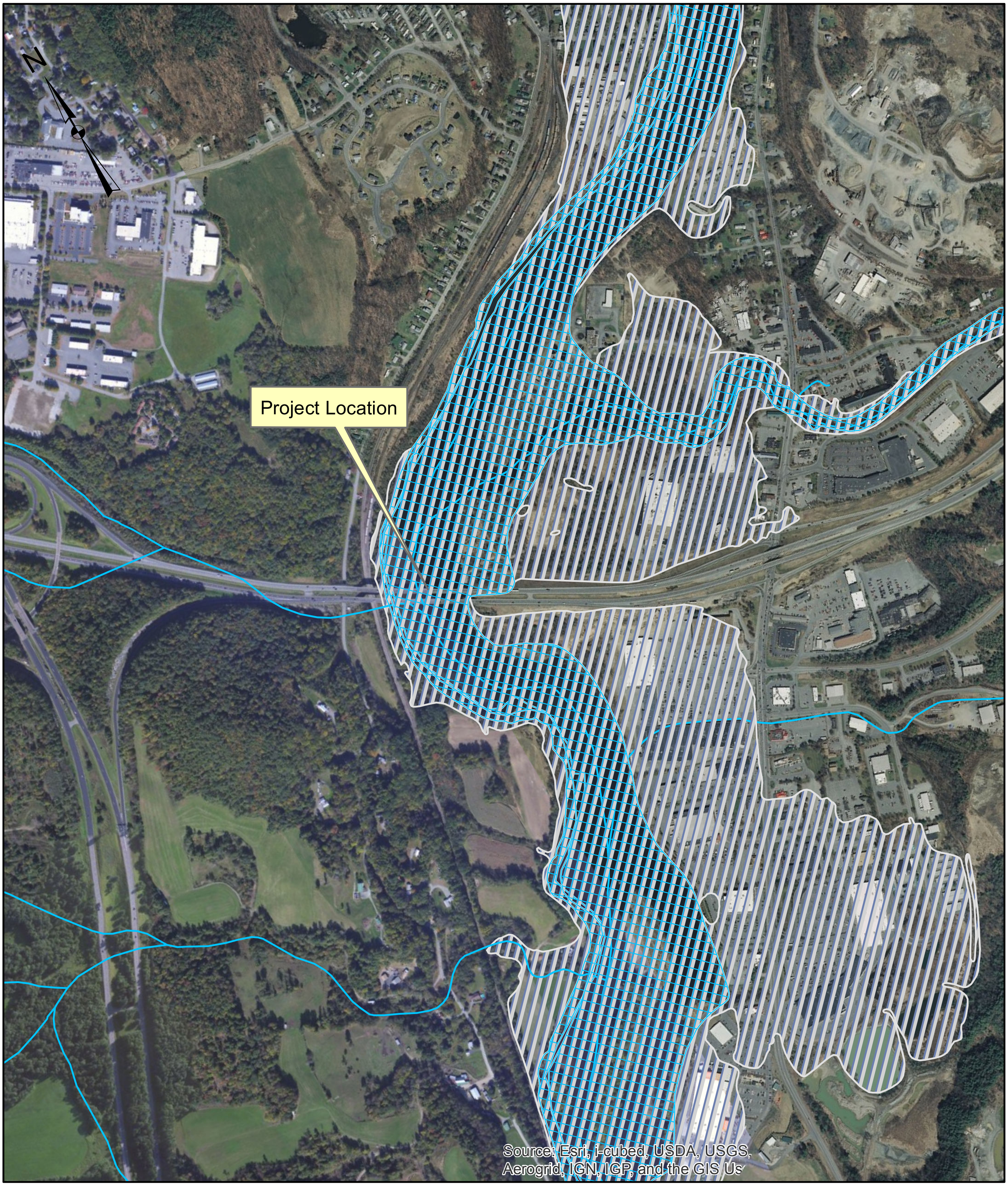
64. (Op.)	~~2 52~~ 62.3
66. (Inv.)	~~2 37~~ 37.3

* GIRDER BEARING DNG PER REVISED CALCS BY NBG 4/22/10.

STATE OF NEW HAMPSHIRE • STEVEN R. WHITE No. 3189 LICENSED PROFESSIONAL ENGINEER

Steven R. White, P.E.
Fay, Spofford & Thorndike, Inc.

APPENDIX C - 1 – FLOODPLAINS GRAPHIC



streams

floodway

100-year floodplain

NHDOT
LEBANON, NH

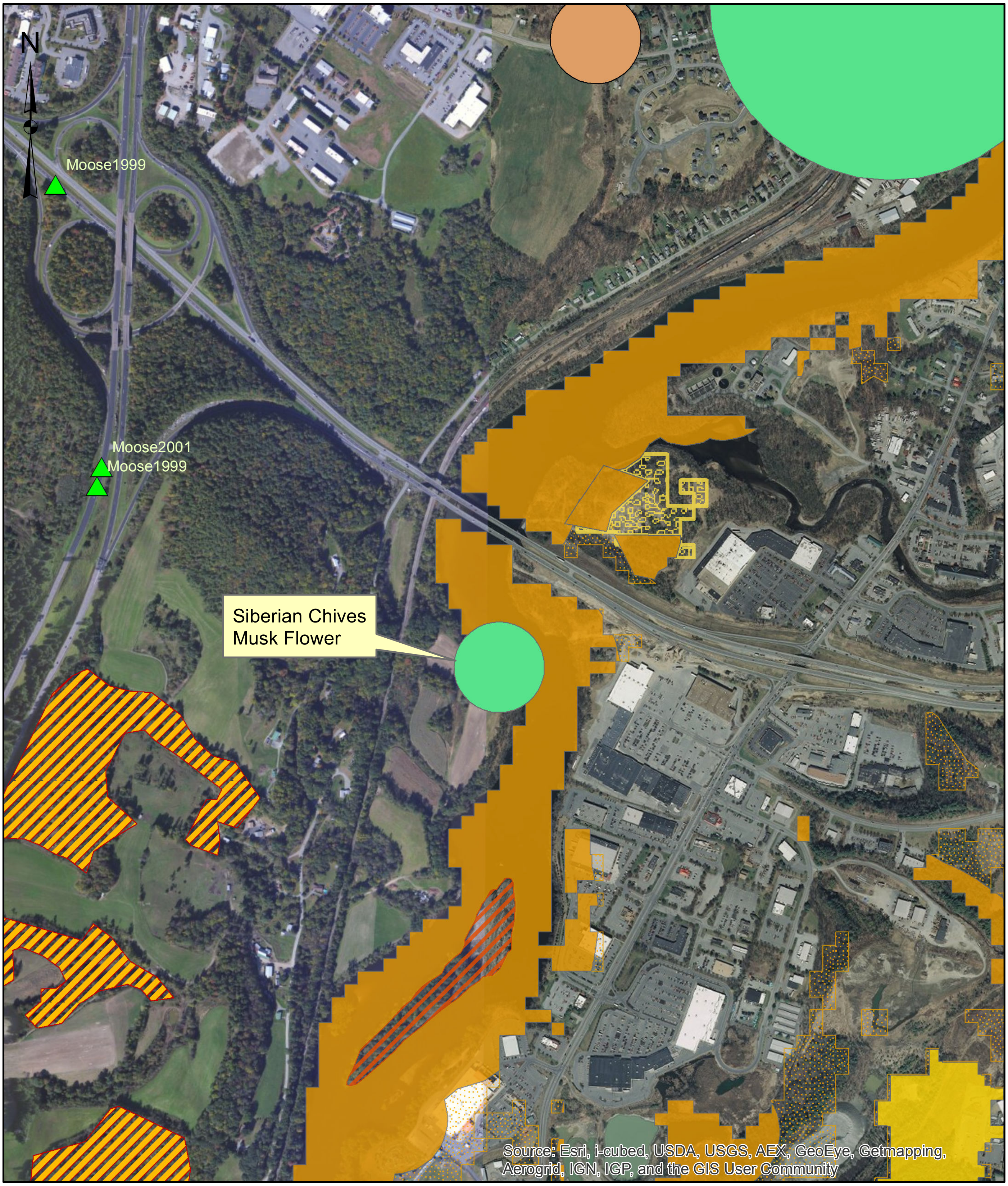
LEBANON, NH - HARTFORD, VT 16148

SCALE :	DATE :	FIGURE :
1:12,000	APRIL 2013	C-1

McFarland Johnson

Path

APPENDIX C - 2 – WILDLIFE HABITAT MAPPING



Vermont Natural Heritage Occurrences

- Animal
- Natural Community
- Plant
- Vermont Roadkill Records

NH Wildlife Action Plan

- Tier 1 EO addin
- Tier 2 Top-ranked in region
- DeerYards
- Tier 3 Matrix forest
- Tier 2 Matrix forest

NHDOT

LEBANON, NH

LEBANON, NH - HARTFORD, VT 16148

SCALE :	DATE :	FIGURE :
1:12,000	APRIL 2013	C-2

McFarland Johnson

Path

APPENDIX C - 3 – NEW HAMPSHIRE FISH AND GAME FISHERIES CORRESPONDENCE

Vicki Chase - RE: I-89 Bridge over the Connecticut River

From: John A Magee <john.magee@wildlife.nh.gov>
To: Vicki Chase <vchase@mjinc.com>
Date: 4/26/2013 4:46 PM
Subject: RE: I-89 Bridge over the Connecticut River
CC: "Gries, Gabriel" <Gabriel.Gries@wildlife.nh.gov>, "Viar, John" <John.Via...

Hi Vicki. The fish species that are known to be there are: walleye, northern pike, eastern chain pickerel, golden shiner, spottail shiner, tessellated darter, American eel, sea lamprey, smallmouth bass, largemouth bass, brown trout, rainbow trout and Atlantic salmon, white sucker, fallfish, bluegill, yellow perch and pumpkinseed sunfish. There are probably other fish species there too, but don't have data on them.

John

John Magee
Fish Habitat Biologist
New Hampshire Fish and Game Department
11 Hazen Drive
Concord, NH 03301
john.a.magee@wildlife.nh.gov
p 603-271-2744

f 603-271-1438

From: Vicki Chase [mailto:vchase@mjinc.com]
Sent: Wednesday, April 24, 2013 4:32 PM
To: John A Magee
Subject: RE: I-89 Bridge over the Connecticut River

Hi John, thanks. I have done the data check - Vermont too. DWM did come up as a hit - then I corresponded with Susi von Oettingen who said it was not a concern - too far away. She also sent me this:

Forgot to suggest this. Go to our IPAC website:

http://ecos.fws.gov/ipac/

You can check for species presence by following procedure. When I highlighted the bridge, notification that no T/E species were present came up. You might be able to print out something for your records and the federal agency that is permitting or funding the work. You should not have to consult with us. You might even want to let NHFG know...

Forgot to suggest this. Go to our IPAC website:

http://ecos.fws.gov/ipac/

You can check for species presence by following procedure. When I highlighted the bridge, notification that no T/E species were present came up. You might be able to print out something for your records and the federal agency that is permitting or funding the work. You should not have to consult with us. You might even want to let NHFG know...

I'll wait to hear from you.

Vicki

Vicki Chase• Environmental Analyst
McFarland Johnson
53 Regional Drive • Concord, NH 03301
Office: 603-225-2978 •
www.mjinc.com

>>> John A Magee <john.magee@wildlife.nh.gov> 4/24/2013 4:03 PM >>>

Hi Vicki. I will check on the fisheries resource and will get back to you next week. I suspect that dwarf wedgemussel will be on the NHB review – have you done the NHB datacheck yet?

Thanks,

John

John Magee
Fish Habitat Biologist
New Hampshire Fish and Game Department
11 Hazen Drive
Concord, NH 03301
john.a.magee@wildlife.nh.gov
p 603-271-2744

f 603-271-1438

From: Vicki Chase [mailto:vchase@mjinc.com]
Sent: Friday, April 19, 2013 3:30 PM
To: John A Magee
Subject: I-89 Bridge over the Connecticut River

Hi John,

McFarland Johnson has been contracted by the NHDOT to provide engineering and permitting services for the rehabilitation of the bridge carrying I-89 over the Connecticut River. To that end , we are requesting information about fisheries resources that may be involved. Rehabilitation options have not yet been developed, but there will likely be work in the water to address scour around the piers, and possibly foundation work on the piers.

Attached is a locus of the bridge.

Thanks for your help.

Vicki

Vicki Chase• Environmental Analyst
McFarland Johnson
53 Regional Drive • Concord, NH 03301
Office: 603-225-2978 •
www.mjinc.com

CONFIDENTIALITY STATEMENT

This message is intended only for the use of the individual or entity to which it is addressed and may contain information that is privileged, confidential and exempt from disclosure under applicable law. If the reader of this message is not the intended recipient or the employee or agent responsible for delivering the message to the intended recipient, YOU ARE HEREBY NOTIFIED that any dissemination, distribution or copying of this communication is strictly prohibited. If you are not the intended recipient of this message, please destroy any printed version and delete this email.

APPENDIX C - 4 – NEW HAMPSHIRE NATURAL HERITAGE DATA CHECK RESULTS

Memo

NH NATURAL HERITAGE BUREAU
NHB DATACHECK RESULTS LETTER

To: Vicki Chase, McFarland Johnson, Inc.
10 Ferry Street, Unit 11, Suite 210
Concord, NH 03301-5022

From: Melissa Coppola, NH Natural Heritage Bureau
Date: 4/17/2013 (valid for one year from this date)
Re: Review by NH Natural Heritage Bureau
NHB File ID: NHB13-1182 Town: Lebanon Location: I-89
Description: Rehabilitation of the bridge carrying I-89 over the Connecticut River.
cc: Kim Tuttle, Susi von Oettingen

As requested, I have searched our database for records of rare species and exemplary natural communities, with the following results.

Comments: This site is within an area flagged for possible impacts on the federally-listed *Alasmidonta heterodon* (dwarf wedgemussel) in Connecticut River.

Invertebrate Species	State[1]	Federal	Notes
Cobblestone Tiger Beetle (*Cicindela marginipennis*)	E	--	Contact the NH Fish & Game Dept (see below).
Dwarf Wedge Mussel (*Alasmidonta heterodon*)	E	E	Contact the NH Fish & Game Dept and the US Fish & Wildlife Service (see below).
Tule Bluet (*Enallagma carunculatum*)	--	--	Contact the NH Fish & Game Dept (see below).

Plant species	State[1]	Federal	Notes
mudflat spikesedge (*Eleocharis intermedia*)*	E	--	

Vertebrate species	State[1]	Federal	Notes
Bald Eagle (*Haliaeetus leucocephalus*)	T	--	Contact the NH Fish & Game Dept (see below).

[1]Codes: "E" = Endangered, "T" = Threatened, "SC" = Special Concern, "--" = an exemplary natural community, or a rare species tracked by NH Natural Heritage that has not yet been added to the official state list. An asterisk (*) indicates that the most recent report for that occurrence was more than 20 years ago.

Contact for all animal reviews: Kim Tuttle, NH F&G, (603) 271-6544. Contact for federally-listed species: Susi von Oettingen, US FWS, at (603) 223-2541.

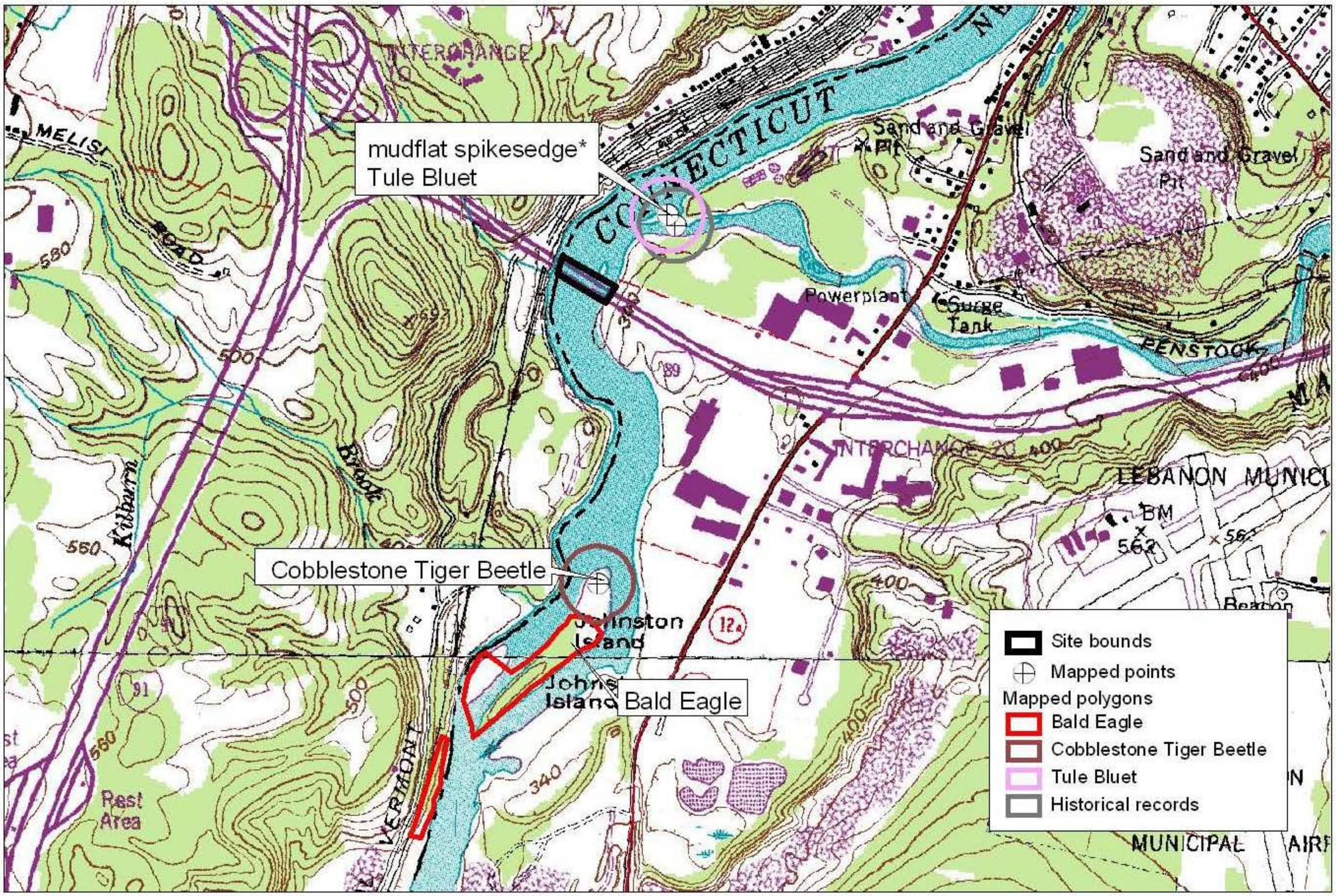
A negative result (no record in our database) does not mean that a sensitive species is not present. Our data can only tell you of known occurrences, based on information gathered by qualified biologists and reported to our office. However, many areas have never been surveyed, or have only been surveyed for certain species. An on-site survey would provide better information on what species and communities are indeed present.

NHB13-1182

NH Natural Heritage Bureau

Known locations of rare species and exemplary natural communities

Note: Mapped locations are not always exact. Occurrences that are not in the vicinity of the project are not shown.



*Historical record

1:15377

Valid for one year from this date: 17 Apr 2013

New Hampshire Natural Heritage Bureau - Animal Record

Cobblestone Tiger Beetle (*Cicindela marginipennis*)

Legal Status		**Conservation Status**	
Federal:	Not listed	Global:	Imperiled due to rarity or vulnerability
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Fair quality, condition and/or landscape context ('C' on a scale of A-D).
Comments on Rank:

Detailed Description: 2007: 18 observed.2006: July 8: 8+ individuals; July 30: estimated 300+ individuals.1993: Population present.1989: 10 Beetles observed.
General Area: Cobblestone portion of island. Between high water and bank.
General Comments:
Management Comments:

Location

Survey Site Name: Johnston Island
Managed By:

County:	Grafton	USGS quad(s):	Hanover (4307263)
Town(s):	Lebanon	Lat, Long:	433737N, 0721941W
Size:	7.9 acres	Elevation:	340 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Between Hartford, VT and West Lebanon, NH on Connecticut River, Johnson's Island.

Dates documented

First reported: 1989 Last reported: 2007-08-07

Hunt, Pam. 2008. E-mail to Jeff Tash with field notes for surveys from 2006 to 2008 of cobblestone tiger beetles at sites along the Connecticut River, dated 11 December.

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

New Hampshire Natural Heritage Bureau - Animal Record

Tule Bluet (*Enallagma carunculatum*)

Legal Status

Federal: Not listed
State: Not listed

Conservation Status

Global: Demonstrably widespread, abundant, and secure
State: Imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Not ranked
Comments on Rank:

Detailed Description: 2006: Area 1: Species observed on 7/30.
General Area:
General Comments:
Management Comments:

Location

Survey Site Name: Mascoma River, mouth of
Managed By: Bascetta

County: Grafton
Town(s): Lebanon
Size: 7.7 acres

USGS quad(s): Hanover (4307263)
Lat, Long: 433810N, 0721933W
Elevation:

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions:

Dates documented

First reported: 2006-07-30
Last reported: 2006-07-30

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

New Hampshire Natural Heritage Bureau - Plant Record

mudflat spikesedge (*Eleocharis intermedia*)

Legal Status		**Conservation Status**	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank:

Detailed Description: 1879: Specimen collected.
General Area:
General Comments:
Management Comments:

Location

Survey Site Name: Mascoma River, mouth of
Managed By: Bascetta

County:	Grafton	USGS quad(s):	Hanover (4307263)
Town(s):	Lebanon	Lat, Long:	433809N, 0721932W
Size:	7.7 acres	Elevation:	

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: 1879: Mouth of Mascoma River.

Dates documented

First reported:	1879-09	Last reported:	1879-09

New Hampshire Natural Heritage Bureau - Animal Record

Bald Eagle (*Haliaeetus leucocephalus*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Threatened	State:	Imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Fair quality, condition and/or landscape context ('C' on a scale of A-D).
Comments on Rank:

Detailed Description: 1998: One adult (male?) starting 12/2/1997, joined by a second (female?) on 1/25/1998.1993: Most perching observed between dam south to Rte. 4. Roosting near Rte. 5/91 intersection in White River Junction. Sightings near Lebanon dump (off Rte. 12a) and off River Road (opposite Ottaqueechee River). 1991: Just 1 bird, perches frequently near dam, roosts in Vermont north of West Lebanon. Same bird has been returning for 8 years.
General Area: 1998: Tall pines on the bank of the Connecticut River, in the vicinity of a dam.
General Comments: 1998: Perch preference indicates that the male may be the same bird that has wintered in this area since 1981-82, and the female may be the same that has shared the area since 1992-93.
Management Comments:

Location

Survey Site Name: Connecticut River, Hanover to Plainfield
Managed By: Mink Brook - South Esker

County:	Sullivan	USGS quad(s):	Hanover (4307263)
Town(s):	Plainfield	Lat, Long:	433457N, 0722144W
Size:	173.5 acres	Elevation:	330 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: From the mouth of the Ompompanoosuc River on the Connecticut River south to the mouth of the Ottauquechee River.

Dates documented

First reported: 1981 Last reported: 1998

Martin, Chris. 2011. Identification of bald eagle wintering habitat based on decades of personal experience.

Cook, Richard A, Christian J. Martin & Laura S. Deming. 1998. New Hampshire Endangered Species Program Status and Management Report. 1 April 1997 - 31 March 1998. Project No. EW-1-16. Prepared by Audubon Society of New Hampshire.

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

APPENDIX C - 5 – RARE SPECIES CORRESPONDENCE WITH NEW HAMPSHIRE FISH AND GAME

Vicki Chase - RE: NHB13-1182 rehabilitation of I-89 bridge Ct. River Lebanon, NH and Hartford, VT

From: "Tuttle, Kim" <Kim.Tuttle@wildlife.nh.gov>
To: Vicki Chase <vchase@mjinc.com>
Date: 4/19/2013 2:42 PM
Subject: RE: NHB13-1182 rehabilitation of I-89 bridge Ct. River Lebanon, NH and Hartford, VT

I can write something more formal once we have the rehabilitation report, with an analysis of rehabilitation alternatives. I don't expect impacts to tiger cobblestone beetle and bluet, but should hear from the biologist who is responsible for them before I respond.

From: Vicki Chase [mailto:vchase@mjinc.com]
Sent: Friday, April 19, 2013 1:38 PM
To: Tuttle, Kim
Subject: Re: NHB13-1182 rehabilitation of I-89 bridge Ct. River Lebanon, NH and Hartford, VT

Thanks Kim, we'll make sure we put something in our documentation to that effect. Do you want to provide something more formal in terms of a response, or should we just say that additional coordination should happen prior to final plan submittals?

Vicki Chase• Environmental Analyst
McFarland Johnson
53 Regional Drive • Concord, NH 03301
Office: 603-225-2978 •
www.mjinc.com
>>> "Tuttle, Kim" <Kim.Tuttle@wildlife.nh.gov> 4/19/2013 11:49 AM >>>

Vicki,

If construction is not slated until 2017, we probably can't provide you anything definite in terms of potential impacts to eagles at this time as the population in that area is steadily increasing i.e. new nests.

Kim

Kim Tuttle
Certified Wildlife Biologist
NH Fish and Game
Nongame and Endangered Species Program
603-271-6544

NH Fish and Game - Protecting Wildlife Since 1935

From: Vicki Chase [mailto:vchase@mjinc.com]
Sent: Friday, April 19, 2013 11:44 AM
To: Tuttle, Kim
Subject: RE: Re: NHB13-1182 dwarf wedge mussel Connecticut River

Construction is slated for 2017.

>>> "Tuttle, Kim" <Kim.Tuttle@wildlife.nh.gov> 4/19/2013 11:36 AM >>>

That would be good. I don't think we will be able to give you anything definite regarding potential impacts to bald eagle at this point. Do you know when they are planning to do the work?

Kim

Kim Tuttle
Certified Wildlife Biologist
NH Fish and Game
Nongame and Endangered Species Program
603-271-6544

NH Fish and Game - Protecting Wildlife Since 1935

From: Vicki Chase [mailto:vchase@mjinc.com]
Sent: Friday, April 19, 2013 11:33 AM
To: Tuttle, Kim
Subject: RE: Re: NHB13-1182 dwarf wedge mussel Connecticut River

At this stage I don't really have anything other than the scope of work which is just to do a rehabilitation of the bridge. They may be adding lanes and widening the bridge, which would require work on the piers. If it would help we can send along the rehabilitation report, with an analysis of rehabilitation alternatives, when it is complete.

Vicki Chase• Environmental Analyst
McFarland Johnson
53 Regional Drive • Concord, NH 03301
Office: 603-225-2978 •
www.mjinc.com

>>> "Tuttle, Kim" <Kim.Tuttle@wildlife.nh.gov> 4/19/2013 11:25 AM >>>

Hi Vicki,

The eagle biologist would like more information on the scope of the job. Do you have a narrative that I could send out?

From: Vicki Chase [mailto:vchase@mjinc.com]
Sent: Friday, April 19, 2013 11:23 AM
To: Tuttle, Kim
Subject: RE: Re: NHB13-1182 dwarf wedge mussel Connecticut River

Thanks Kim I'll wait to hear what the eagle biologist says.

Is there someone else we should consult with about the Cobbblestone Tiger Beetle and the Bluet?

Vicki Chase• Environmental Analyst
McFarland Johnson
53 Regional Drive • Concord, NH 03301
Office: 603-225-2978 •
www.mjinc.com
>>> "Tuttle, Kim" <Kim.Tuttle@wildlife.nh.gov> 4/18/2013 11:08 AM >>>
Great. We will concur with her finding. Once I hear back from eagle biologist, I will be able to respond more formally.
p.s. I didn't know they had an on-line tool either.

From: Vicki Chase [mailto:vchase@mjinc.com]
Sent: Thursday, April 18, 2013 11:03 AM
To: Tuttle, Kim
Subject: Fwd: Re: NHB13-1182 dwarf wedge mussel Connecticut River

Hi Kim - Susi sent this back - see also text from a second email she copied in - I did not realize USFWS had an online tool like Natural Heritage. Very helpful.

Vicki Chase• Environmental Analyst
McFarland Johnson
53 Regional Drive • Concord, NH 03301
Office: 603-225-2978 •
www.mjinc.com
>>> "vonOettingen, Susi" <susi_vonoettingen@fws.gov> 4/18/2013 10:44 AM >>>
Hi Vicki,

Thanks for the email. Yes, the NHB had a hit, but the closest DWM location is at the mouth of the Ottaquechee River. We buffered our site maps and including the buffer, the bridge is still over one mile from the area of DWM concern.

This shouldn't be an issue at all if proper erosion controls are in place.

Susi
++++++++++++++++++++++
Hi again,

Forgot to suggest this. Go to our IPAC website:

http://ecos.fws.gov/ipac/

You can check for species presence by following procedure. When I highlighted the bridge, notification that no T/E species were present came up. You might be able to print out something for your records and the federal agency that is permitting or funding the work. You should not have to consult with us. You might even want to let NHFG know...

Susi
++++++++++++++++++++++++++++++++++++++

On Thu, Apr 18, 2013 at 9:39 AM, Vicki Chase <vchase@mjinc.com> wrote:

Good morning Susi,
McFarland Johnson has been contracted by the NHDOT to provide engineering and permitting services for the rehabilitation of the bridge carrying I-89 over the Connecticut River in Lebanon, NH and Hartford, VT. A data request submitted to the New Hampshire Natural Heritage Bureau yielded a record for the dwarf wedge mussel (Alasmidonta heterodon) in the Connecticut River. We do not yet have design plans for your review, but I wanted to alert you to the project and check to see if you had any preliminary response or requests.
Attached is the NHB response we received.
Thanks for your help.

Vicki Chase• Environmental Analyst
McFarland Johnson
53 Regional Drive • Concord, NH 03301
Office: 603-225-2978 •
www.mjinc.com

--

Susi von Oettingen
Endangered Species Biologist
New England Field Office
70 Commercial Street, Suite 300

Concord, NH 03301
(WO) 603-223-2541 ext. 22
(Cell) 603-491-8219
www.fws.gov/newengland

Celebrate the 40th anniversary of the Endangered Species Act!

CONFIDENTIALITY STATEMENT

This message is intended only for the use of the individual or entity to which it is addressed and may contain information that is privileged, confidential and exempt from disclosure under applicable law. If the reader of this message is not the intended recipient or the employee or agent responsible for delivering the message to the intended recipient, YOU ARE HEREBY NOTIFIED that any dissemination, distribution or copying of this communication is strictly prohibited. If you are not the intended recipient of this message, please destroy any printed version and delete this email.

CONFIDENTIALITY STATEMENT

This message is intended only for the use of the individual or entity to which it is addressed and may contain information that is privileged, confidential and exempt from disclosure under applicable law. If the reader of this message is not the intended recipient or the employee or agent responsible for delivering the message to the intended recipient, YOU ARE HEREBY NOTIFIED that any dissemination, distribution or copying of this communication is strictly prohibited. If you are not the intended recipient of this message, please destroy any printed version and delete this email.

CONFIDENTIALITY STATEMENT

This message is intended only for the use of the individual or entity to which it is addressed and may contain information that is privileged, confidential and exempt from disclosure under applicable law. If the reader of this message is not the intended recipient or the employee or agent responsible for delivering the message to the intended recipient, YOU ARE HEREBY NOTIFIED that any dissemination, distribution or copying of this communication is strictly prohibited. If you are not the intended recipient of this message, please destroy any printed version and delete this email.

CONFIDENTIALITY STATEMENT

This message is intended only for the use of the individual or entity to which it is addressed and may contain information that is privileged, confidential and exempt from disclosure under applicable law. If the reader of this message is not the intended recipient or the employee or agent responsible for delivering the message to the intended recipient, YOU ARE HEREBY NOTIFIED that any dissemination, distribution or copying of this communication is strictly prohibited. If you are not the intended recipient of this message, please destroy any printed version and delete this email.

CONFIDENTIALITY STATEMENT

This message is intended only for the use of the individual or entity to which it is addressed and may contain information that is privileged, confidential and exempt from disclosure under applicable law. If the reader of this message is not the intended recipient or the employee or agent responsible for delivering the message to the intended recipient, YOU ARE HEREBY NOTIFIED that any dissemination, distribution or copying of this communication is strictly prohibited. If you are not the intended recipient of this message, please destroy any printed version and delete this email.

APPENDIX C - 6 – CORRESPONDENCE WITH VERMONT DEPARTMENT OF FISH AND WILDLIFE (NATURAL HERITAGE INVENTORY)

Vicki Chase - RE: Project review

From: "Popp, Bob" <Bob.Popp@state.vt.us>
To: 'Vicki Chase' <vchase@mjinc.com>
Date: 4/18/2013 12:41 PM
Subject: RE: Project review
CC: "Ferguson, Mark" <mark.ferguson@state.vt.us>

Vicki, the 4766 and 1002 Element codes represent two rare plant species (Siberian chives and Musk flower) that were observed on a rock outcrop about 850 ft. downstream of the bridge. Unless there were to be a direct impact to the outcrop, they should not be affected. Element code 4400 represents an uncommon terrestrial species which would not be impacted by bridge work.

Please let me know if you need additional information. You should also be in contact with Mark Ferguson regarding the presence of mussels in the river if you have not already done so.

Thank you for contacting us.

Bob Popp
Department Botanist
VT. Dept of Fish and Wildlife
Natural Heritage Inventory
(802) 476-0127

From: Vicki Chase [mailto:vchase@mjinc.com]
Sent: Wednesday, April 17, 2013 11:07 AM
To: Popp, Bob
Subject: Project review

Good Morning,

McFarland Johnson has been retained by the New Hampshire Department of transportation to provide engineering and permitting services for the rehabilitation of the Lebanon-Hartford bridge carrying I-89 over the Connecticut River. To that end, we are requesting a review of the project area to determine if the proposed action would affect any rare plants or significant natural communities.

Attached please find a map of the proposed project area with Natural Heritage data from VCGI. Bridge rehabilitation plans are not yet available.

Thanks for your help.

Vicki Chase• Environmental Analyst
McFarland Johnson
53 Regional Drive • Concord, NH 03301
Office: 603-225-2978 •
www.mjinc.com

APPENDIX C - 7 – CORRESPONDENCE WITH U.S. FISH AND WILDLIFE SERVICE

Vicki Chase - Re: NHB13-1182 dwarf wedge mussel Connecticut River

From: "vonOettingen, Susi" <susi_vonoettingen@fws.gov>
To: Vicki Chase <vchase@mjinc.com>
Date: 4/18/2013 10:45 AM
Subject: Re: NHB13-1182 dwarf wedge mussel Connecticut River

Hi Vicki,

Thanks for the email. Yes, the NHB had a hit, but the closest DWM location is at the mouth of the Ottaquechee River. We buffered our site maps and including the buffer, the bridge is still over one mile from the area of DWM concern.

This shouldn't be an issue at all if proper erosion controls are in place.

Susi

On Thu, Apr 18, 2013 at 9:39 AM, Vicki Chase <vchase@mjinc.com> wrote:

> Good morning Susi,
> McFarland Johnson has been contracted by the NHDOT to provide engineering and permitting services for the rehabilitation of the bridge carrying I-89 over the Connecticut River in Lebanon, NH and Hartford, VT. A data request submitted to the New Hampshire Natural Heritage Bureau yielded a record for the dwarf wedge mussel (Alasmidonta heterodon) in the Connecticut River. We do not yet have design plans for your review, but I wanted to alert you to the project and check to see if you had any preliminary response or requests.
> Attached is the NHB response we received.
> Thanks for your help.
> **Vicki Chase•** Environmental Analyst
> McFarland Johnson
> 53 Regional Drive • Concord, NH 03301
> Office: 603-225-2978 •
> www.mjinc.com
>
>

--

Susi von Oettingen

Endangered Species Biologist
New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301
(WO) 603-223-2541 ext. 22
(Cell) 603-491-8219
www.fws.gov/newengland

Celebrate the 40th anniversary of the Endangered Species Act!

APPENDIX C - 8 – U.S. FISH AND WILDLIFE SERVICE LIST OF NATURAL RESOURCES OF CONCERN

U.S. Fish and Wildlife Service

Natural Resources of Concern

This resource list is to be used for planning purposes only — it is not an official species list.

Endangered Species Act species list information for your project is available online and listed below for the following FWS Field Offices:

NEW ENGLAND ECOLOGICAL SERVICES FIELD OFFICE
70 COMMERCIAL STREET, SUITE 300
CONCORD, NH 03301
(603) 223-2541
http://www.fws.gov/newengland

Project Name:

Lebanon-Hartford

U.S. Fish and Wildlife Service

Natural Resources of Concern

Project Location Map:

Project Counties:

Grafton, NH | Windsor, VT

Geographic coordinates (Open Geospatial Consortium Well-Known Text, NAD83):

MULTIPOLYGON (((-72.3301225 43.6354367, -72.3265176 43.6339148, -72.3269897 43.6332625, -72.3305087 43.6347844, -72.3301225 43.6354367)))

Project Type:

Bridge Construction / Maintenance

Natural Resources of Concern

Endangered Species Act Species List (USFWS Endangered Species Program).

There are no listed species found within the vicinity of your project.

FWS National Wildlife Refuges (USFWS National Wildlife Refuges Program).

There are no refuges found within the vicinity of your project.

FWS Migratory Birds (USFWS Migratory Bird Program).

Most species of birds, including eagles and other raptors, are protected under the Migratory Bird Treaty Act (16 U.S.C. 703). Bald eagles and golden eagles receive additional protection under the Bald and Golden Eagle Protection Act (16 U.S.C. 668). The Service's Birds of Conservation Concern (2008) report identifies species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become listed under the Endangered Species Act as amended (16 U.S.C 1531 et seq.).

NWI Wetlands (USFWS National Wetlands Inventory).

The U.S. Fish and Wildlife Service is the principal Federal agency that provides information on the extent and status of wetlands in the U.S., via the National Wetlands Inventory Program (NWI). In addition to impacts to wetlands within your immediate project area, wetlands outside of your project area may need to be considered in any evaluation of project impacts, due to the hydrologic nature of wetlands (for example, project activities may affect local hydrology within, and outside of, your immediate project area). It may be helpful to refer to the USFWS National Wetland Inventory website. The designated FWS office can also assist you. Impacts to wetlands and other aquatic habitats from your project may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal Statutes. Project Proponents should discuss the relationship of these requirements to their project with the Regulatory Program of the appropriate U.S. Army Corps of Engineers District.

The following wetlands intersect your project area:

Wetland Types	NWI Classification Code	Approximate Acres
Riverine	R2UBH	2769.132632

APPENDIX C - 9 – NEW HAMPSHIRE DIVISION OF HISTORICAL RESOURCES RESPONSE

Please mail the completed form and required material to:

Cultural Resources Staff
Bureau of Environment
NH Department of Transportation
7 Hazen Drive
Concord, NH 03302

RECEIVED
JAN 23 2013

DHR Use Only	
R&C #	4493
Log In Date	___/___/___
Response Date	___/___/___
Sent Date	___/___/___

Request for Project Review by the New Hampshire Division of Historical Resources for Transportation Projects

☒ This is a new submittal.
☐ This is additional information relating to DHR Review and Compliance (R&C)#:

GENERAL PROJECT INFORMATION

DOT Project Name & Number Interstate 89 Lebanon, NH - Hartford, VT (NH Project #16148)

Brief Descriptive Project Title Rehabilitation and widening of the northbound and southbound bridges (Bridge No.'s 044/104 & 044/103), that carry Interstate Route 89 (I-89) over the Connecticut River between Lebanon, NH and Hartford, VT.

Project Location I-89 at Connecticut River

City/Town Lebanon

Lead Federal Agency and Contact *(if applicable)* FHWA
(Agency providing funds, licenses, or permits)

Permit Type and Permit or Job Reference # A001(154)

DOT Environmental Manager *(if applicable)* Marc Laurin

PROJECT SPONSOR INFORMATION

Project Sponsor Name Bob Landry NHDOT

Mailing Address 7 Hazen Drive Phone Number 6032713921

City Concord State NH Zip 03301 Email RLandry@dot.state.nh.us

CONTACT PERSON TO RECEIVE RESPONSE

Name/Company Vicki Chase / McFarland Johnson

Mailing Address 53 Regional Drive Phone Number -6032252978

City Concord State NH Zip 03301 Email vchase@mjinc.com

Thank You

This form is updated periodically. Please download the current form at http://www.nh.gov/DHR/review. *Please refer to the Request for Project Review for Transportation Projects Instructions for direction on completing this form.* Submit one copy of this project review form for each project for which review is requested. Include a self-addressed stamped envelope to expedite review response. Project submissions will not be accepted via facsimile or e-mail. This form is required. Review request form must be complete for review to begin. Incomplete forms will be sent back to the applicant without comment. Please be aware that this form may only initiate consultation. For some projects, additional information will be needed to complete the Section 106 review. All items and supporting documentation submitted with a review request, including photographs and publications, will be retained by the DHR as part of its review records. Items to be kept confidential should be clearly identified. For

PROJECTS CANNOT BE PROCESSED WITHOUT THIS INFORMATION

Project Boundaries and Description

- ☒ Attach the relevant portion of a 7.5' USGS Map (photocopied or computer-generated) ***indicating the proposed area of potential effect (APE).*** *(See RPR for Transportation Projects Instructions and R&C FAQs for guidance. Note that the APE is subject to approval by lead federal agency and SHPO.)*
- ☒ Attach a detailed narrative description of the proposed project.
- ☐ Attach current engineering plans with tax parcel, landscape, and building references, and areas of proposed excavation, if available.
- ☐ Attach photos of the project area/APE with photo key (overview of project location and area adjacent to project location, and specific areas of proposed impacts and disturbances.) *(Blank photo logs are available on the DHR website. Informative photo captions can be used in place of a photo log.)*
- ☐ A DHR file review must be conducted to identify properties within or adjacent to the APE. Provide file review results in **Table 1**. *(Blank table forms are available on the DHR website.)*
  File review conducted on / / .*

  **The DHR recommends that all survey/National Register nomination forms and their Determination of Eligibility (green) sheets are copied for your use in project development.*

Architecture

Are there any buildings, structures (bridges, walls, culverts, etc.) objects, districts or landscapes within the APE? ☐ Yes ☒ No
If no, skip to Archaeology section. If yes, submit all of the following information:

- ☐ Attach completed **Table 2.**
- ☐ Photographs of ***each*** resource or streetscape located within the APE. Add to the photo key and photo log noted above. (Digital photographs are accepted. All photographs must be clear, crisp and focused.)
- ☐ Copies of National Register boundary (listed *or* eligible) mapping, and add National Register boundaries for listed and eligible properties to the 7.5' USGS project map *(if applicable).*

Archaeology

Does the proposed undertaking involve ground-disturbing activity? ☒ Yes ☐ No
If yes, submit all of the following information:

- ☐ Description of current and previous land use and disturbances.
- ☐ Available information concerning known or suspected archaeological resources within the project area (such as cellar holes, wells, foundations, dams, etc.)

Please note that for many projects an architectural and/or archaeological survey or other additional information may be needed to complete the Section 106 process.

AGENCY COMMENT *This Space for DOT and Division of Historical Resources Use Only*

Sent to DHR; Authorized DOT Signature: [signature] Date: 1/22/2013

☐ Insufficient information to initiate review.

☐ Additional information is needed in order to complete review.

Comments: DHR concurs on archaeological sensitivity assessment - no further review on NH side.

If plans change or resources are discovered in the course of this project, you must contact the Division of Historical Resources as required by federal law and regulation.

Authorized DHR Signature: Edna Feighner Date: 1/24/13

New Hampshire Division of Historical Resources / State Historic Preservation Office
September 2012

APPENDIX D – TRAFFIC ASSESSMENT

RSG INC.
TRANSPORTATION

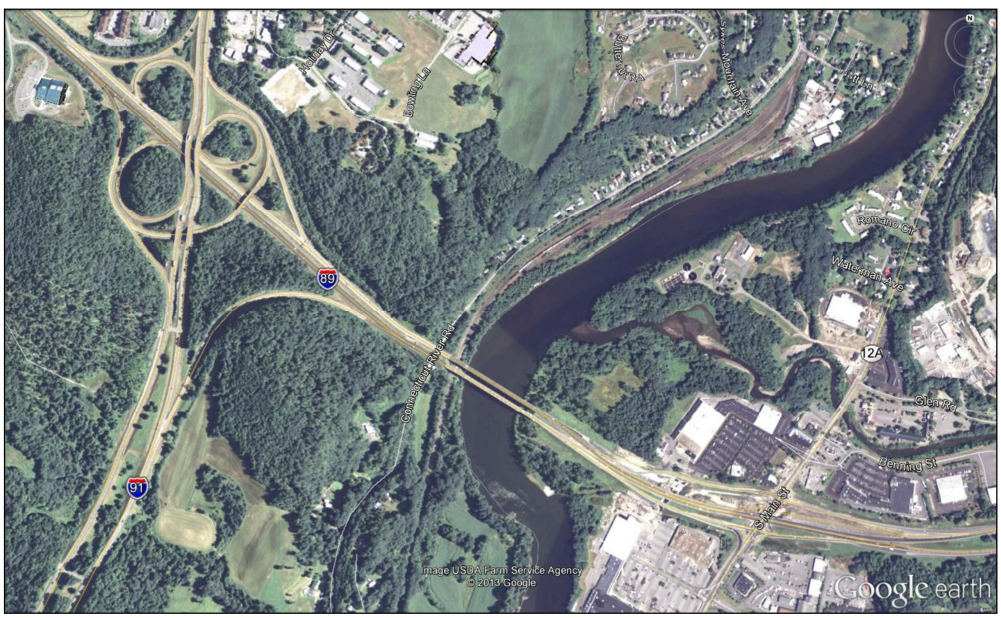
TECHNICAL MEMORANDUM

To: Gene McCarthy, McFarland Johnson
From: David Saladino, P.E.; Ivan Hooper, P.E.
Subject: I-89 Connecticut River Bridge Traffic Assessment
Date: 10 April 2013 *(updated 2 May 2013)*

Introduction

The New Hampshire Department of Transportation (NHDOT) is planning to rehabilitate the I-89 bridges over the Connecticut River on the New Hampshire/Vermont state line (bridge numbers 044/104 and 044/103). The Connecticut River bridges are located along I-89 between two interchanges approximately one mile apart. On the west side in Hartford, Vermont is the I-91 system interchange and on the east side, in Lebanon, New Hampshire, is the NH-12A (Exit 20) service interchange. Figure 1 is an aerial photo of the project study area.

Figure 1. Project Study Area



As part of this bridge rehabilitation project the NHDOT is considering whether bridge deck widening is needed in either or both directions. RSG was tasked with evaluating whether additional lanes on the bridge are justified or not based on an assessment of traffic and safety conditions. The primary reasons for considering bridge widening is the close proximity between the I-91 and Exit 20 ramps and the relatively steep grades on the Vermont side, which lead to sub-optimal merge and weaving areas.

RSG evaluated the bridge and adjacent area for conformity with design standards, existing and forecasted traffic performance, and crash history to develop our recommendation.

55 Railroad Row, White River Junction, Vermont 05001
TEL 802.295.4999 ▪ FAX 802.295.1006 ▪ www.rsginc.com

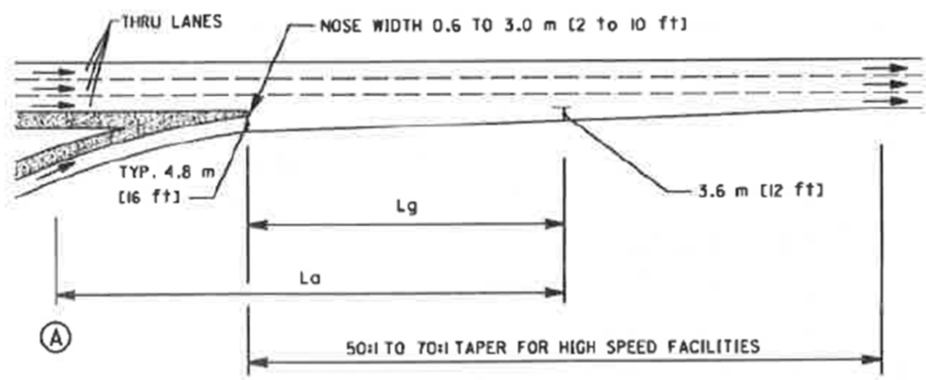
Design Standard Review

Because design standards change over time, a review was conducted of the existing interchanges to determine how well they comply with current design standards, which were taken from *A Policy on Geometric Design of Highways and Streets,*[1] which is commonly referred to as the "Green Book" and is the generally accepted national standard for highway design. The standards consulted in the *Green Book* related to the length of freeway ramp merges and the application of auxiliary lanes.

Freeway Ramp Merges

There are two types of freeway ramp merges described in the *Green Book*. The first is the tapered design wherein the on-ramp gradually tapers into the mainline, typically over a distance of 700 to 1,300 feet depending on a variety of factors, including: the freeway grade, the width of the ramp, and the speed on the ramp. The second type is the parallel design which brings the on-ramp into a short new parallel lane on the freeway that runs for 300 to 800 feet before tapering into the adjacent through lane over an additional 300 or more feet. The same factors are utilized to determine the length of the parallel lane. The freeway on-ramps in the project area are of the tapered type. Figure 2 shows the portion of Figure 10-69 from the *Green Book* that illustrates the various components that go into calculating the required merge distance for a tapered design.

Figure 2. On-Ramp Merge Length Parameters



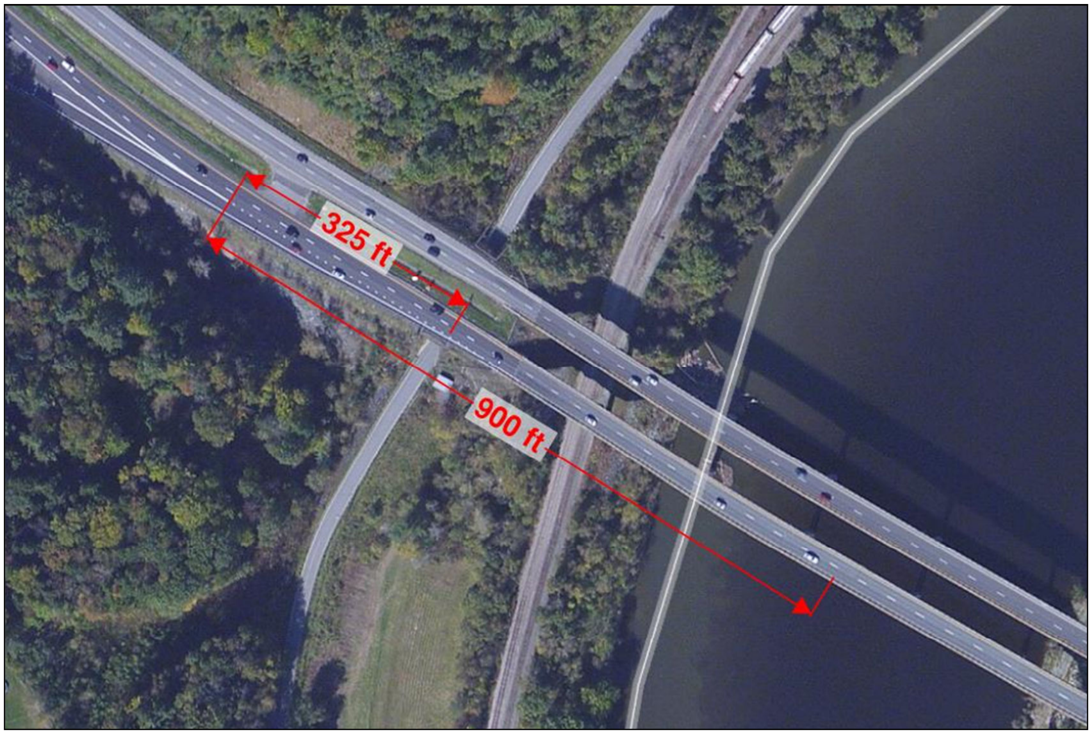
NOTES:

1. La IS THE REQUIRED ACCELERATION LENGTH AS SHOWN IN EXHIBIT 10-70 OR AS ADJUSTED BY EXHIBIT 10-71.
2. POINT (A) CONTROLS SPEED ON THE RAMP. La SHOULD NOT START BACK ON THE CURVATURE OF THE RAMP UNLESS THE RADIUS EQUALS 300 m [1000 ft] OR MORE.
3. Lg IS REQUIRED GAP ACCEPTANCE LENGTH. Lg SHOULD BE A MINIMUM OF 90 TO 150 m [300 to 500 ft] DEPENDING ON THE NOSE WIDTH.
4. THE VALUE OF La OR Lg, WHICHEVER PRODUCES THE GREATER DISTANCE DOWNSTREAM FROM WHERE THE NOSE EQUAL 0.6 m [2 ft], IS SUGGESTED FOR USE IN THE DESIGN OF THE RAMP ENTRANCE.

[1] American Association of State Highway and Transportation Officials (AASHTO), *A Policy on Geometric Design of Highways and Streets*, 6th Edition (Washington DC: AASHTO, 2011).

We performed an analysis on the on-ramp from northbound I-91 to southbound I-89 to compare the required merge distance (per *Green Book* standards) with the actual merge length provided. Assuming that the on-ramp is 16 feet wide with a two foot nose width and a 50:1 taper, then the on-ramp would require 900 feet to fully merge with the mainline. The existing northbound I-91 on-ramp has a merge distance of approximately 325 feet meaning that about 575 additional feet of merge distance are required to meet the current *Green Book* standard. Provision of this additional merge distance would necessitate widening of the I-89 southbound bridge as shown in the figure below.

Figure 3: Existing and Minimum Required Merge Distances (On-Ramp from I-91 Northbound)



Since the on-ramp from NH-12A at Exit 20 was just fully reconstructed, we have assumed that the ramp merge geometry complies with all appropriate design standards and as such did not perform a similar analysis for that ramp.

AUXILIARY LANES

Auxiliary lanes are continuous lanes that connect an on-ramp to an adjacent off-ramp. They are generally utilized when traffic volumes are high or when the distance between ramps is limited. The *Green Book* recommends that auxiliary lanes be utilized when the distance between the on- and off-ramps of adjacent interchange is 1,500 feet or less. The distance between the two study ramps on I-89 southbound is approximately 1,850 feet while the distance between the adjacent I-89 northbound ramps is about 3,000 feet. Per Figure 10-68 in the *Green Book*, the recommended spacing between adjacent on- and off-ramps when the on-ramp is from a system interchange is 2,000 feet. When the on-ramp is a service interchange the recommended spacing is 1,600 feet. Since the southbound on-ramp from I-91 is part of a system interchange the available spacing distance of 1,850 feet is less than the recommended 2,000 feet, which suggests that a southbound auxiliary lane may be applicable between the two interchanges in this direction.

Traffic Analysis

A micro-simulation traffic analysis was performed for the study area using VISSIM software, which is widely utilized to analyze complex roadway geometries. The VISSIM model geometry was developed using aerial photography and engineered drawings of the new Exit 20 interchange, which was obtained from NHDOT.[1] The analysis was performed for the weekday AM and PM peak hours and for the Saturday peak hour. The three analysis periods were analyzed for existing (2013) conditions, year of project opening (assumed to be 2019), and twenty years after opening (assumed to be 2039).The following sub-sections describe how the analysis was performed and the results of the analysis.

Traffic Data Collection

To analyze traffic on I-89 between the I-91 and Exit interchanges, it was important to understand the traffic patterns among the various facilities. An origin-destination (O-D) study was performed using sensors to record the travel patterns of Bluetooth-enabled devices through the study area. Five sensors were deployed for a week in February 2013 at strategic locations on I-89 and I-91. Each sensor recorded a unique identifier of each Bluetooth-enabled device as it passed by. These unique identifiers were then matched up to determine the path that the vehicle took through the study area. By counting the number of times each of the possible routes through the study area occurred, an initial O-D table was developed for each time-of-day study periods. The O-D tables included I-89, I-91, and the Exit 20 ramps to/from the west. The three tables were then calibrated using a manual traffic count of the Exit 20 ramps conducted by RSG staff on 14 March 2013 and then scaled to match January 2013 traffic counts at the bridges from the NHDOT continuous traffic counter located immediately adjacent to the bridge (station # 253090). The resulting O-D tables were the basis for all of the subsequent traffic analyses. Appendix A contains a detailed description of the Bluetooth data collection process.

There was a desire for the analysis to reflect conditions during the peak time of the year, which is during the summer. However, the Bluetooth data was adjusted to January 2013 volumes. To get the O-D tables to represent summer 2013 conditions seasonal factors ranging from 1.08 to 1.16 were applied to the O-D tables. The seasonal factors were developed from NHDOT continuous traffic counters data in the general study area.

To represent the pulsing of traffic onto the freeway when the traffic lights turn green, the Exit 20 ramp terminals were included in the VISSIM model. Intersection turning movement counts from 2008 were utilized to determine the O-D patterns for the ramp terminals. These volumes were adjusted to match the Exit 20 ramp volumes in the summer 2013 O-D table. Appendix B contains figures showing the O-D tables, freeway volumes, and ramp terminal volumes.

Peak hour factors (PHF) for the analysis were obtained from the intersection turning movement counts and were 0.86 for the weekday AM peak hour, 0.93 for the weekday PM peak hour, and 0.95 for the Saturday peak hour. PHF values less than 0.95 were assumed to gradually increase over time as traffic volumes increase. In 2039 the assumed PHFs were 0.92 for the AM and 0.95 for the PM and Saturday.

Heavy vehicle percentages were primarily obtained from the *Vermont 2012 Automatic Vehicle Classification Report*[2] and were classified as single unit trucks and tractor-trailer trucks. Using data from the VTrans continuous traffic counter on I-89 north of the I-91 interchange and from the ramps comprising that interchange, an approximate heavy vehicle percentage was estimated for the I-89 Connecticut River bridges segment. Daily heavy vehicle data was used to estimate the AM percentages, peak hour data to estimate the PM percentages, and an average of the two to estimate Saturday

---

[1] Lebanon 11700 – Project Specific Information, New Hampshire DOT, Accessed March 9, 2013, http://www.nh.gov/dot/projects/lebanon11700/index.htm.

[2] Vermont Agency of Transportation; Policy, Planning & Intermodal Development; Traffic Research Unit; *2012 Automatic Vehicle Classification Report* (March 2013).

percentages. Figure 4 shows the resulting heavy vehicle percentages utilized for the micro-simulation analysis.

Figure 4: Assumed Freeway Heavy Vehicle Percentages

Analysis Period	Passenger Vehicles	Single Unit Trucks	Tractor-Trailer Trucks
Weekday AM Peak Hour	91.1%	5.6%	3.3%
Weekday PM Peak Hour	94.1%	3.5%	2.4%
Saturday Peak Hour	93.1%	4.5%	2.4%

Heavy vehicle percentages for NH-12A were taken from 2008 intersection turning movement volumes, which were 6% for the AM, 3% for the PM, and 4% for Saturday peak hours. The freeway proportions of single unit to tractor-trailer trucks were utilized for NH-12A.

TRAFFIC ANALYSIS METHODOLOGY

This section describes the process utilized to estimate the future year volumes, the measures of effectiveness used to compare scenarios, and how the VISSIM modeling was performed.

Future Year Volume Estimation

Future year volumes for 2019 and 2039 were estimated using interstate facility growth factors obtained from Vermont's *Continuous Traffic Counter Grouping Study and Regression Analysis Based on 2012 Traffic Data*[1] report.[2] The growth factors obtained from that report were 1.05 for adjusting from 2013 to 2019 and 1.21 for adjusting from 2013 to 2039. These factors were applied to the summer 2013 values to estimate the future year volumes for 2019 and 2039. Appendix B contains figures showing the 2019 and 2039 freeway and ramp terminal volumes.

VISSIM Modeling Approach and Calibration

The VISSIM micro-simulation software, developed by PTV was used for the traffic operations analysis. Version 5.4-07 of VISSIM was used to evaluate traffic operations in the study area. The model was run for an hour and ten minutes with no data being collected for the first ten minutes while the network was seeded. Data was then collected for the next four 15-minute intervals. The traffic volumes for the second 15-minute period were increased in accordance with the peak hour factor and the volumes for the other three 15-minute periods were correspondingly reduced so that the total hourly volume was unchanged.

Traffic signal timing data for the Exit 20 ramp terminals were developed for all scenarios using the Synchro software and a cycle length of 90 seconds. Because no evaluation was performed for the ramp terminals it was not necessary to match existing signal timing plans. The important thing was to have appropriate timing plans that fed vehicles onto the freeway in an appropriate manner.

The VISSIM model was calibrated to vehicle travel speeds measured by RSG personnel using the floating car method during peak- and off-peak periods. The average observed travel speeds were 63 mph in the southbound direction and 60 mph in the northbound direction. The January 2013 PM peak hour model was run five times and the speeds between I-91 and Exit 20 were averaged and compared to the target values. Adjustments were made to the desired vehicle speeds until the modeled speeds were within one

[1] Vermont Agency of Transportation; Policy, Planning & Intermodal Development; Traffic Research Unit; *Continuous Traffic Counter Grouping Study and Regression Analysis Based on 2012 Traffic Data* (March 2013).

[2] We initially looked to conduct a trendline regression analysis on the historic AADT's reported at the NHDOT Continuous Count Station located on I-89 immediately east of the bridges. However, we found that the growth projections varied significantly depending on which year the regression analysis was started in and that the count station has not been functioning in recent years due to adjacent construction activities. We therefore, utilized the VTrans average interstate facility growth factors to grow traffic across the bridges.

mph of the observed speeds. The calibrated model that was used for all of the analyses had an average southbound speed of 63.3 mph and an average northbound speed of 59.3 mph.

The same desired vehicle speeds were assumed for both directions. The speed difference between the two directions was due primarily to the grades on the freeway. In the northbound direction the VISSIM analysis assumed a positive grade of 2% from Exit 20 to the Vermont side of the bridge at which point the grade increased to 5% until approximately the I-91 mainline overpasses. The same grades were assumed for the same locations in the southbound direction, only as negative instead of positive grades.

An important component of micro-simulation modeling is making sure that enough model runs are performed to ensure a statistically reliable result. Using the same speed data from the calibration model run, the following formula was used to calculate the minimum number of runs to achieve a 95% confidence interval.

$$N = \left(\frac{t_{0.05,N-1} * S_s}{Z} \right)^2$$

Where:
- t = t-test statistic for 95% confidence level with N-1 degrees of freedom
- Z = number of standard deviations from the mean (1.96 for a 95% confidence level)
- S_s = sample standard deviation
- N = minimum number of runs (sample size)

Using data from the five model calibration runs, the standard deviation of the speed data was determined to be 0.29 mph in the southbound direction and 0.78 mph in the northbound direction. Using a t value of 2.78, the minimum number of runs was determined to be 0.2 runs in the southbound direction and 1.2 runs in the northbound direction; therefore 5 runs were adequate to provide satisfactory results. The VISSIM model was run five times for all of the scenario analyses and the results were averaged.

Measures of Effectiveness

The measures of effectiveness (MOEs) are the criteria used to compare the various scenarios. Two primary MOEs were utilized for the Connecticut River bridge analysis. The first was freeway level of service (LOS) and the second is a detailed examination of average speed along the length of the freeway segments.

Level-of-service (LOS) is a qualitative measure describing the operating conditions as perceived by motorists driving in a traffic stream. LOS is estimated using the procedures outlined in the *2010 Highway Capacity Manual (HCM).* [1] The HCM divides freeway facilities into three types of segments: (1) basic – sections with no ramps, (2) merge or diverge – 1,500 foot sections with either an on ramp or an off ramp, and (3) weaving – sections with an on-ramp followed within 2,500 feet or less by an off-ramp. Freeway LOS for all three segment types is based on vehicle density per lane, which is calculated by dividing the number of vehicles by the number of lanes and the average speed of those vehicles. Figure 5 shows the various LOS grades and descriptions for the three freeway segment types. New Hampshire and Vermont have a goal for freeway facilities to operate at LOS C within the general study area.

[1] Transportation Research Board, National Research Council, *Highway Capacity Manual* (Washington, DC: National Academy of Sciences, 2010).

Figure 5. Level-of-Service Criteria for Freeway Segments

LOS	Characteristics	Basic Segment Density (pc/hr/ln)	Merge/Diverge Density (pc/hr/ln)	Weaving Segment Density (pc/hr/ln)
A	Free flow operation	≤ 11.0	≤ 10.0	≤ 10.0
B	Reasonably free flow	11.1-18.0	10.1-20.0	10.1-20.0
C	Restricted freedom to maneuver	15.1-26.0	20.1-28.0	20.1-28.0
D	More restricted maneuverability	26.1-35.0	28.1-35.0	28.1-35.0
E	Closely spaced vehicles	35.1-45.0	> 35.0	35.1-43.0
F	Breakdowns in vehicular flow	> 45.0	Exceeds Capacity	> 43.0

Using the VISSIM software it is possible to estimate the freeway LOS for the various segments. In the southbound direction the section between the on-ramp from northbound I-91 and the Exit 20 off-ramp is considered a *weaving* segment since they are less than 2,500 feet apart. In the northbound direction, there is a *merge* segment at the Exit 20 on-ramp, followed by a short *basic* segment, and finally a *diverge* segment associated with the off-ramp to northbound I-91.

Some of the traffic issues in the study area are localized in nature occurring right at an on-ramp merge area, with the effects being diminished when looking at a 1,500 foot or longer segment over a 15 minute analysis period. To better understand traffic operations in these sections, the freeway section was divided into 100-foot segments and the average speed recorded in 60 second intervals. By having short segments and short time intervals it was possible to pick up on smaller disturbances in the traffic flow.

EXISTING CONDITIONS ANALYSIS

The existing conditions analysis was performed using the summer 2013 VISSIM models. Figure 6 shows the resulting volumes, speeds, and LOS for the weekday AM, weekday PM, and Saturday peak hours. The figure shows that all of the segments operate at LOS C or better. Appendix C contains some additional information regarding how well the simulation model volumes matched the target (input) volumes.

Figure 6. Existing Conditions Freeway LOS

Segment	AM Peak Hour			PM Peak Hour			Sat. Peak Hour		
	Vol.	Speed	LOS	Vol.	Speed	LOS	Vol.	Speed	LOS
I-89 Southbound									
Basic North of NB I-91 On Ramp	1,330	63	B	1,160	64	A	1,110	64	A
Weave NB I-91 On Ramp to Exit 20	1,680	59	B	1,360	62	B	1,460	60	B
Basic Between Exit 20 Ramps	920	64	A	820	65	A	600	65	A
I-89 Northbound									
Basic North of NB I-91 Off Ramp	640	61	A	1,370	53	B	930	61	A
Diverge at NB I-91 Off Ramp	1,070	61	A	2,110	57	C	1,350	61	B
Basic Exit 20 to NB I-91 Off Ramp	1,110	62	A	2,180	59	C	1,390	63	B
Merge at Exit 20 On Ramp	1,110	62	A	2,180	59	C	1,390	62	A
Between Exit 20 Ramps	850	65	A	1,220	65	A	950	65	A

Note: Speed and LOS results taken from peak 15-minute period.

Detailed speed data were extracted from the simulation models in the southbound direction from the weekday AM peak hour since that is when volumes are the highest. Figure 7 graphically illustrates the speeds along the freeway over time during 2013 AM peak conditions. The x-axis represents time and the y-axis distance. The green colors represent speeds of over 50 mph, while the orange is speeds of 40-50 mph. The figure shows consistent turbulence where the ramp from I-91 northbound merges with I-89 southbound (indicated as "NB I-91 On Ramp" in the figure below) with average speeds always below 60 mph and occasionally dropping below 40 mph. This turbulence generally dissipates over 500-700 feet, but occasionally continues all the way to Exit 20.

Figure 7. Existing Conditions AM Southbound Speed Details

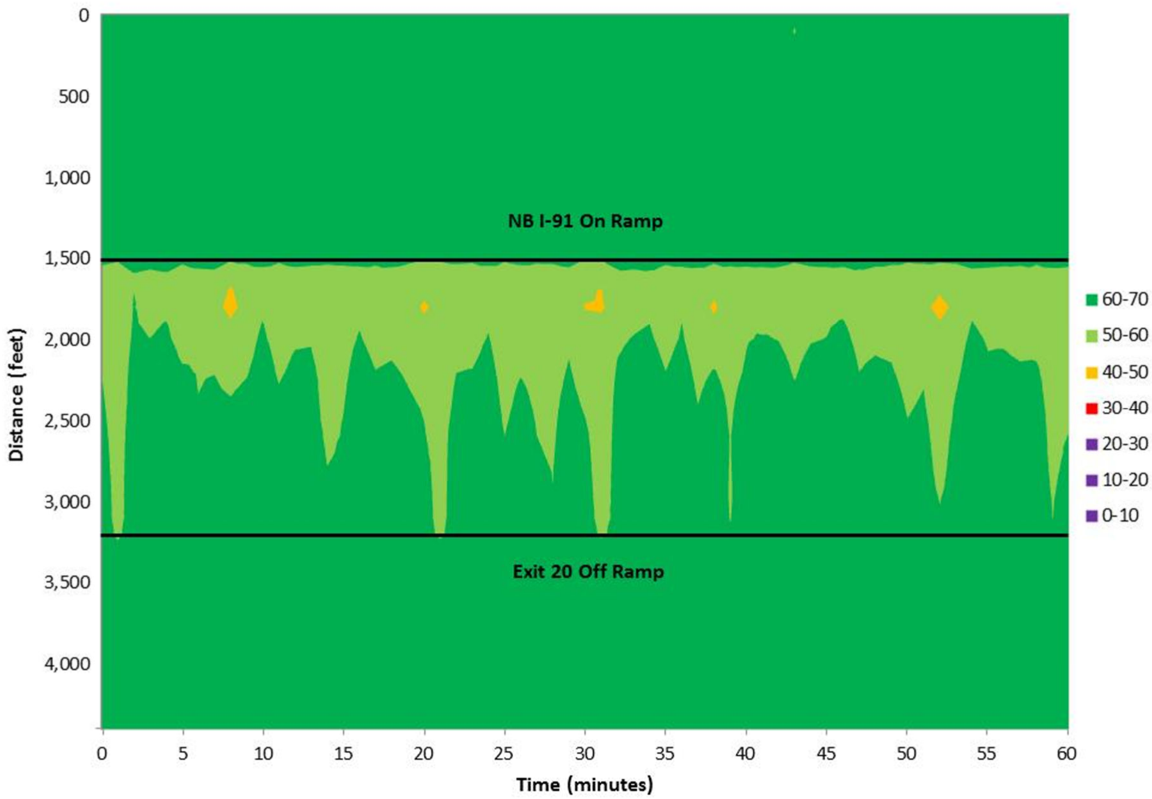
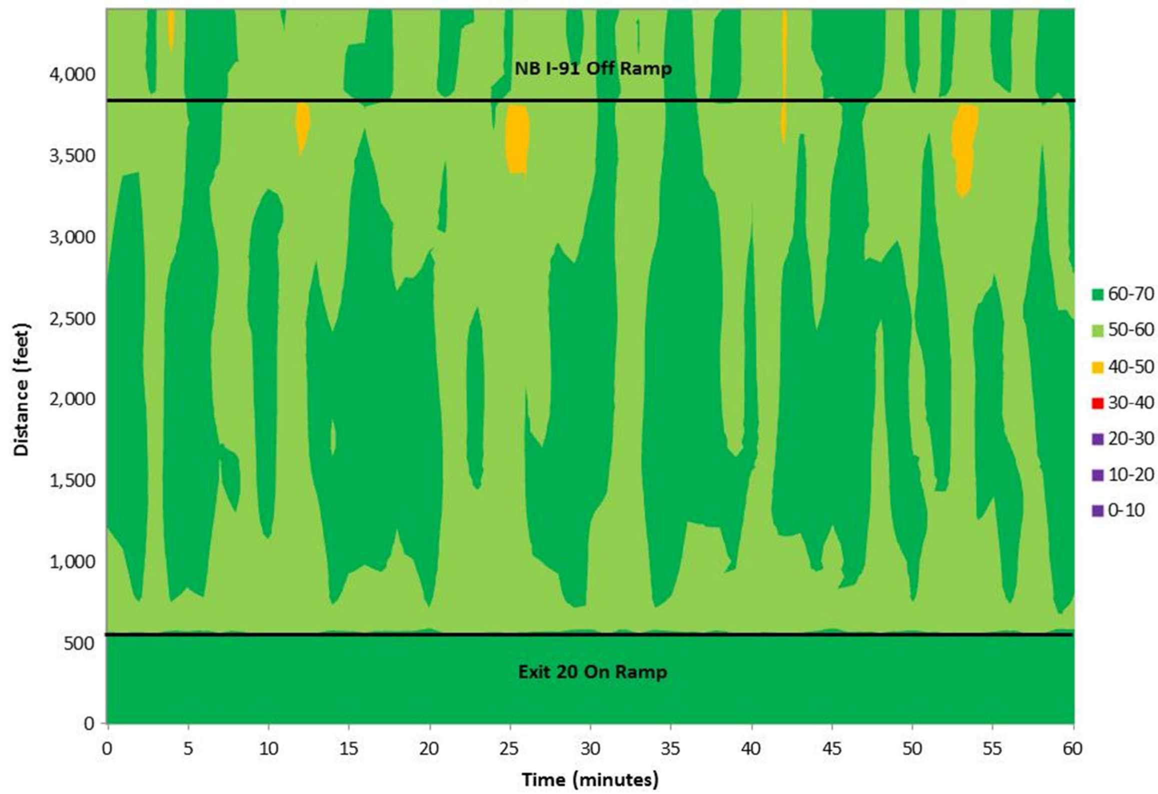


Figure 8 shows the same information for the northbound direction, which is much more turbulent than the southbound direction. This is due to the positive grades of 2 to 5% along these segments and the affect that they have on traffic, particularly heavy vehicles. However, one can see that the turbulence increases at the merge and diverge points where lane changing operations are occurring. The effect is noticeably pronounced at the northbound I-91 off ramp where there is a 5% grade and lane changing operations for vehicles desiring to take the off ramp to I-91.

Figure 8. Existing Conditions PM Northbound Speed Details



A numerical analysis was performed on the "cells" that lie between the on- and off-ramps in both directions. Each cell is 100 feet by one minute. Figure 9 lists the number of cells in each direction and the percentage of those cells that fall within the various speed categories. The northbound direction has more cells because the distance between the ramps is longer than the southbound direction.

Figure 9. Existing Conditions Speed Detail Summary

	Southbound	Northbound
# of Cells	1,020	1,980
< 40 mph	0%	0%
40 - 50 mph	1%	1%
50 - 60 mph	42%	54%
> 60 mph	57%	44%

YEAR 2019 ANALYSIS

The year 2019 analysis was performed in the same manner as the existing conditions with a couple of differences in the MOEs that were reported and the scenarios that were evaluated. The detailed speed analysis was not performed for 2019 since it represents a mid-point between the existing conditions and the 2039 conditions and is therefore not as useful.

Because 2019 represents the opening year of the project, a build scenario was evaluated that added an auxiliary lane to I-89 in each direction between the ramps on either side of the bridges. For the purposes of the analysis, the auxiliary lane was assumed to come in at the on-ramp and drop as a single lane exit at the off-ramp. This configuration is not consistent with the principles of lane balance described in the

Green Book, which says that between the mainline and the ramp there should be one more lane exiting the diverge area than entered it. Lane balance is generally achieved by having two-lane off ramps or by continuing the auxiliary lane beyond the exit and then dropping it before the next ramp (or usually before the next structure to save money). This approach was chosen because it represents the lowest capacity weaving section where every weaving vehicle is required to make one lane change. As such, it provides a conservative estimate of traffic performance.

Figure 10 compares the build and no build 2019 scenarios for the key freeway segments. The freeway is expected to operate effectively at LOS C or better in both scenarios. In the peak direction of the peak hour, the build scenario improves freeway speeds between I-91 and Exit 20 by 4-7 miles per hour. Additional information on each scenario can be found in Appendix C.

Figure 10. 2019 Freeway Performance Comparison

Segment	No Build			Build (*auxiliary lane*)		
	Volume	Speed	LOS	Volume	Speed	LOS
Weekday AM Peak Hour						
I-89 SB - Basic North of NB I-91 On Ramp	1,390	62	B	1,390	62	B
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,760	58	B	1,820	63	A
I-89 SB - Basic Between Exit 20 Ramps	970	64	A	970	65	A
I-89 NB - Basic North of NB I-91 Off Ramp	670	61	A	670	62	A
I-89 NB - Diverge at NB I-91 Off Ramp	1,120	60	A	1,160	62	A
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	1,160	62	A	1,160	64	A
I-89 NB - Merge at Exit 20 On Ramp	1,160	62	A	1,160	64	A
I-89 NB - Between Exit 20 Ramps	890	65	A	890	65	A
Weekday PM Peak Hour						
I-89 SB - Basic North of NB I-91 On Ramp	1,220	64	A	1,220	64	A
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,430	62	B	1,470	64	A
I-89 SB - Basic Between Exit 20 Ramps	860	65	A	860	65	A
I-89 NB - Basic North of NB I-91 Off Ramp	1,440	53	B	1,440	60	B
I-89 NB - Diverge at NB I-91 Off Ramp	2,210	53	C	2,280	60	B
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	2,280	58	C	2,280	62	B
I-89 NB - Merge at Exit 20 On Ramp	2,280	58	C	2,280	62	B
I-89 NB - Between Exit 20 Ramps	1,280	64	A	1,280	64	A
Saturday Peak Hour						
I-89 SB - Basic North of NB I-91 On Ramp	1,160	64	A	1,160	64	A
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,530	59	B	1,610	63	A
I-89 SB - Basic Between Exit 20 Ramps	620	65	A	620	65	A
I-89 NB - Basic North of NB I-91 Off Ramp	970	60	A	970	62	A
I-89 NB - Diverge at NB I-91 Off Ramp	1,410	61	B	1,460	62	A
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	1,460	62	B	1,460	64	A
I-89 NB - Merge at Exit 20 On Ramp	1,450	62	B	1,460	63	A
I-89 NB - Between Exit 20 Ramps	990	65	A	990	65	A

Note: Speed and LOS results taken from peak 15-minute period.

2039 Conditions

The year 2039 analysis was performed in the same manner as the other years and all of the MOEs and scenarios were evaluated. The build scenario assumed the same lane configuration as described in the

2019 Conditions section. Figure 11 compares the build and no build 2039 scenarios for the key freeway segments. The freeway is expected to operate effectively at LOS C or better in both scenarios. In the peak direction of the peak hour the Build scenario improves freeway speeds between I-91 and Exit 20 by 4-6 miles per hour and improves the LOS from C to B. Additional information on each scenario can be found in Appendix C.

Figure 11. 2039 Freeway Performance Comparison

Segment	No Build			Build		
	Volume	Speed	LOS	Volume	Speed	LOS
Weekday AM Peak Hour						
I-89 SB - Basic North of NB I-91 On Ramp	1,610	62	B	1,610	62	B
I-89 SB - Weave NB I-91 On Ramp to Exit 20	2,040	56	C	2,110	63	B
I-89 SB - Basic Between Exit 20 Ramps	1,120	64	A	1,120	64	A
I-89 NB - Basic North of NB I-91 Off Ramp	770	59	A	770	62	A
I-89 NB - Diverge at NB I-91 Off Ramp	1,300	59	B	1,350	62	A
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	1,350	62	B	1,350	64	A
I-89 NB - Merge at Exit 20 On Ramp	1,350	62	A	1,340	64	A
I-89 NB - Between Exit 20 Ramps	1,030	65	A	1,030	65	A
Weekday PM Peak Hour						
I-89 SB - Basic North of NB I-91 On Ramp	1,400	64	B	1,400	64	B
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,640	62	B	1,690	64	A
I-89 SB - Basic Between Exit 20 Ramps	990	65	A	990	65	A
I-89 NB - Basic North of NB I-91 Off Ramp	1,660	52	B	1,660	57	B
I-89 NB - Diverge at NB I-91 Off Ramp	2,540	52	C	2,640	57	B
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	2,630	57	C	2,640	62	B
I-89 NB - Merge at Exit 20 On Ramp	2,630	57	C	2,630	62	B
I-89 NB - Between Exit 20 Ramps	1,480	64	B	1,480	64	B
Saturday Peak Hour						
I-89 SB - Basic North of NB I-91 On Ramp	1,350	64	B	1,350	64	B
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,780	57	B	1,860	63	A
I-89 SB - Basic Between Exit 20 Ramps	730	64	A	730	65	A
I-89 NB - Basic North of NB I-91 Off Ramp	1,120	56	A	1,120	61	A
I-89 NB - Diverge at NB I-91 Off Ramp	1,630	59	B	1,680	62	A
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	1,680	61	B	1,680	64	A
I-89 NB - Merge at Exit 20 On Ramp	1,680	61	B	1,680	63	A
I-89 NB - Between Exit 20 Ramps	1,150	65	A	1,150	65	A

Note: Speed and LOS results taken from peak 15-minute period.

As with the existing conditions analysis, detailed speed data were extracted from the simulation models in the southbound direction from the weekday AM peak hour and in the northbound direction from the weekday PM peak hour. Figure 12 graphically illustrates the speeds along the southbound freeway for the 2039 No Build scenario. The figure shows consistent turbulence at the northbound I-91 on ramp merge with average speeds always below 60 mph and regularly below 50 and occasionally even dropping below 30 mph. By 2039 it will be much more common for the slower speeds to continue all the way to Exit 20.

Figure 12. 2039 AM No Build Conditions Southbound Speed Details

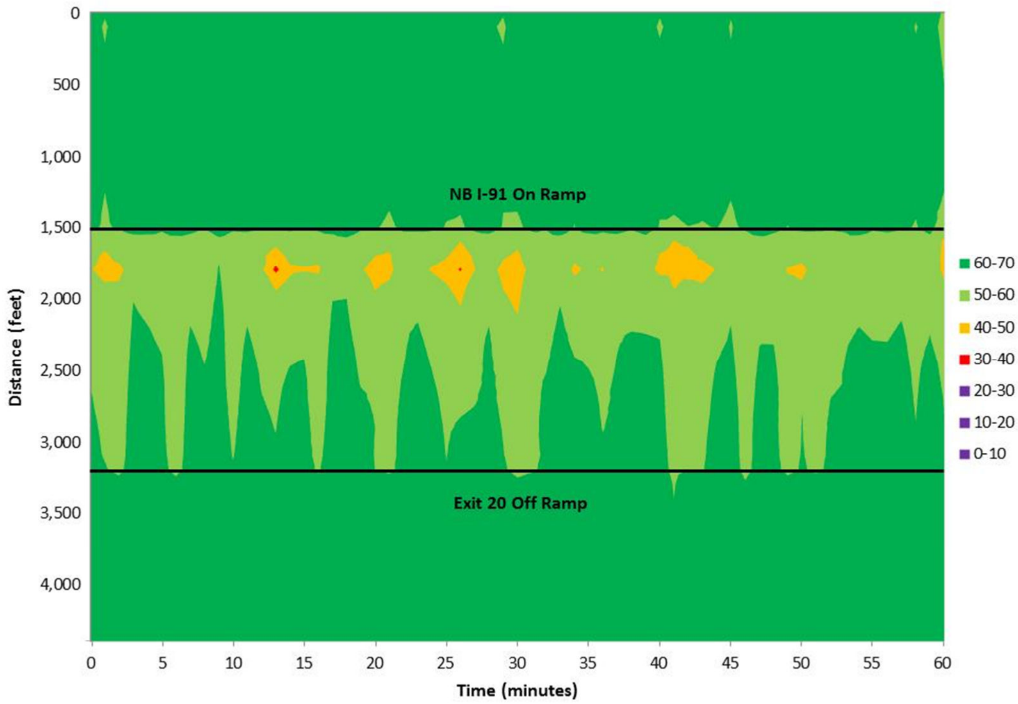


Figure 13 shows the same information for the 2039 Build scenario and clearly illustrates that adding a southbound auxiliary lane will eliminate virtually all of the areas of speeds below 60 mph.

Figure 13. 2039 AM Build Conditions Southbound Speed Details

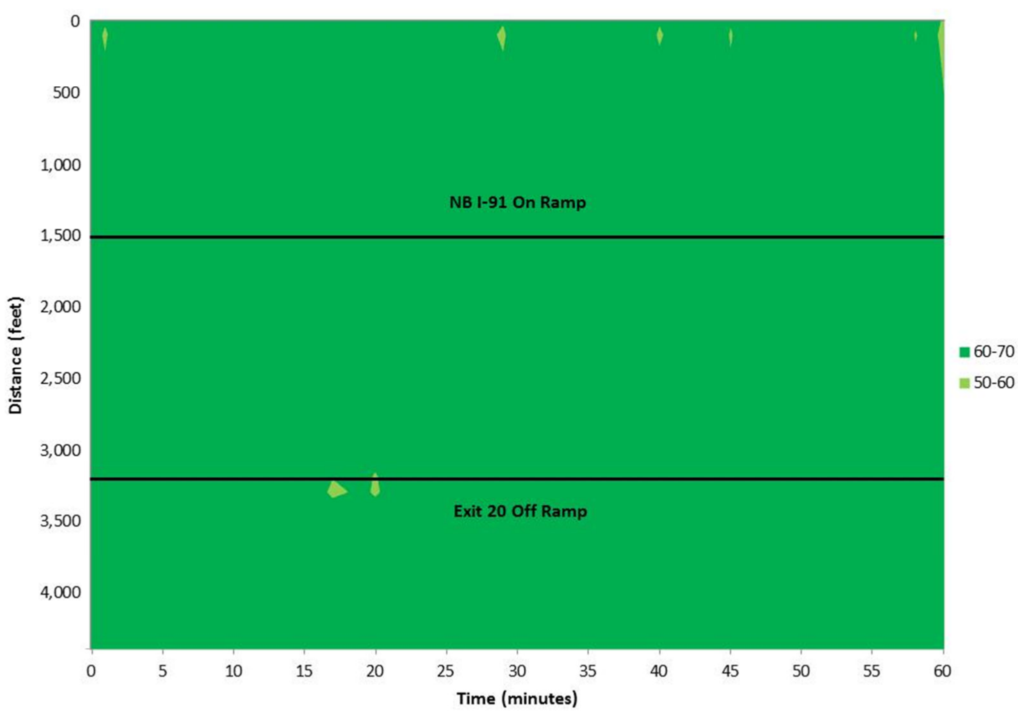


Figure 14 shows 2039 PM peak hour detailed speed information for the northbound direction, which, as seen in the existing conditions analysis, is much more turbulent than the southbound direction, again due to the positive grades. By 2039 nearly the entire section between ramps can be expected to operate at speeds less than 50 mph with substantial time at speeds less than 50 mph at the northbound I-91 off-ramp.

Figure 14. 2039 PM No Build Conditions Northbound Speed Details

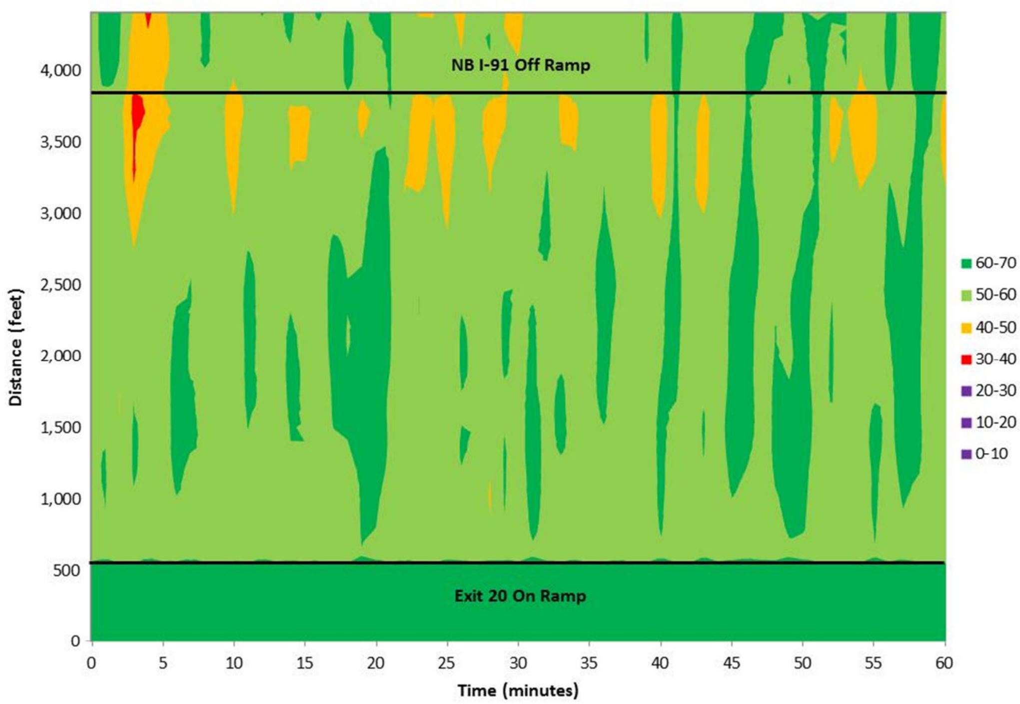
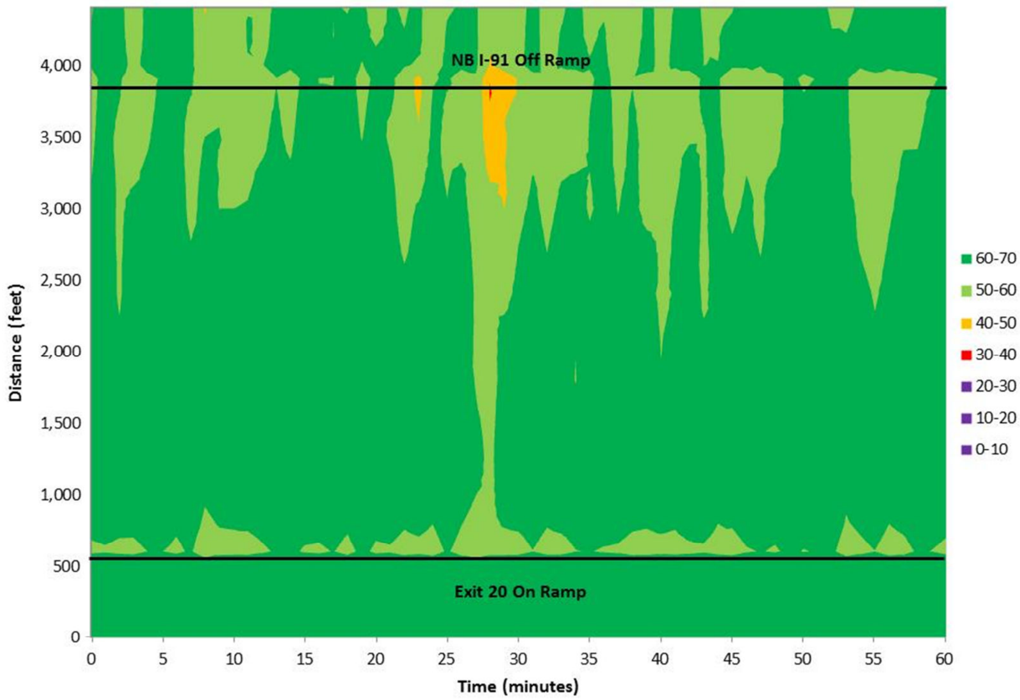


Figure 15 shows that the 2039 PM Build scenario dramatically improves the average vehicle speeds in the northbound direction, although not to the same level as previously shown for the southbound direction. Most of the section would operate at speeds over 60 mph, but there would still be occasional pockets of lower speeds.

Figure 15. 2039 PM Build Conditions Northbound Speed Details



As with the existing conditions, a numerical analysis was performed on the "cells" that lie between the on- and off-ramps. Figure 16 lists the number of cells in each direction and the percentage of those cells that fall within the various speed categories. As shown in the previous figures and quantified here, the Build scenario does a good job of increasing I-89 speeds between I-91 and Exit 20, particularly in the southbound direction.

Figure 16. Speed Detail Summary Comparison

	Existing Conditions		2039 No Build Conditions		2039 Build Conditions	
	Southbound	**Northbound**	**Southbound**	**Northbound**	**Southbound**	**Northbound**
# of Cells	1,020	1,980	1,020	1,980	1,020	1,980
< 40 mph	0%	0%	0%	0%	0%	0%
40 - 50 mph	1%	1%	4%	6%	0%	1%
50 - 60 mph	42%	54%	59%	73%	0%	22%
> 60 mph	57%	44%	37%	21%	100%	77%

Safety Analysis

A safety analysis was performed for the study area to better understand the crashes that have taken place and to determine if high crash rates might provide justification for widening the I-89 bridges across the Connecticut River.

Crash Histories

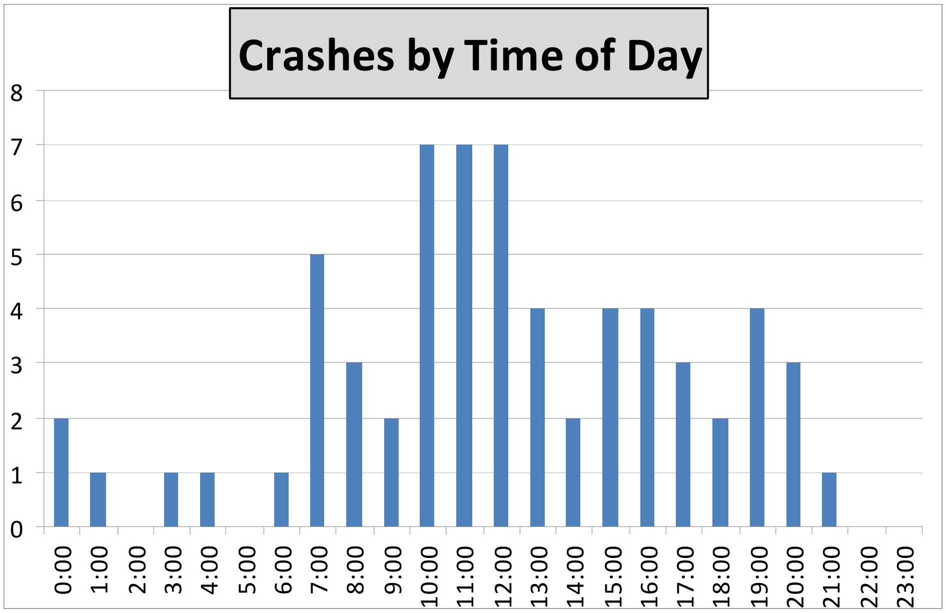
Five year crash histories for the study area on and around the Connecticut River bridges were collected from NHDOT and VTrans. The total number of crashes based on both NHDOT and VTrans data that occurred in the five year period between 2007 and 2011 is shown in Figure 17. There are several locations that jump out as high crash locations, although they are all outside of the study area defined by the red rectangle. The highest concentrations of crashes (~120) occur at the Exit 20 ramp terminals, which isn't too surprising given that intersections typically have the highest crash rates largely due to all of the conflicting turning movements made there. The other location that stands out is at the merge of the southbound and northbound I-89 ramps to northbound I-91, which had 41 crashes during this time period.

Figure 17. Study Area Crash Locations

Study Area Crashes

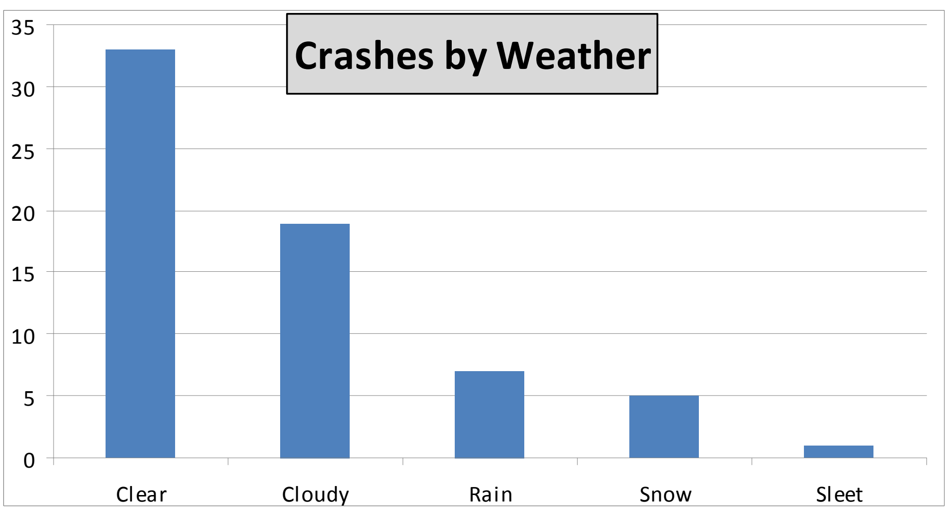
Within the study area (ie. red rectangle shown in the figure above) there were a total of 65 reported crashes with 18 injuries and no fatalities in the period between 2007 and 2011. As illustrated in Figure 18, the peak crash period occurs between 10am and 1pm, with 21 (32%) accidents occurring in this span. Nearly half (48%) of all crashes occur between the hours of 7:00 am and 1:00 pm.

Figure 18. Study Area Crashes by Time of Day



The three highest crash months are: July (10), January (8) and October (8). Crashes appear to be declining during the interval examined, with 17 in 2007, 15 in 2008 and 2009, 13 in 2010, and 5 in 2011. Adverse weather conditions do not seem to be a major factor in causing crashes. Figure 19 shows that 33 occurred while conditions were clear, 19 while conditions were cloudy, 7 while it was raining, 5 while it was snowing, and 1 during sleet conditions. Forty-eight (74%) crashes involved multiple vehicles while 17 involved only a single vehicle.

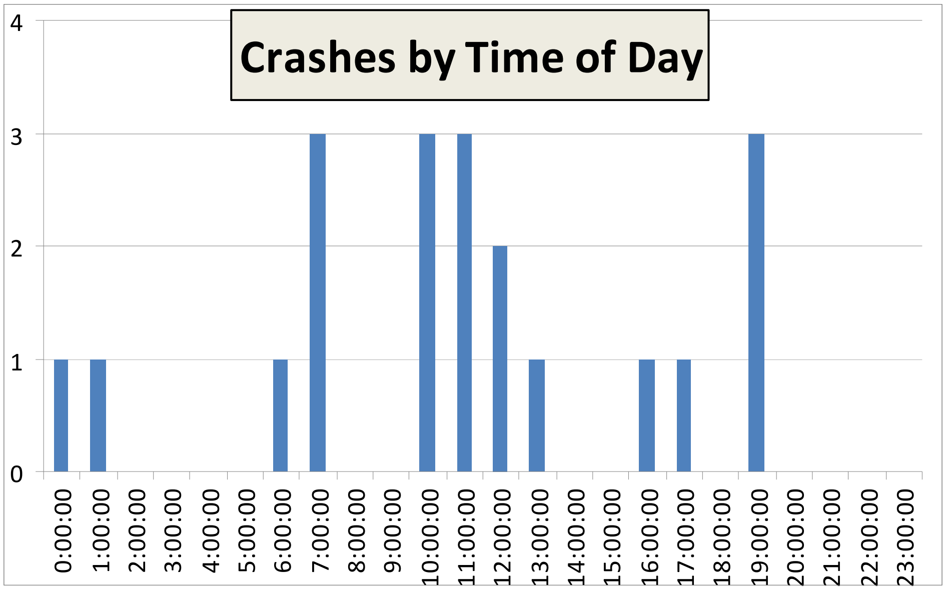
Figure 19. Study Area Crashes by Weather



Crashes on the Bridge

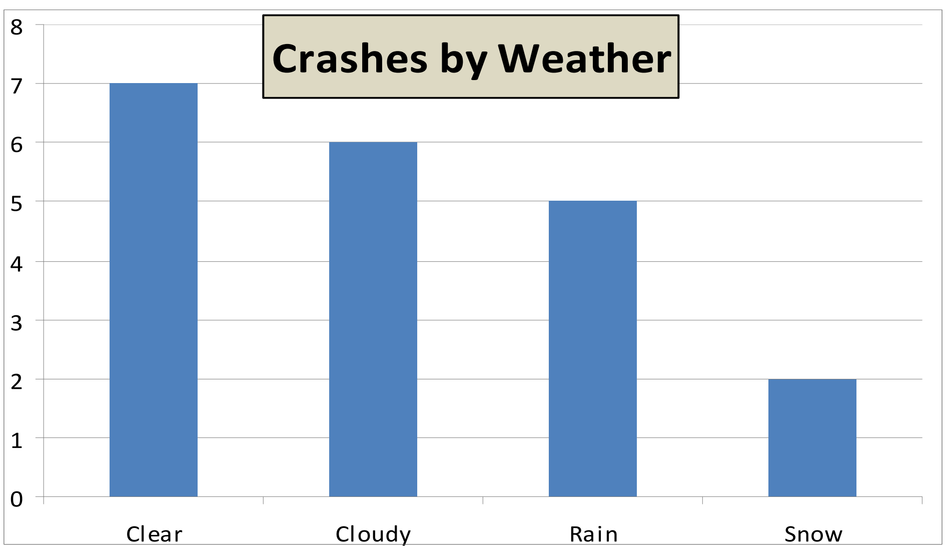
Looking specifically at crashes that occurred on the bridge itself, there were a total of 20 crashes in the five year span with 6 injuries and 0 deaths. Figure 20 shows that the peak crash time on the bridge is between 7am and 1pm, with 6 accidents (30%) occurring in this time period. The peak crash months are: October (4), December (4), January (3), and July (3). Crashes appear to be declining, with 8 in 2007, 7 in 2008, 2 in 2009 and 2010, and 1 in 2011.

Figure 20. Bridge Crashes by Time of Day



Weather does not seem to play a significant factor in causing crashes on the bridge, with 7 occurring while it was clear, 6 while cloudy, 5 during rain, and 2 during snow, as shown in Figure 21. However, of the 7 accidents in the study area that happened during rainy conditions, 5 of them occurred on the bridge. Twelve accidents on the bridge involved multiple cars while 8 involved only one car.

Figure 21. Bridge Crashes by Weather



Crashes at Northbound I-91 to Southbound I-89 Merge

Of particular relevance to the question of whether to widen the bridges or not are those crashes that occurred at the merge of the on-ramp from northbound I-91 to southbound I-89. In this area there were a total of 9 reported crashes comprising 14% of the total study area crashes with two injuries and no fatalities. Weather does not seem to play a significant factor as 6 accidents (67%) occurred while conditions were clear. However, 89% of the crashes involved multiple vehicles, with 7 cases or 78% of the crashes citing “followed too closely” as the principle reason for the accident. It is likely that the majority of these crashes are occurring as vehicles attempt to merge onto the I-89 mainline. It is not unreasonable to think that the presence of a longer acceleration lane or a continuous auxiliary lane would reduce the accident rate in this location.

Conclusions

The preceding analyses were performed to determine whether there is a reasonable rationale to widen the I-89 bridges over the Connecticut River as part of a current bridge rehabilitation project. This analysis considered the study area's compatibility with current design standards, future traffic performance, and crash history. Based on the results of this analysis, it is recommended that a continuous auxiliary lane be added to southbound I-89 between the on-ramp from northbound I-91 and the Exit 20 off ramp for the following reasons:

1. The review of geometric design standards found that the on-ramp merge distance is currently insufficient, suggesting that either the acceleration lane should be extended or an auxiliary lane should be built.
2. The review of geometric design standards also found that there would ideally be 2,000 feet between the two ramps; since the distance between ramps is virtually unchangeable, having an auxiliary lane would help mitigate this issue.
3. The traffic operations analysis found that vehicle speeds on southbound I-89 between the two ramps will continue to fall as traffic volumes increase. Adding an auxiliary lane is estimated to eliminate nearly all of the delay.
4. The crash analysis showed that there are several crashes where the on-ramp from northbound I-91 merges with southbound I-89. Many of these crashes are likely due to the sub-standard merge distance and if an auxiliary lane were provided the crash rate would be expected to decrease in this area.

The case for a northbound auxiliary lane is not nearly so compelling. The recently reconstructed Exit 20 interchange provides sufficient merge length and many of the vehicle speed issues are related to the high positive grade on the Vermont side of the river. There is a noticeable decrease in vehicle speeds at the exit to northbound I-91. While an auxiliary lane would certainly provide an improvement, it is possible that lengthening the deceleration lane would also be beneficial, but at a fraction of the cost.

Overall, it is our recommendation to pursue further consideration of an auxiliary lane on southbound I-89 between the on-ramp from northbound I-91 and not additional auxiliary lane or widening on the northbound section of I-89.

Appendix A – Bluetooth Data Collection Process

BLUETOOTH DATA COLLECTION OVERVIEW

Bluetooth Technology

Bluetooth technology is a wireless communications system that is used in mobile phones, computers, personal digital assistants, car radios, and other short range wireless communications devices. Bluetooth technology operates by proximity – Bluetooth-enabled devices that are close to one another can connect to allow transmission of voice and/or data. In order for a connection to occur, each device needs to be in "discoverable" mode, with the Bluetooth enabled.

Bluetooth devices are rated as Type I (100 meter detection zone); Type II (10 meter detection zone); or Type III (1 meter detection zone). The Bluetooth detectors used to record data in this project were Type I detectors which can detect any other Bluetooth device within its range. All Bluetooth-enabled devices operate within a globally available frequency band of 2.45 GHz.

Each device emits a unique, 48-bit electronic identifier known as a Media Access Control (MAC) address, or MAC ID. The MAC ID is generated in two parts: the first half of the MAC ID is assigned to the device manufacturer, while the second half of the MAC ID is assigned to the specific device. While the MAC ID is unique to each Bluetooth device, it is not linked to an individual person.

Bluetooth for Traffic Data Collection

Traffax, Inc., a company based in Maryland, has developed a Bluetooth system that can be used for traffic data collection. Traffax's technology consists of a series of Bluetooth devices, named BlueFax sensors, which are placed on or near a roadway to capture the signals of other Bluetooth-enabled devices as they travel through the corridor. The BlueFax sensors are self-contained, discrete units that contain a Bluetooth device set to "discovery" mode, a GPS system, a small computer to record the data, and a battery to power the unit (Figure 1).

Figure 1: BlueFax Device (left) and Typical Post-Mounted Deployment on SR-826 (right)

When a Bluetooth-enabled device passes by a BlueFax sensor, the unique MAC ID of the device and the date and time are captured and stored in the on-board computer. As vehicles with Bluetooth-enabled devices travel through the corridor, they will pass other BlueFax sensors, where the MAC ID and timestamp will be recorded again. At the end of the study period, the data from each BlueFax device can be downloaded and aggregated into a database for analysis. By searching for the common MAC IDs recorded across pairs of BlueFax sensors, it is possible to identify origin-destination and travel time information for each vehicle.

DATA ANALYSIS

At the end of the deployment period, the data from the BlueFax sensors were downloaded and aggregated into a single dataset. For developing OD estimates, custom code using Python was written to process the raw Bluetooth data. OD tables were estimated for week day AM, week day PM, and Saturday peak hours. To develop the OD tables, the following steps were used.

Step 1. Establish Bluetooth Detector Locations

Each Bluetooth detector is outfitted with a GPS unit which records its latitude and longitude. Each detector location was buffered with a 100 meter radius (approximately 325 feet) to establish the detector area. This is the approximate range of Bluetooth devices. The broader detector area is used to determine whether other surface street traffic might be included in the raw data.

Step 2. Get all Plausible Paths through and around the Study Area, Assign Detector Sequences

Step two started by getting the set of all *plausible paths* through the study area. The study area has several entry points and exit points, most of which constitute "plausible paths" (i.e. paths, or trips, that make sense given the network).

Once we had generated a list of plausible paths, we determined the *actual detector sequence* (ADS) for each path, where an ADS is the sequence of detectors areas that the path passes through on its way from origin to destination.

Step 3. Process the Bluetooth Data to Get Observed Detector Sequence (ODS) Frequencies

To make the raw Bluetooth data useful we follow three sub-steps:

- assemble the Bluetooth data into trajectories
- remove redundant detections
- divide trajectories into trips

The first sub-step, to assemble the Bluetooth data into trajectories, is straightforward. We group the data from all detectors by device ID, then and sort by date and time, all while retaining the ID for the detector where each detection occurred. The result is a collection of trajectories, where each trajectory is a sequence of places and times where a particular Bluetooth device was detected.

Trip trajectories were formed using the following criteria:

1. *Trips were formed using a single MAC ID. Consecutive reads of the same MAC ID at the same detector, as would occur if a vehicle were idling in place, were clustered into one unique read using a 5 minute rule: if consecutive reads of the same ID were recorded within 5 minutes, they were considered as one read occurring at an averaged time point. Consecutive reads of the same MAC ID that occurred more than 5 minutes apart were considered as the end and/or beginning of different trips.*

2. *Within each MAC ID, links of consecutive sensor pairs were joined together in chronological order to form complete trips linking each sensor in sequence.*

3. *To determine whether any specific trip segment was an outlier, the zone-to-zone travel times of any specific trip were compared to the 30 travel times closest by time of day (e.g. if the trip occurred at 9:00, the 30 trips closest to 9:00 AM over the entire week were used to determine the mean travel speed for OD pair). The Blustats software uses this rule for determining segment speed, which is based on a statistical rule of thumb for a normal distribution with a 90% confidence. The travel times of these 30 trips were used to develop a normal distribution. Any trip length that is outside of +/- 3 standard deviations from the mean was determined to be an outlier, indicating a break in the trip sequence.*

4. *Any given trip could not pass the same sensor twice.*

The unique combination of MAC ID, sensor location, and timestamp were only included in a single trip.
To illustrate the trip itinerary concept, a subset of the data for a sample MAC ID is shown below. Based on the timestamps for this MAC ID and the trip linking criteria, two trips were generated as shown in

Figure 2. These two records would enter the OD matrix as one vehicle trip in two cells: the 15 → 8 cell and the 8 → 15 cells. The intermediate station information is retained to validate the estimates in a later stage of the analysis.

Figure 2: Example of Two Unique Trip Trajectories

Raw Data

MAC ID	Location	Date	Time
00:24:9F:D8:F9:E3	15	9/18/2011	1:09:23 PM
00:24:9F:D8:F9:E3	14	9/18/2011	1:12:57 PM
00:24:9F:D8:F9:E3	12	9/18/2011	1:16:12 PM
00:24:9F:D8:F9:E3	12	9/18/2011	1:16:17 PM
00:24:9F:D8:F9:E3	10	9/18/2011	1:19:54 PM
00:24:9F:D8:F9:E3	10	9/18/2011	1:19:59 PM
00:24:9F:D8:F9:E3	8	9/18/2011	1:24:48 PM
00:24:9F:D8:F9:E3	8	9/18/2011	11:47:28 PM
00:24:9F:D8:F9:E3	10	9/18/2011	11:51:02 PM
00:24:9F:D8:F9:E3	12	9/18/2011	11:54:05 PM
00:24:9F:D8:F9:E3	14	9/18/2011	11:56:38 PM
00:24:9F:D8:F9:E3	14	9/18/2011	11:56:43 PM
00:24:9F:D8:F9:E3	15	9/18/2011	11:59:36 PM
00:24:9F:D8:F9:E3	15	9/18/2011	11:59:42 PM
00:24:9F:D8:F9:E3	15	9/18/2011	11:59:47 PM

Clustered Data

MAC ID	Location	Date	Time
00:24:9F:D8:F9:E3	15	9/18/2011	1:09:23 PM
00:24:9F:D8:F9:E3	14	9/18/2011	1:12:57 PM
00:24:9F:D8:F9:E3	12	9/18/2011	1:16:17 PM
00:24:9F:D8:F9:E3	10	9/18/2011	1:19:59 PM
00:24:9F:D8:F9:E3	8	9/18/2011	1:24:48 PM
00:24:9F:D8:F9:E3	8	9/18/2011	11:47:28 PM
00:24:9F:D8:F9:E3	10	9/18/2011	11:51:02 PM
00:24:9F:D8:F9:E3	12	9/18/2011	11:54:05 PM
00:24:9F:D8:F9:E3	14	9/18/2011	11:56:43 PM
00:24:9F:D8:F9:E3	15	9/18/2011	11:59:42 PM

Trip 1

MAC ID	Location	Date	Time
00:24:9F:D8:F9:E3	15	9/18/2011	1:09:23 PM
00:24:9F:D8:F9:E3	14	9/18/2011	1:12:57 PM
00:24:9F:D8:F9:E3	12	9/18/2011	1:16:17 PM
00:24:9F:D8:F9:E3	10	9/18/2011	1:19:59 PM
00:24:9F:D8:F9:E3	8	9/18/2011	1:24:48 PM

Trip 2

MAC ID	Location	Date	Time
00:24:9F:D8:F9:E3	8	9/18/2011	11:47:28 PM
00:24:9F:D8:F9:E3	10	9/18/2011	11:51:02 PM
00:24:9F:D8:F9:E3	12	9/18/2011	11:54:05 PM
00:24:9F:D8:F9:E3	14	9/18/2011	11:56:43 PM
00:24:9F:D8:F9:E3	15	9/18/2011	11:59:42 PM

The second sub-step is to remove redundant detections, which can occur because the detectors record new detections every five seconds. If a Bluetooth device is within range of a detector for more than five seconds, it can result in multiple recorded detections. To correct this problem we group redundant detections into clusters, and then choose the middle detection of each cluster to represent that cluster in a new, shorter version of the trajectory. Clusters consist of adjacent detections that are not more than 5 minutes apart. This rule ensures that a cluster really represents just one visit to a detector, rather than a visit and return visit to a detector.

The final sub-step is to divide the trajectories into sub-trajectories, since each trajectory could contain data from more than one trip. We divide the trajectories where the time difference between two adjacent detectors is too large, where we define "too large" to be greater than the free flow travel time between the two detectors plus 30 minutes. This rule separates trajectories at the point where one trip has ended and another begins, since diverting a trip to a particular destination plus participating in the activity at that destination usually takes longer than 30 minutes. At the same time the rule allows trips subject to congestion to remain intact.

We aggregate by time of day, then we drop the time stamps from the sub-trajectories so that only the sequence of detectors remains. We call this sequence the *observed detector sequence* (ODS), and group together sub-trajectories that have identical ODSs. The result of aggregating these two ways is a data set which contains the number of sub-trajectories that fall into each unique combination of time-of-day group and ODS group. We average these frequencies to represent one average weekday, and call the result the *ODS frequencies* dataset.

Comparing the ODSs to the ADSs shows that most ODSs do not perfectly match any ADS. In some cases, the ODSs would match the ADSs if you allow for "missed" detections, or detections that appear in the ADS but not in the ODS. The ODS data indicate that Bluetooth devices can be missed at intermediate detector stations.

Step 4. Distribute the ODS Frequencies to the Plausible Paths to Get Path Volumes

The task in step five is to apportion the counts from the ODS frequencies dataset to the plausible paths as *path volumes*. We do this in two sub-steps. First we apportion the ODS frequencies to the ADSs to form an ADS frequencies database, then we apportion the ADS frequencies to the paths to create the path volumes.

Once we have an ADS frequencies dataset, we can apportion the ADS counts to the associated paths.

Step 5. Summarize the Path Volumes in an Aggregated OD Table

The last step is to summarize the path volumes. We do this by tabulating the path volumes by first and last detector to form an OD table

Appendix B – Traffic Volume Data

CT River Bridge Analysis Intersection Volumes

Exit 20 Ramp Intersections

April 3, 2013

#	Intersection	Northbound			Southbound			Eastbound			Westbound			Total	PHF
		Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right		
2008 Traffic Counts															
1	SB Ramps - AM	0	426	238	44	601	0	210	0	418	0	0	0	1,937	0.86
2	NB Ramps - AM	191	445	0	0	292	120	0	0	0	353	0	148	1,549	
1	SB Ramps - PM	0	1,006	317	68	1,000	0	200	0	358	0	0	0	2,949	0.93
2	NB Ramps - PM	492	714	0	0	643	403	0	0	0	425	1	195	2,873	
1	SB Ramps - Sat	0	1,069	464	95	1,240	0	198	0	495	0	0	0	3,561	0.95
2	NB Ramps - Sat	401	866	0	0	891	229	0	0	0	444	1	186	3,018	
Adjusted to January 2013															
1	SB Ramps - AM	0	485	271	50	684	0	239	0	476	0	0	0	2,204	0.86
2	NB Ramps - AM	142	582	0	0	472	89	0	0	0	262	0	110	1,657	
1	SB Ramps - PM	0	942	295	63	935	0	186	0	334	0	0	0	2,756	0.93
2	NB Ramps - PM	460	668	0	0	601	377	0	0	0	397	1	182	2,687	
1	SB Ramps - Sat	0	952	580	119	1,145	0	248	0	619	0	0	0	3,662	0.95
2	NB Ramps - Sat	258	942	0	0	979	147	0	0	0	285	1	120	2,731	
Adjusted to Summer 2013															
1	SB Ramps - AM	0	560	310	60	790	0	280	0	550	0	0	0	2,550	0.86
2	NB Ramps - AM	160	680	0	0	550	100	0	0	0	300	0	130	1,920	
1	SB Ramps - PM	0	1,070	330	70	1,060	0	210	0	380	0	0	0	3,120	0.93
2	NB Ramps - PM	520	760	0	0	680	430	0	0	0	450	0	210	3,050	
1	SB Ramps - Sat	0	1,030	630	130	1,250	0	270	0	670	0	0	0	3,980	0.95
2	NB Ramps - Sat	280	1,020	0	0	1,070	160	0	0	0	310	0	130	2,970	
Adjusted to Summer 2019															
1	SB Ramps - AM	0	590	330	60	830	0	290	0	580	0	0	0	2,680	0.88
2	NB Ramps - AM	170	710	0	0	580	110	0	0	0	320	0	140	2,030	
1	SB Ramps - PM	0	1,120	350	70	1,110	0	220	0	400	0	0	0	3,270	0.94
2	NB Ramps - PM	550	800	0	0	710	450	0	0	0	470	0	220	3,200	
1	SB Ramps - Sat	0	1,080	660	140	1,310	0	280	0	700	0	0	0	4,170	0.95
2	NB Ramps - Sat	290	1,070	0	0	1,120	170	0	0	0	330	0	140	3,120	
Adjusted to Summer 2039															
1	SB Ramps - AM	0	680	380	70	960	0	340	0	670	0	0	0	3,100	0.92
2	NB Ramps - AM	190	820	0	0	670	120	0	0	0	360	0	160	2,320	
1	SB Ramps - PM	0	1,290	400	80	1,280	0	250	0	460	0	0	0	3,760	0.95
2	NB Ramps - PM	630	920	0	0	820	520	0	0	0	540	0	250	3,680	
1	SB Ramps - Sat	0	1,250	760	160	1,510	0	330	0	810	0	0	0	4,820	0.95
2	NB Ramps - Sat	340	1,230	0	0	1,290	190	0	0	0	380	0	160	3,590	

January 2013 OD Table

AM Peak		4	5	7	8	9	
		Exit 20 SB	I-89 SB-South	Exit 20 NB	I-89 NB to I-91 NB	I-89 NB-North	
1	I-89 SB-North	196	367				**563**
2	I-91 SB to I-89 SB	333	254				**587**
3	I-91 NB to I-89 SB	185	176				**361**
4	Exit 20 SB		321				**321**
6	I-89 NB-South			372	248	475	**1,095**
7	Exit 20 NB				158	73	**231**
		714	**1,117**	**372**	**406**	**548**	**3,158**

PM Peak		4	5	7	8	9	
1	I-89 SB-North	186	375				**561**
2	I-91 SB to I-89 SB	264	201				**465**
3	I-91 NB to I-89 SB	70	155				**225**
4	Exit 20 SB		359				**359**
6	I-89 NB-South			581	231	843	**1,655**
7	Exit 20 NB				465	372	**837**
		520	**1,090**	**581**	**696**	**1,215**	**4,102**

Sat. Peak		4	5	7	8	9	
1	I-89 SB-North	278	322				**600**
2	I-91 SB to I-89 SB	300	122				**422**
3	I-91 NB to I-89 SB	289	111				**400**
4	Exit 20 SB		699				**699**
6	I-89 NB-South			406	167	709	**1,282**
7	Exit 20 NB				251	154	**405**
		867	**1,254**	**406**	**419**	**862**	**3,808**

	AM	PM	Sat
I-89 SB - North End	**563**	**561**	**600**
I-89 SB - SB I-91 On Ramp	587	465	422
I-89 SB - SB I-91 On to NB I-91 On	**1,150**	**1,026**	**1,022**
I-89 SB - NB I-91 On Ramp	361	225	400
I-89 SB - NB I-91 On to Exit 20	**1,511**	**1,251**	**1,422**
I-89 SB - Exit 20 Off Ramp	714	520	867
I-89 SB - Between Exit 20 Ramps	**797**	**731**	**555**
I-89 SB - Exit 20 On Ramp	321	359	699
I-89 SB - South End	**1,117**	**1,090**	**1,254**
I-89 NB - North End	**548**	**1,215**	**862**
I-89 NB - NB I-91 Off Ramp	406	696	419
I-89 NB - Exit 20 to NB I-91 Off Ramp	**954**	**1,911**	**1,281**
I-89 NB - Exit 20 On Ramp	231	837	405
I-89 NB - Between Exit 20 Ramps	**723**	**1,074**	**876**
I-89 NB - Exit 20 Off Ramp	372	581	406
I-89 NB - South End	**1,095**	**1,655**	**1,282**

Summer 2013 OD tables

Adjustment Factors:	AM	PM	Sat.
	1.16	1.13	1.08

		4	5	7	8	9	
		Exit 20 SB	I-89 SB-South	Exit 20 NB	I-89 NB to I-91 NB	I-89 NB-North	
1	I-89 SB-North	227	423				**650**
2	I-91 SB to I-89 SB	386	294				**680**
3	I-91 NB to I-89 SB	215	205				**420**
4	Exit 20 SB		370				**370**
6	I-89 NB-South			430	288	552	**1,270**
7	Exit 20 NB				185	85	**270**
		828	**1,292**	**430**	**473**	**637**	**3,660**

		4	5	7	8	9	
1	I-89 SB-North	209	421				**630**
2	I-91 SB to I-89 SB	301	229				**530**
3	I-91 NB to I-89 SB	77	173				**250**
4	Exit 20 SB		400				**400**
6	I-89 NB-South			660	260	950	**1,870**
7	Exit 20 NB				528	422	**950**
		587	**1,223**	**660**	**788**	**1,372**	**4,630**

		4	5	7	8	9	
1	I-89 SB-North	301	349				**650**
2	I-91 SB to I-89 SB	327	133				**460**
3	I-91 NB to I-89 SB	311	119				**430**
4	Exit 20 SB		760				**760**
6	I-89 NB-South			440	180	760	**1,380**
7	Exit 20 NB				273	167	**440**
		938	**1,362**	**440**	**453**	**927**	**4,120**

	AM	PM	Sat
I-89 SB - North End	**650**	**630**	**650**
I-89 SB - SB I-91 On Ramp	680	530	460
I-89 SB - SB I-91 On to NB I-91 On	**1,330**	**1,160**	**1,110**
I-89 SB - NB I-91 On Ramp	420	250	430
I-89 SB - NB I-91 On to Exit 20	**1,750**	**1,410**	**1,540**
I-89 SB - Exit 20 Off Ramp	830	590	940
I-89 SB - Between Exit 20 Ramps	**920**	**820**	**600**
I-89 SB - Exit 20 On Ramp	370	400	760
I-89 SB - South End	**1,290**	**1,220**	**1,360**
I-89 NB - North End	**640**	**1,370**	**930**
I-89 NB - NB I-91 Off Ramp	470	790	450
I-89 NB - Exit 20 to NB I-91 Off Ramp	**1,110**	**2,160**	**1,380**
I-89 NB - Exit 20 On Ramp	270	950	440
I-89 NB - Between Exit 20 Ramps	**840**	**1,210**	**940**
I-89 NB - Exit 20 Off Ramp	430	660	440
I-89 NB - South End	**1,270**	**1,870**	**1,380**

Summer 2019 OD tables

Adjustment Factor: 1.05

		4	5	7	8	9	
		Exit 20 SB	I-89 SB-South	Exit 20 NB	I-89 NB to I-91 NB	I-89 NB-North	
1	I-89 SB-North	237	443				**680**
2	I-91 SB to I-89 SB	403	307				**710**
3	I-91 NB to I-89 SB	226	214				**440**
4	Exit 20 SB		390				**390**
6	I-89 NB-South			460	299	571	**1,330**
7	Exit 20 NB				191	89	**280**
		865	**1,355**	**460**	**490**	**660**	**3,830**

		4	5	7	8	9	
1	I-89 SB-North	219	441				**660**
2	I-91 SB to I-89 SB	318	242				**560**
3	I-91 NB to I-89 SB	81	179				**260**
4	Exit 20 SB		420				**420**
6	I-89 NB-South			690	273	997	**1,960**
7	Exit 20 NB				556	444	**1,000**
		618	**1,282**	**690**	**829**	**1,441**	**4,860**

		4	5	7	8	9	
1	I-89 SB-North	315	365				**680**
2	I-91 SB to I-89 SB	341	139				**480**
3	I-91 NB to I-89 SB	325	125				**450**
4	Exit 20 SB		800				**800**
6	I-89 NB-South			470	187	793	**1,450**
7	Exit 20 NB				285	175	**460**
		981	**1,429**	**470**	**473**	**967**	**4,320**

	AM	PM	Sat
I-89 SB - North End	**680**	**660**	**680**
I-89 SB - SB I-91 On Ramp	710	560	480
I-89 SB - SB I-91 On to NB I-91 On	**1,390**	**1,220**	**1,160**
I-89 SB - NB I-91 On Ramp	440	260	450
I-89 SB - NB I-91 On to Exit 20	**1,830**	**1,480**	**1,610**
I-89 SB - Exit 20 Off Ramp	870	620	990
I-89 SB - Between Exit 20 Ramps	**960**	**860**	**620**
I-89 SB - Exit 20 On Ramp	390	420	800
I-89 SB - South End	**1,350**	**1,280**	**1,420**
I-89 NB - North End	**660**	**1,440**	**970**
I-89 NB - NB I-91 Off Ramp	490	830	470
I-89 NB - Exit 20 to NB I-91 Off Ramp	**1,150**	**2,270**	**1,440**
I-89 NB - Exit 20 On Ramp	280	1,000	460
I-89 NB - Between Exit 20 Ramps	**870**	**1,270**	**980**
I-89 NB - Exit 20 Off Ramp	460	690	470
I-89 NB - South End	**1,330**	**1,960**	**1,450**

Summer 2039 OD tables

Adjustment Factor: 1.21

		4 Exit 20 SB	5 I-89 SB-South	7 Exit 20 NB	8 I-89 NB to I-91 NB	9 I-89 NB-North	
1	I-89 SB-North	276	514				**790**
2	I-91 SB to I-89 SB	465	355				**820**
3	I-91 NB to I-89 SB	261	249				**510**
4	Exit 20 SB		450				**450**
6	I-89 NB-South			520	350	670	**1,540**
7	Exit 20 NB				226	104	**330**
		1,002	**1,568**	**520**	**576**	**774**	**4,440**

		4	5	7	8	9	
1	I-89 SB-North	252	508				**760**
2	I-91 SB to I-89 SB	364	276				**640**
3	I-91 NB to I-89 SB	93	207				**300**
4	Exit 20 SB		480				**480**
6	I-89 NB-South			790	316	1,154	**2,260**
7	Exit 20 NB				639	511	**1,150**
		709	**1,471**	**790**	**955**	**1,665**	**5,590**

		4	5	7	8	9	
1	I-89 SB-North	366	424				**790**
2	I-91 SB to I-89 SB	398	162				**560**
3	I-91 NB to I-89 SB	376	144				**520**
4	Exit 20 SB		920				**920**
6	I-89 NB-South			540	216	914	**1,670**
7	Exit 20 NB				329	201	**530**
		1,139	**1,651**	**540**	**545**	**1,115**	**4,990**

	AM	PM	Sat
I-89 SB - North End	**790**	**760**	**790**
I-89 SB - SB I-91 On Ramp	820	640	560
I-89 SB - SB I-91 On to NB I-91 On	**1,610**	**1,400**	**1,350**
I-89 SB - NB I-91 On Ramp	510	300	520
I-89 SB - NB I-91 On to Exit 20	**2,120**	**1,700**	**1,870**
I-89 SB - Exit 20 Off Ramp	1,000	710	1,140
I-89 SB - Between Exit 20 Ramps	**1,120**	**990**	**730**
I-89 SB - Exit 20 On Ramp	450	480	920
I-89 SB - South End	**1,570**	**1,470**	**1,650**
I-89 NB - North End	**780**	**1,660**	**1,120**
I-89 NB - NB I-91 Off Ramp	570	960	540
I-89 NB - Exit 20 to NB I-91 Off Ramp	**1,350**	**2,620**	**1,660**
I-89 NB - Exit 20 On Ramp	330	1,150	530
I-89 NB - Between Exit 20 Ramps	**1,020**	**1,470**	**1,130**
I-89 NB - Exit 20 Off Ramp	520	790	540
I-89 NB - South End	**1,540**	**2,260**	**1,670**

APPENDIX C – SCENARIO SPECIFIC SIMULATION RESULTS

CT River Bridge Traffic Analysis

Summer 2013 AM No Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,330	1,330	100%	63	12	B
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	1,680	1,750	96%	59	15	B
I-89 SB - Basic Between Exit 20 Ramps	1,100	920	920	100%	64	8	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	640	640	100%	61	6	A
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	1,070	1,110	96%	61	10	A
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	1,110	1,110	100%	62	10	A
I-89 NB - Merge at Exit 20 On Ramp	1,500	1,110	1,110	100%	62	10	A
I-89 NB - Between Exit 20 Ramps	500	850	840	101%	65	8	A

Note: Speed and LOS results taken from peak 15-minute period.

CT River Bridge Traffic Analysis

Summer 2013 PM No Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,160	1,160	100%	64	10	A
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	1,360	1,410	97%	62	11	B
I-89 SB - Basic Between Exit 20 Ramps	1,100	820	820	100%	65	7	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	1,370	1,370	100%	53	13	B
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	2,110	2,160	98%	57	20	C
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	2,180	2,160	101%	59	20	C
I-89 NB - Merge at Exit 20 On Ramp	1,500	2,180	2,160	101%	59	18	C
I-89 NB - Between Exit 20 Ramps	500	1,220	1,210	101%	65	10	A

Note: Speed and LOS results taken from peak 15-minute period.

CT River Bridge Traffic Analysis
Summer 2013 Sat No Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,110	1,110	100%	64	9	A
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	1,460	1,540	95%	60	12	B
I-89 SB - Basic Between Exit 20 Ramps	1,100	600	600	100%	65	5	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	930	930	100%	61	8	A
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	1,350	1,380	98%	61	12	B
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	1,390	1,380	101%	63	12	B
I-89 NB - Merge at Exit 20 On Ramp	1,500	1,390	1,380	101%	62	11	A
I-89 NB - Between Exit 20 Ramps	500	950	940	101%	65	8	A

Note: Speed and LOS results taken from peak 15-minute period.

CT River Bridge Traffic Analysis
Summer 2019 AM No Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,390	1,390	100%	62	12	B
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	1,760	1,830	96%	58	16	B
I-89 SB - Basic Between Exit 20 Ramps	1,100	970	960	101%	64	8	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	670	660	101%	61	6	A
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	1,120	1,150	97%	60	11	A
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	1,160	1,150	101%	62	11	A
I-89 NB - Merge at Exit 20 On Ramp	1,500	1,160	1,150	101%	62	10	A
I-89 NB - Between Exit 20 Ramps	500	890	870	102%	65	8	A

Note: Speed and LOS results taken from peak 15-minute period.

CT River Bridge Traffic Analysis

Summer 2019 PM No Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,220	1,220	100%	64	10	A
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	1,430	1,480	96%	62	11	B
I-89 SB - Basic Between Exit 20 Ramps	1,100	860	860	100%	65	7	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	1,440	1,440	100%	53	14	B
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	2,210	2,270	97%	53	22	C
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	2,280	2,270	101%	58	21	C
I-89 NB - Merge at Exit 20 On Ramp	1,500	2,280	2,270	100%	58	19	C
I-89 NB - Between Exit 20 Ramps	500	1,280	1,270	101%	64	11	A

Note: Speed and LOS results taken from peak 15-minute period.

CT River Bridge Traffic Analysis

Summer 2019 Sat No Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,160	1,160	100%	64	10	A
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	1,530	1,610	95%	59	13	B
I-89 SB - Basic Between Exit 20 Ramps	1,100	620	620	100%	65	5	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	970	970	100%	60	8	A
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	1,410	1,440	98%	61	12	B
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	1,460	1,440	101%	62	12	B
I-89 NB - Merge at Exit 20 On Ramp	1,500	1,450	1,440	101%	62	11	B
I-89 NB - Between Exit 20 Ramps	500	990	980	101%	65	8	A

Note: Speed and LOS results taken from peak 15-minute period.

CT River Bridge Traffic Analysis
Summer 2019 AM Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,390	1,390	100%	62	12	B
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	1,820	1,830	100%	63	11	A
I-89 SB - Basic Between Exit 20 Ramps	1,100	970	960	101%	65	8	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	670	660	101%	62	6	A
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	1,160	1,150	101%	62	7	A
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	1,160	1,150	101%	64	7	A
I-89 NB - Merge at Exit 20 On Ramp	1,500	1,160	1,150	101%	64	7	A
I-89 NB - Between Exit 20 Ramps	500	890	870	102%	65	8	A

Note: Speed and LOS results taken from peak 15-minute period.

CT River Bridge Traffic Analysis
Summer 2019 PM Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,220	1,220	100%	64	10	A
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	1,470	1,480	100%	64	8	A
I-89 SB - Basic Between Exit 20 Ramps	1,100	860	860	100%	65	7	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	1,440	1,440	100%	60	13	B
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	2,280	2,270	101%	60	13	B
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	2,280	2,270	101%	62	13	B
I-89 NB - Merge at Exit 20 On Ramp	1,500	2,280	2,270	100%	62	13	B
I-89 NB - Between Exit 20 Ramps	500	1,280	1,270	101%	64	11	A

Note: Speed and LOS results taken from peak 15-minute period.

CT River Bridge Traffic Analysis
Summer 2019 Sat Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,160	1,160	100%	64	10	A
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	1,610	1,610	100%	63	9	A
I-89 SB - Basic Between Exit 20 Ramps	1,100	620	620	100%	65	5	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	970	970	100%	62	8	A
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	1,460	1,440	101%	62	8	A
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	1,460	1,440	101%	64	8	A
I-89 NB - Merge at Exit 20 On Ramp	1,500	1,460	1,440	101%	63	8	A
I-89 NB - Between Exit 20 Ramps	500	990	980	101%	65	8	A

Note: Speed and LOS results taken from peak 15-minute period.

CT River Bridge Traffic Analysis

Summer 2039 AM No Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,610	1,610	100%	62	14	B
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	2,040	2,120	96%	56	18	C
I-89 SB - Basic Between Exit 20 Ramps	1,100	1,120	1,120	100%	64	9	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	770	780	98%	59	7	A
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	1,300	1,350	96%	59	12	B
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	1,350	1,350	100%	62	12	B
I-89 NB - Merge at Exit 20 On Ramp	1,500	1,350	1,350	100%	62	11	A
I-89 NB - Between Exit 20 Ramps	500	1,030	1,020	101%	65	9	A

Note: Speed and LOS results taken from peak 15-minute period.

CT River Bridge Traffic Analysis
Summer 2039 PM No Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,400	1,400	100%	64	11	B
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	1,640	1,700	96%	62	13	B
I-89 SB - Basic Between Exit 20 Ramps	1,100	990	990	100%	65	8	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	1,660	1,660	100%	52	17	B
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	2,540	2,620	97%	52	25	C
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	2,630	2,620	101%	57	24	C
I-89 NB - Merge at Exit 20 On Ramp	1,500	2,630	2,620	100%	57	22	C
I-89 NB - Between Exit 20 Ramps	500	1,480	1,470	101%	64	12	B

Note: Speed and LOS results taken from peak 15-minute period.

CT River Bridge Traffic Analysis
Summer 2039 Sat No Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,350	1,350	100%	64	11	B
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	1,780	1,870	95%	57	15	B
I-89 SB - Basic Between Exit 20 Ramps	1,100	730	730	101%	64	6	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	1,120	1,120	100%	56	10	A
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	1,630	1,660	98%	59	15	B
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	1,680	1,660	101%	61	14	B
I-89 NB - Merge at Exit 20 On Ramp	1,500	1,680	1,660	101%	61	13	B
I-89 NB - Between Exit 20 Ramps	500	1,150	1,130	101%	65	9	A

Note: Speed and LOS results taken from peak 15-minute period.

CT River Bridge Traffic Analysis
Summer 2039 AM Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,610	1,610	100%	62	14	B
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	2,110	2,120	100%	63	12	B
I-89 SB - Basic Between Exit 20 Ramps	1,100	1,120	1,120	100%	64	9	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	770	780	98%	62	7	A
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	1,350	1,350	100%	62	8	A
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	1,350	1,350	100%	64	8	A
I-89 NB - Merge at Exit 20 On Ramp	1,500	1,340	1,350	100%	64	8	A
I-89 NB - Between Exit 20 Ramps	500	1,030	1,020	101%	65	9	A

Note: Speed and LOS results taken from peak 15-minute period.

CT River Bridge Traffic Analysis
Summer 2039 PM Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,400	1,400	100%	64	11	B
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	1,690	1,700	100%	64	9	A
I-89 SB - Basic Between Exit 20 Ramps	1,100	990	990	100%	65	8	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	1,660	1,660	100%	57	15	B
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	2,640	2,620	101%	57	16	B
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	2,640	2,620	101%	62	15	B
I-89 NB - Merge at Exit 20 On Ramp	1,500	2,630	2,620	100%	62	15	B
I-89 NB - Between Exit 20 Ramps	500	1,480	1,470	101%	64	12	B

Note: Speed and LOS results taken from peak 15-minute period.

CT River Bridge Traffic Analysis

Summer 2039 Sat Build Freeway Operations

Segment	Length (ft)	Volume (vph)	Volume Target	% Served	Speed (mph)	Density	LOS
Southbound							
I-89 SB - Basic North of NB I-91 On Ramp	1,500	1,350	1,350	100%	64	11	B
I-89 SB - Weave NB I-91 On Ramp to Exit 20	1,800	1,860	1,870	100%	63	10	A
I-89 SB - Basic Between Exit 20 Ramps	1,100	730	730	101%	65	6	A
Northbound							
I-89 NB - Basic North of NB I-91 Off Ramp	500	1,120	1,120	100%	61	10	A
I-89 NB - Diverge at NB I-91 Off Ramp	1,500	1,680	1,660	101%	62	9	A
I-89 NB - Basic Exit 20 to NB I-91 Off Ramp	300	1,680	1,660	101%	64	9	A
I-89 NB - Merge at Exit 20 On Ramp	1,500	1,680	1,660	101%	63	9	A
I-89 NB - Between Exit 20 Ramps	500	1,150	1,130	101%	65	9	A

Note: Speed and LOS results taken from peak 15-minute period.

APPENDIX D - HIGHWAY CAPACITY SOFTWARE RESULTS

CT River Bridge Traffic Analysis

HCS Analysis Summary

AM Peak Hour

Southbound	2013			2019 No Build			2019 Build			2039 No Build			2039 Build		
	Speed	Density	LOS	Speed	Density	LOS	Speed	Density	LOS	Speed	Density	LOS	Speed	Density	LOS
I-89 SB - SB I-91 On to NB I-91 On	63.0	13.4	B	63.0	13.7	B	63.0	13.7	B	63.0	15.1	B	63.0	15.1	B
I-89 SB - NB I-91 On to Exit 20 Weave (A)	50.4	17.4	B	49.8	18.4	B	50.0	12.2	B	47.9	22.1	C	48.4	14.6	B
I-89 SB - Between Exit 20 Ramps	61.8	9.0	A	61.7	9.2	A	61.8	9.2	A	61.6	10.3	A	61.6	10.3	A
Northbound	**Speed**	**Density**	**LOS**	**Speed**	**Density**	**LOS**	**Speed**	**Density**	**LOS**	**Speed**	**Density**	**LOS**	**Speed**	**Density**	**LOS**
I-89 NB - North End	61.5	8.1	A	61.5	8.2	A	63.0	8.0	A	61.5	9.2	A	63.0	9.0	A
I-89 NB - I-91 Off Ramp Diverge	55.7	13.3	B	55.6	13.5	B				55.5	14.9	B			
I-89 NB - Exit 20 to NB I-91 Off Ramp	61.7	10.9	A	61.7	11.1	B	63.0	6.0	A	61.7	12.4	B	63.0	7.1	A
I-89 NB - Exit 20 Merge	57.5	12.0	B	57.5	12.2	B	(Weaving Section)			57.4	13.7	B	(Weaving Section)		
I-89 NB - Between Exit 20 Ramps	63.0	8.1	A	63.0	8.2	A	63.0	8.2	A	63.0	9.2	A	63.0	9.2	A

PM Peak Hour

Southbound	2013			2019 No Build			2019 Build			2039 No Build			2039 Build		
	Speed	Density	LOS	Speed	Density	LOS	Speed	Density	LOS	Speed	Density	LOS	Speed	Density	LOS
I-89 SB - SB I-91 On to NB I-91 On	63.0	10.5	A	63.0	10.9	A	63.0	10.9	A	63.0	12.4	B	63.0	12.4	B
I-89 SB - NB I-91 On to Exit 20 Weave (A)	52.6	13.4	B	52.1	14.2	B	51.7	9.5	A	50.3	16.9	B	50.2	11.3	B
I-89 SB - Between Exit 20 Ramps	62.0	7.3	A	62.0	7.6	A	61.9	7.6	A	61.8	8.7	A	61.8	8.7	A
Northbound	**Speed**	**Density**	**LOS**	**Speed**	**Density**	**LOS**	**Speed**	**Density**	**LOS**	**Speed**	**Density**	**LOS**	**Speed**	**Density**	**LOS**
I-89 NB - North End	61.4	15.6	B	61.4	15.8	B	62.9	15.5	B	61.4	18.1	C	62.8	17.7	B
I-89 NB - I-91 Off Ramp Diverge	55.1	22.3	C	55.0	23.1	C				54.8	26.1	C			
I-89 NB - Exit 20 to NB I-91 Off Ramp	61.5	19.5	C	61.5	20.2	C	60.2	12.6	B	61.4	23.1	C	59.0	14.8	B
I-89 NB - Exit 20 Merge	56.7	20.3	C	56.6	20.8	C	(Weaving Section)			56.0	23.8	C	(Weaving Section)		
I-89 NB - Between Exit 20 Ramps	63.0	10.7	A	63.0	11.0	B	63.0	11.0	B	63.0	12.6	B	63.0	12.6	B

Saturday Peak Hour

Southbound	2013			2019 No Build			2019 Build			2039 No Build			2039 Build		
	Speed	Density	LOS	Speed	Density	LOS	Speed	Density	LOS	Speed	Density	LOS	Speed	Density	LOS
I-89 SB - SB I-91 On to NB I-91 On	63.0	9.9	A	63.0	10.4	A	63.0	10.4	A	63.0	12.1	B	63.0	12.1	B
I-89 SB - NB I-91 On to Exit 20 Weave (A)	51.5	14.9	B	50.8	15.8	B	50.6	10.6	B	49.0	19.1	B	49.1	12.7	B
I-89 SB - Between Exit 20 Ramps	61.9	5.3	A	61.8	5.5	A	61.8	5.5	A	61.7	6.4	A	61.7	6.4	A
Northbound	**Speed**	**Density**	**LOS**	**Speed**	**Density**	**LOS**	**Speed**	**Density**	**LOS**	**Speed**	**Density**	**LOS**	**Speed**	**Density**	**LOS**
I-89 NB - North End	61.6	10.3	A	61.6	10.8	A	62.6	8.4	A	61.6	12.4	B	63.0	12.1	B
I-89 NB - I-91 Off Ramp Diverge	55.8	14.8	B	55.8	15.3	B				55.8	17.3	B			
I-89 NB - Exit 20 to NB I-91 Off Ramp	61.7	12.2	B	61.7	12.7	B	61.1	7.9	A	61.7	14.7	B	63.0	8.7	A
I-89 NB - Exit 20 Merge	57.5	13.1	B	57.4	13.6	B	(Weaving Section)			57.3	15.7	B	(Weaving Section)		
I-89 NB - Between Exit 20 Ramps	63.0	8.1	A	63.0	8.5	A	63.0	8.5	A	63.0	9.8	A	63.0	9.8	A

APPENDIX E - TRAFFIC ADJUSTMENTS

Continuous Traffic Counter Grouping Study and Regression Analysis Based on 2012 Traffic Data

Vermont Agency of Transportation
Policy, Planning, & Intermodal Development Division
Traffic Research Unit
March 2013

A: Interstate Highways

					Short Term Growth				**2007**	**to**	**2012**	**1.03**
					20 Year Growth				**2012**	**to**	**2032**	**1.16**
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
2007	1.00											
2008	1.01	1.00										
2009	1.01	1.01	1.00									
2010	1.02	1.01	1.01	1.00								
2011	1.02	1.02	1.01	1.01	1.00							
2012	1.03	1.02	1.02	1.01	1.01	1.00						
2013						1.01	1.00					
2014						1.02	1.01	1.00				
2015						1.02	1.02	1.01	1.00			
2016						1.03	1.02	1.02	1.01	1.00		
2017						1.04	1.03	1.02	1.02	1.01	1.00	
2018						1.05	1.04	1.03	1.02	1.02	1.01	1.00
2019						1.06	1.05	1.04	1.03	1.02	1.02	1.01
2020						1.06	1.06	1.05	1.04	1.03	1.02	1.02
2021						1.07	1.06	1.06	1.05	1.04	1.03	1.02
2022						1.08	1.07	1.06	1.05	1.05	1.04	1.03
2023						1.09	1.08	1.07	1.06	1.05	1.05	1.04
2024						1.10	1.09	1.08	1.07	1.06	1.05	1.05
2025						1.10	1.10	1.09	1.08	1.07	1.06	1.05
2026						1.11	1.10	1.09	1.09	1.08	1.07	1.06
2027						1.12	1.11	1.10	1.09	1.09	1.08	1.07
2028						1.13	1.12	1.11	1.10	1.09	1.08	1.08
2029						1.14	1.13	1.12	1.11	1.10	1.09	1.08
2030						1.14	1.13	1.13	1.12	1.11	1.10	1.09
2031						1.15	1.14	1.13	1.13	1.12	1.11	1.10
2032						1.16	1.15	1.14	1.13	1.12	1.12	1.11
2033						1.17	1.16	1.15	1.14	1.13	1.12	1.11
2034						1.18	1.17	1.16	1.15	1.14	1.13	1.12
2035						1.18	1.17	1.17	1.16	1.15	1.14	1.13
2036						1.19	1.18	1.17	1.16	1.16	1.15	1.14
2037						1.20	1.19	1.18	1.17	1.16	1.15	1.15
2038						1.21	1.20	1.19	1.18	1.17	1.16	1.15
2039						1.22	1.21	1.20	1.19	1.18	1.17	1.16
2040						1.22	1.21	1.20	1.20	1.19	1.18	1.17
2041						1.23	1.22	1.21	1.20	1.19	1.18	1.18
2042						1.24	1.23	1.22	1.21	1.20	1.19	1.18
2043						1.25	1.24	1.23	1.22	1.21	1.20	1.19
2044						1.26	1.25	1.24	1.23	1.22	1.21	1.20
2045						1.26	1.25	1.24	1.23	1.22	1.22	1.21
2046						1.27	1.26	1.25	1.24	1.23	1.22	1.21
2047						1.28	1.27	1.26	1.25	1.24	1.23	1.22
2048						1.29	1.28	1.27	1.26	1.25	1.24	1.23
2049						1.30	1.29	1.28	1.27	1.26	1.25	1.24
2050						1.30	1.29	1.28	1.27	1.26	1.25	1.24
2051						1.31	1.30	1.29	1.28	1.27	1.26	1.25
2052						1.32	1.31	1.30	1.29	1.28	1.27	1.26
2053						1.33	1.32	1.31	1.30	1.29	1.28	1.27
2054						1.34	1.33	1.31	1.30	1.29	1.28	1.27
2055						1.34	1.33	1.32	1.31	1.30	1.29	1.28
2056						1.35	1.34	1.33	1.32	1.31	1.30	1.29
2057						1.36	1.35	1.34	1.33	1.32	1.31	1.30

STATE OF NEW HAMPSHIRE, DEPARTMENT OF TRANSPORTATION - BUREAU OF TRAFFIC
IN COOPERATION WITH U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION
AUTOMATIC TRAFFIC RECORDER DATA FOR THE MONTH OF JANUARY 2013

02 253090 LEBANON- I-89 AT CROSSOVER SOUTH OF VERMONT SL (SB-NB) (01253001-01253002)

MON	DATE	DAY	12 AM	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM	Total
1	1	3	279	183	59	54	109	274	442	523	813	1540	2378	2950	3130	3064	2756	2494	1986	1469	1072	684	437	293	160	79	27228
1	2	4	74	86	117	227	512	1376	2559	2239	1873	2090	2278	2495	2532	2661	2957	3445	3137	1868	1153	813	564	335	296	135	35822
1	3	5	110	106	116	181	518	1343	2434	2313	1919	1922	2056	2332	2428	2725	2913	3356	3254	1990	1272	952	712	391	311	166	35820
1	4	6	107	131	124	212	488	1266	2409	2240	1902	2019	2325	2493	2585	2880	3336	3615	3676	2347	1878	1673	1162	681	413	232	40194
1	5	7	135	111	120	165	198	550	860	1399	1716	2293	2631	2710	2703	2543	2507	2455	2131	1658	1165	937	737	481	283	199	30687
1	6	1	111	76	52	80	108	293	555	809	1292	1720	2233	2571	2561	2733	2765	2679	2217	1645	1092	767	495	320	151	101	27426
1	7	2	72	97	113	202	537	1449	2635	2296	1883	2046	1944	2087	2301	2317	2445	2833	3170	3030	1806	1220	718	544	326	296	36367
1	8	3	131	97	105	120	230	537	1402	2583	2362	1889	1989	2013	2195	2258	2469	2960	3289	3068	1908	1251	779	601	410	270	34916
1	9	4	141	82	92	112	219	519	1465	2662	2314	1872	1927	2052	2162	2264	2525	2978	3293	3110	1849	1243	839	577	382	276	34955
1	10	5	114	128	111	130	236	508	1374	2726	2375	1911	1832	2147	2313	2356	2526	2948	3383	3219	2026	1351	996	764	434	283	36191
1	11	6	146	121	131	116	223	474	1375	2433	2197	1950	2042	2220	2455	2675	2920	3488	3672	3416	2359	1565	1348	1151	747	377	39601
1	12	7	163	134	102	87	128	228	486	856	1354	1719	2196	2655	2560	2444	2541	2594	2439	2016	1601	1181	864	766	497	319	29930
1	13	1	188	119	77	50	67	113	351	482	866	1355	2049	2693	2939	3015	3128	3014	2583	1929	1440	1003	843	574	343	205	29426
1	14	2	131	92	89	102	233	565	1408	2679	2334	1952	1902	2101	2312	2303	2542	2734	3177	2904	1726	1009	751	534	366	248	34194
1	15	3	136	81	111	110	236	541	1440	2571	2262	1775	1839	2007	2169	2162	2396	2808	3098	2987	1820	1119	776	590	349	290	33673
1	16	4	163	93	104	134	202	477	1238	2145	2030	1499	1408	1407	1675	1678	1836	2171	2552	2369	1462	932	715	472	357	270	27389
1	17	5	122	103	105	129	216	487	1399	2547	2238	1920	1867	2043	2182	2265	2484	3008	3302	3170	1992	1263	961	783	414	315	35315
1	18	6	156	115	116	163	219	476	1338	2420	2174	1933	2220	2406	2660	2679	3070	3745	3968	3780	2909	2133	1936	1841	960	481	43898
1	19	7	246	171	110	104	135	203	522	983	1489	1870	2362	2821	2883	2771	2586	2637	2520	2301	1685	1281	894	753	510	316	32153
1	20	1	196	107	77	56	89	120	312	507	874	1394	1907	2309	2564	2537	2510	2432	2291	1855	1315	841	595	479	388	205	25960
1	21	2	108	90	91	113	214	514	1282	2205	2001	1983	2507	2898	3226	3186	3481	3459	3543	3072	1784	1083	663	456	316	233	38508
1	22	3	124	83	121	123	257	479	1287	2514	2166	1723	1716	1967	2005	2050	2270	2625	2966	2811	1627	1037	728	460	316	270	31725
1	23	4	118	92	92	110	192	454	1390	2492	2147	1749	1777	1882	2081	2074	2305	2615	3010	3077	1659	1042	731	589	336	274	32288
1	24	5	118	91	100	132	208	489	1353	2481	2177	1759	1776	1985	2130	2171	2364	2812	3180	3072	1899	1238	933	725	372	305	33870
1	25	6	149	130	111	132	227	488	1311	2417	2071	1954	2040	2239	2476	2555	3062	3362	3729	3584	2549	1897	1536	1239	633	434	40325
1	26	7	233	141	96	109	187	161	495	837	1311	1784	2295	2624	2488	2461	2330	2366	2335	1957	1552	1058	907	717	420	295	29159
1	27	1	184	135	80	56	85	103	360	536	837	1272	1759	2393	2689	2848	2903	2832	2799	2306	1726	1158	699	464	311	177	28712
1	28	2	104	79	80	111	230	546	1443	2691	2284	1848	1922	2018	1949	1752	1756	1925	2222	2019	1095	722	452	413	296	201	28158
1	29	3	103	94	105	121	235	475	1214	2462	2061	1666	1708	1722	1972	2002	2235	2588	2970	2765	1602	1017	579	423	322	222	30663
1	30	4	126	117	102	101	179	454	1262	2221	2070	1834	1867	1902	1999	2062	2398	2718	3058	2899	1738	1135	776	552	521	301	32392
1	31	5	134	91	92	137	227	485	1396	2577	2194	1791	1897	1963	2203	2221	2432	2719	3102	3055	1954	1237	883	699	384	330	34203

	12 AM	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM	Total
:al average weekday	**127**	**99**	**104**	**127**	**239**	**550**	**1429**	**2495**	**2186**	**1837**	**1871**	**2009**	**2180**	**2214**	**2446**	**2835**	**3175**	**3019**	**1888**	**1245**	**913**	**720**	**440**	**302**	

APPENDIX E – PROJECTED PROJECT COSTS

Lebanon, NH – Hartford, VT
Interstate 89 over the Connecticut River
Bridge No. 044/104 (N.B.) & Bridge No. 044/103 (S.B.)
State Project No. 16148

Conceptual Construction Costs
Decision Matrix

Cost Item (2013 Costs)	REHABILITATED BRIDGE (Shoulder Widening)	REHABILITATED BRIDGE (Full Widening)	COMPLETE BRIDGE REPLACEMENT
Permanent Bridge Cost	$17.0 M	$24.0 M	$37.5 M
Bridge Demolition Cost	$1.5 M	$1.5 M	$3.0 M
Temporary Bridge Cost	$6.5 M	N/A	N/A
Approach Roadway Cost	$3.0 M	$5.5 M	$5.5 M
Total Estimated Construction Cost	**$28 M**	**$31 M**	**$46 M**

Notes:

1. Conceptual costs shown are for construction items only in current year (2013) dollars. Design, permitting, and construction phase engineering costs are not included.
2. Costs were developed based on comparable past projects, with adjustments for site-specific constraints. Unit bridge costs listed below apply to the square foot of bridge deck area.
3. The shoulder widening rehabilitation option options assume complete superstructure replacement ($175/sf) and minor substructure widening ($50/sf).
4. The full widening rehabilitation option uses $400/sf for new bridge structure and $175/sf for superstructure replacement.
5. Bridge demolition costs use $25/sf for superstructure removal and $50/sf for full bridge removal.
6. Complete replacement bridge option assumes either segmental concrete bridge (3-spans) or steel plate girder bridge (4-spans) at $400/sf for new bridge structure. Additional superstructure bridge cost ($175/sf) is included for median infill at Exit 20 bridge underpass.
7. Temporary bridge costs use $150/sf for foundations and $125/sf for superstructure costs, and include full purchase, installation, removal, and storage.
8. Approach roadway costs use $2.5M per lane mile for any new full-depth interstate roadway construction, and $1.0M per lane mile for reconstruction of existing interstate roadway.

Description:
Develop unit cost for new bridge construction (superstructure & substructure) based on comparable past projects. Sample projects will include both segmental concrete and steel plate girder construction.

Comparison #1: Newington-Dover 11238L

Nine span, 1,600-ft long bridge using haunched steel plate girders. Difficult site access due to adjacent bridges and strong tidal currents.

Bridge Costs	$42,000,000	(bridge pay items only + proporational share of mobilization cost)
Bridge Width	75 ft	
Bridge Length	1,590 ft	
Bridge Area	119,250 Sq. Ft.	
Bridge Unit Costs	$352	(June 2010 Advertisement)

Comparison #2: Brattleboro IM 091-(65)

Three span, 1,000-ft long bridge using precast segmental box girders. Difficult site access due to adjacent bridges and high level piers required.

Bridge Costs (Est.	$40,000,000	(D/B Project: Need to confirm construction cost with VTrans)
Bridge Width	100 ft	
Bridge Length	1,000 ft	
Bridge Area	100,000 Sq. Ft.	
Bridge Unit Costs	$400	(March 2013 Advertisement)

Comparison #3: LEBANON, NH-HARTFORD, VT A000(627), 14957

Three span, 444-ft long bridge carrying Route 4 over the Connecticut River. Difficult site access due to adjacent temporary bridge and village location.

Bridge Costs	$7,900,000	
Bridge Width	45 ft	
Bridge Length	444 ft	
Bridge Area	19,980 Sq. Ft.	
Bridge Unit Costs	$395	(August 2013 Advertisement)

Proposed Bridge Costs

Use **$400/sf** based on piers being higher than Newington-Dover, constructibility issues of constructing the first phase in the median in-fill area, and cost escalation to 2013.

	Complete Bridge Replacement Alternative	Superstructure In-Fill at Exit 20 ($175/sf)
Bridge Width	110 ft	40 ft
Bridge Length	840 ft	60 ft
Bridge Area	92400 Sq. Ft.	2400 Sq. Ft.
Bridge Costs	$37.0 M	$0.5 M

Description:

Develop unit cost for new superstructure for rehabilitation options. Sample projects will include only steel plate girder construction due to unknown strength of existing piers.

Comparison #1: Newington-Dover 11238L

Nine span, 1,600-ft long bridge using haunched steel plate girders. Difficult site access due to adjacent bridges and strong tidal currents.

Superstructure Co	$20,200,000	(bridge pay items only + proporational share of mobilization cost)	
Bridge Width	75	ft	
Bridge Length	1,590	ft	
Bridge Area	119,250	Sq. Ft.	
Bridge Unit Costs	$169		(June 2010 Advertisement)

Comparison #2: LEBANON, NH-HARTFORD, VT A000(627), 14957

Three span, 444-ft long bridge carrying Route 4 over the Connecticut River. Moderately difficult site access due to adjacent temporary bridge and village location.

Superstructure Co	$3,400,000		
Bridge Width	45	ft	
Bridge Length	444	ft	
Bridge Area	19,980	Sq. Ft.	
Bridge Unit Costs	$170		(August 2013 Advertisement)

Use **$175/sf** based on height of bridge above water and cost escalation to 2013.

Shoulder Widening Alternative

Bridge Width	90	ft
Bridge Length	840	ft
Bridge Area	75600	Sq. Ft.
Bridge Costs	$14.0 M	

Full Bridge Widening (superstructure cost only)

Bridge Width	110	ft
Bridge Length	840	ft
Bridge Area	92400	Sq. Ft.
Bridge Costs	$17.0 M	

Description:

Develop unit cost for minor widening of existing bridge substructure. Due to the lack of similar comaprable projects, this estimate will be based on approximate quantities of work.

Pier Cap Widening: Assume pier caps are widened by 8 feet (4-ft on each end)

Assume $200k for each pier cap for partial concrete removal, and forming and placing new concrete

Cost per pier cap =	$ 200,000
Total no. of pier caps =	10
Total Pier Costs =	$ 2,000,000

Abutment/Wingwall Widening: Assume new wingwall stems and footing extension

Assume $125k for each wingwall for partial concrete removal, and forming and placing new concrete

Cost per pier cap =	$ 125,000
Total no. of pier caps =	8
Total Pier Costs =	$ 1,000,000

Total Widening Cost = $3,000,000

Sq. Ft. Widening Cost = $50 (840-ft long x 72-ft wide existing bridges)

Use **$50/sf** for minor substructure widening based on the above.

Description:
Develop unit costs for bridge demolition for both superstructure removal and complete bridge removal.

Comparison #1: LEBANON, NH-HARTFORD, VT A000(627), 14957

Three span, 400-ft long bridge carrying Route 4 over the Connecticut River. Moderately difficult site access due to adjacent temporary bridge and village location.

Demolition Cost	$440,000		
Bridge Width	26	ft	
Bridge Length	392	ft	
Bridge Area	10,192	Sq. Ft.	
Bridge Unit Costs	$43		(August 2013 Advertisement)

Comparison #2: Richmond/Dresden, Maine - Route 197 over the Kennebec River

Ten span, 1,200-ft long bridge over the Kennebec River In Maine. Moderately difficult site access due to USCG naviagable waterway and multiple deep pier systems.

Demolition Cost	$1,200,000		
Bridge Width	24	ft	
Bridge Length	1,235	ft	
Bridge Area	29,640	Sq. Ft.	
Bridge Unit Costs	$40		(June 2013 Advertisement)

Comparison #2: MANCHESTER-HOOKSETT A000(461), 14604

Multi-span bridge deck replacement project using phased construction. I-93 over Merrimack River.

Demolition Cost	$1,000,000		
Bridge Width	70	ft	
Bridge Length	820	ft	
Bridge Area	57,400	Sq. Ft.	
Bridge Unit Costs	$17		(June 2010 Advertisement)

Use **$50/sf** for complete bridge demo due to tall pier systems and multiple in-water piers.

Use **$25/sf** for superstructure demolition based on comparable deck removal costs and an additional allowance for steel girder removal

Widening Options			Complete Bridge Replacement Options		
					ft
Bridge Width	70	ft	Bridge Width	70	ft
Bridge Length	840	ft	Bridge Length	840	Sq. Ft.
Bridge Area	58800	Sq. Ft.	Bridge Area	58800	
Bridge Demo Cost	$1.5 M		Bridge Demo Cost	$3.0 M	

Description:
Develop unit costs for temporary bridge components. Breakout cost separately for the superstructure and for the temporary foundations for use in other potential bridge alternatives.

Comparison #1: Tyngsborough, MA Temporary Bridge

Four span, 650-ft long Acrow panel bridge on temporary steel tower bents and pile supported concrete pier caps. Difficult site due to water depth, adjacent arch bridge and railroad tracks.

Temp. Bridge Cos	$5,300,000	(2005 installation & 2013 removal)	
Bridge Width	32	ft	
Bridge Length	650	ft	
Bridge Area	20,800	Sq. Ft.	
Bridge Unit Costs	$255		(2005 Advertisement)

Comparison #2: LEBANON, NH-HARTFORD, VT A000(627), 14957

Four span, 440-ft long Acrow panel temporary bridge carrying Route 4 over the Connecticut River. Moderately difficult site access due to adjacent truss bridge and village location.

Temp. Bridge Cos	$3,000,000	(2009 installation & 2015 removal)	
Bridge Width	28	ft	
Bridge Length	440	ft	
Bridge Area	12,320	Sq. Ft.	
Bridge Unit Costs	$244		(August 2013 Advertisement)

Comparison #3: ACROW Temporary Bridge Quote
Acrow bridges provided a site-specific quote for the superstructure only. They quoted $2.5M for full purchase and delivery to the site. Add 20% for Contractor installation, including overhead and profit.

Temp. Bridge Cos	$3,000,000	
Bridge Width	28	ft
Bridge Length	840	ft
Bridge Area	23,520	Sq. Ft.
Bridge Unit Costs	$128	

Use **$275/sf** for complete temporary bridge based on height of bridge above water and multiple river piers
Use **$125/sf** for superstructure portion of temporary bridge based on Acrow quote.
Use **$150/sf** for substructure portion of temporary bridge based on difference between full bridge cost and Acrow quote.

Shoulder Widening Alternative

Temp. Bridge Width	28	ft
Temp. Bridge Length	840	ft
Temp. Bridge Area	23520	Sq. Ft.
Temp. Bridge Costs	$6.5 M	

Description:

Develop unit cost for approach roadway work based on comparable past projects. Separate unit costs will be developed for new full-depth interstate roadway construction and existing interstate roadway reconstruction.

Comparison #1: Newington-Dover 11238L

Four lane interstate typical with 12-ft lanes and shoulders (12-12-12-12-12-12). New full-depth roadway approach construction adjacent to existing alignment for a major river crossing bridge.

Roadway Cost	$5,400,000	(excludes bridge, retaining wall, sound wall, and utility costs)
No. Lane Miles	2.25	(lane mile is defined here as 12-ft paved width x 1-mile length)

Roadway Unit Co $2,400,000 (June 2010 Advertisement)

Comparison #1: Bow-Concord 13742B

Three lane interstate typical with 12-ft lanes and shoulders (12-12-12-12-12). New full-depth roadway approach construction adjacent to existing alignment.

Roadway Cost	$7,000,000	(excludes bridge, retaining wall, sound wall, and utility costs)
No. Lane Miles	3	(lane mile is defined here as 12-ft paved width x 1-mile length)

Roadway Unit Co $2,333,333 (August 2011 Advertisement)

Proposed Roadway Costs (assume 1,000 LF of approach roadway at each end of bridge)

Use **$2.5M / lane mile** for full-depth construction based on comparable projects and cost escalation to 2013.
Use **$1.0M / lane mile** for existing roadway reconstruction based on engineering judgment.

Shoulder Widening Option		Full Widening Options	
Full-Depth Lengtl	0.5 lane miles	Full-Depth Lengtl	1.3 lane miles
Reconstr. Length	1.8 lane miles	Reconstr. Length	2.0 lane miles
Roadway Cost	$3.0 M	Roadway Cost	$5.5 M

Steel Replacement vs. Steel Rehabilitation

Work Item	STEEL REHABILITATION Fatigue Retrofits and Complete Repainting	STEEL REPLACEMENT Constant Depth Weathering Steel Plate Girders
Existing Steel Girder Fatigue Retrofits	$0.9 M	N/A
Existing Steel Girder Repairs	$1.2 M	N/A
Clean & Paint Existing Steel Girders	$4.0 M	N/A
Removal of Existing Steel Girders	N/A	$1.5 M
New Steel Plate Girders	N/A	$4.5 M
Bridge Seat Modifications	N/A	$1.0 M
Estimated Initial Steel Costs (2015)	**$6.1 M**	**$7.0 M**
Estimated Remaining Service Life	50 Years	75 Years
Bridge Life Cycle Cost Analysis (Base Year = 2015)	**$10.2 M**	**$9.4 M**

Notes:

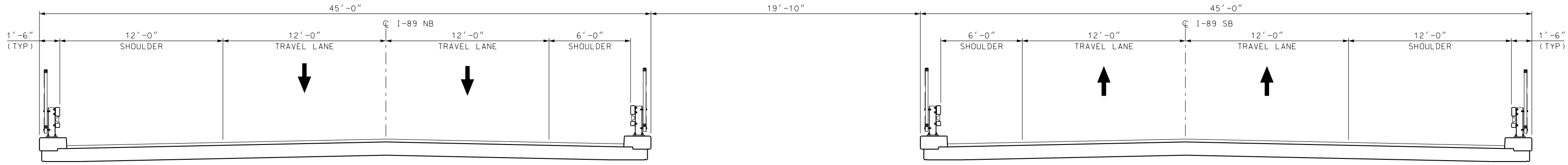
1. Life Cycle Cost Analyses (LCCA) were determined using Bridge LCC (Version 2.0), developed by the National Institute of Standards & Technology (NIST)

2. LCCA Financial Assumptions: Inflation = 2%, Real Discount Rate = 3%

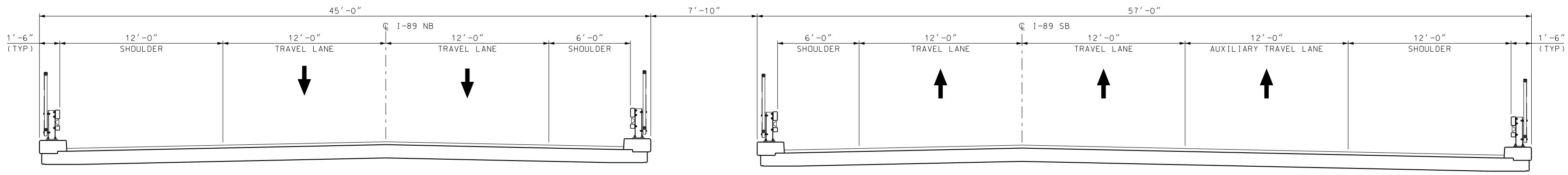
3. Future Maintenance Assumptions: Steel Painting and Steel Repairs every 20 years

4. LCCA uses a present worth calculation and a seventy-five year bridge life cycle.

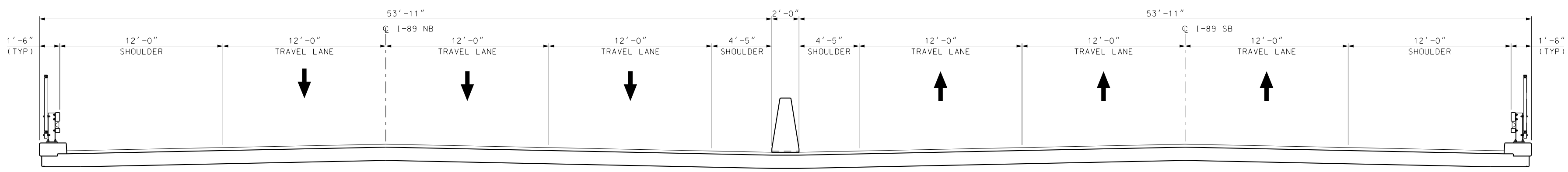
APPENDIX F – PROPOSED PROJECT ALTERNATIVES



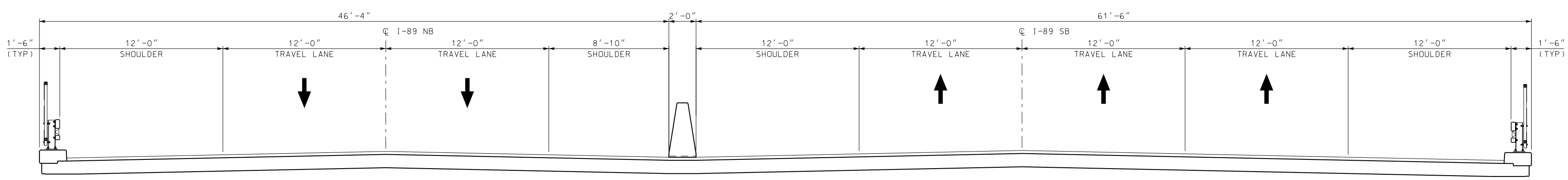
SHOULDER WIDENING ONLY



SOUTHBOUND AUXILIARY LANE



3 LANES NORTHBOUND AND SOUTHBOUND



3-LANE SB INTERSTATE TYPICAL

4 0 4 8
SCALE IN FEET

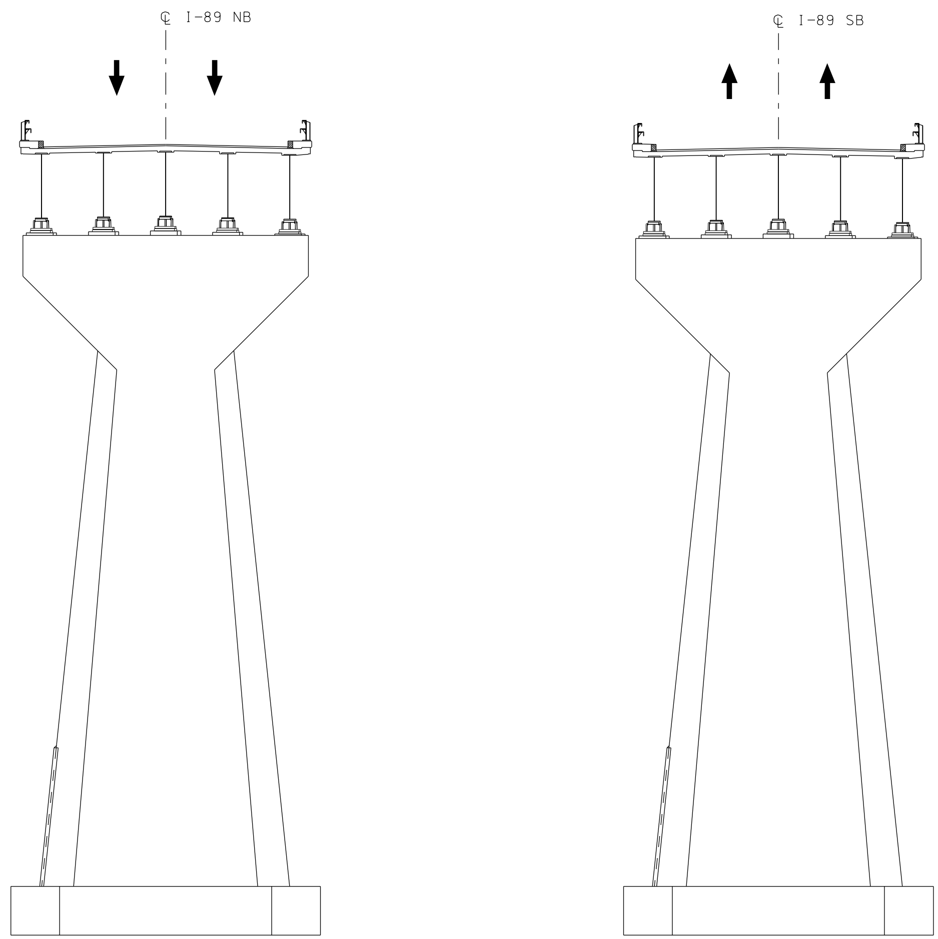
LEBANON, NH - HARTFORD, VT 16148

BRIDGE WIDTH OPTIONS

New Hampshire DOT Department of Transportation

McFarland Johnson

EXISTING PIER IV ELEVATION



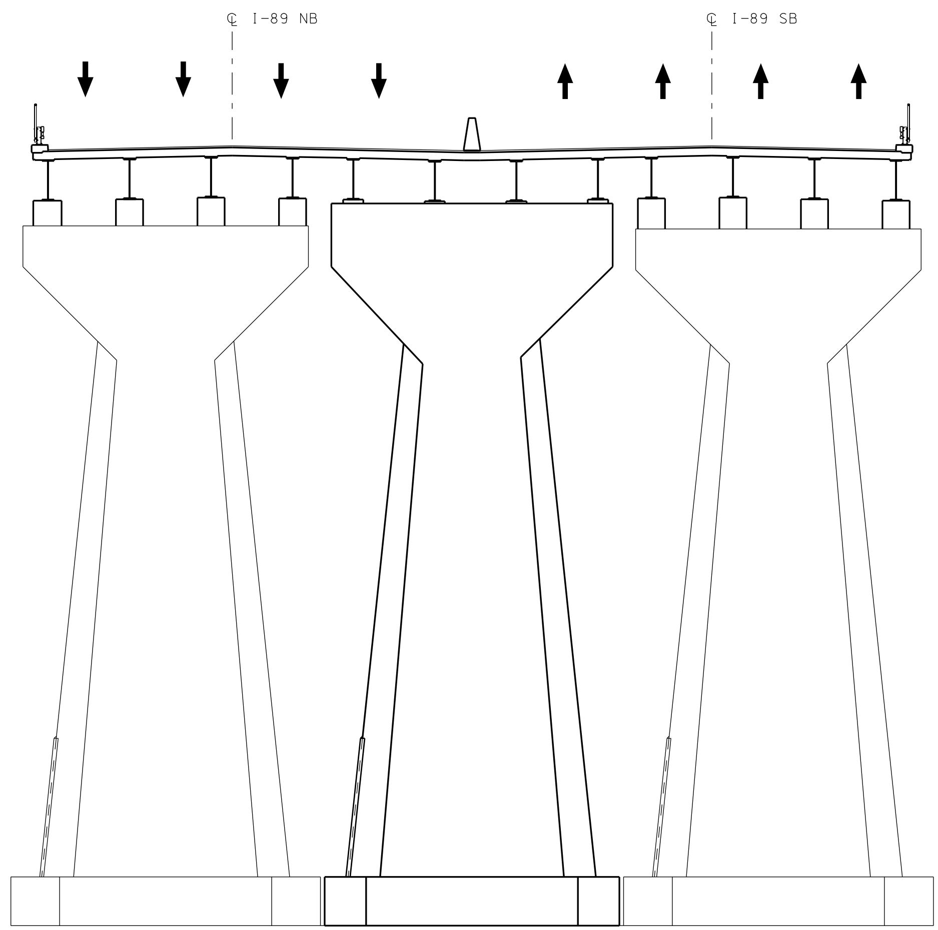
LEBANON, NH - HARTFORD, VT 16148

EXISTING CONDITION

New Hampshire DOT Department of Transportation

McFarland Johnson

IN-FILL PIER OPTION AT PIER IV

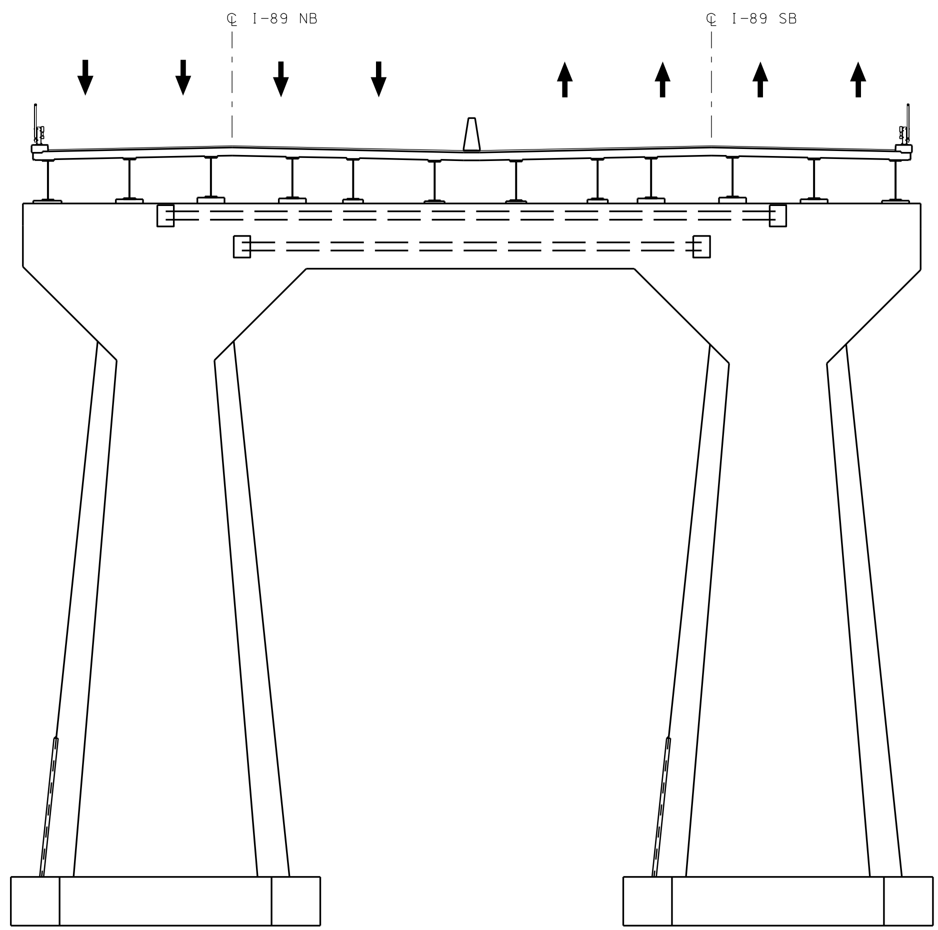


LEBANON, NH - HARTFORD, VT 16148

NEW IN-FILL PIER OPTION

New Hampshire DOT Department of Transportation | McFarland Johnson

CONNECTED PIER OPTION AT PIER IV



LEBANON, NH - HARTFORD, VT 16148

CONNECTED EXISTING PIER OPTION

McFarland Johnson