Massachusetts Cultural Resource Information System

Scanned Record Cover Page

Inventory No:	LAW.902
Historic Name:	Duck Bridge - Union Street Bridge
Common Name:	
Address:	
City/Town:	Lawrence
Village/Neighborhood:	Lawrence
Local No:	991
Year Constructed:	
Architect(s):	Boston Bridge Works
Architectural Style(s):	
Use(s):	Other Engineering; Other Transportation
Significance:	Engineering; Transportation
Area(s):	LAW.A: North Canal Historic District LAW.W: North Canal Historic District (Boundary Increase)
Designation(s):	Nat'l Register District (11/13/1984); Nat'l Register District (5/8/2009)

Commonwealth of Massachusetts
Massachusetts Historical Commission
220 Morrissey Boulevard, Boston, Massachusetts 02125
www.sec.state.ma.us/mhc

URBAN SYSTEMS

HISTORIC BRIDGE INVENTORY & EVALUATION

LAW.902

DUCK BRIDGE

Date: 5/19/80

Municipality LAWRENCE S.H. N.S.H. X

Street Name & Route # UNION ST.

Over MERRIMACK RIVER

Street Name & Route #

Bridge No. L-4-3 Bridge Key # 431 ~~899~~-514-002 100 Dist. 5

CRITERIA FOR DETERMINATION OF HISTORIC SIGNIFICANCE

I. Builders Contribution AASHTO rating: 140 (1-10-86)

Quantity

Unknown --- Several (1-10) Many X (10 or more)

Name of Builder: BOSTON BRIDGE WORKS (plate)

Designer: ---- George L Vose, consulting engineer (plate)

Plaque: Yes X No.

II. AGE: Pre 1850 1850-1900 1887-1888 1900-1930

III. TECHNICAL

Bridge type ~~Steel~~ Iron truss — Double intersection Warren through truss riveted. no verticals

Bridge Width 49.0

Total Length of Bridge 610.1

Number of Spans: 5 Span Lengths 126'-8" 114.0, 114.0, 114.0, 126

Patented: Yes No Unknown X

Load Carrying Capacity: Adequate Inadequate

Configuration: Unique Unusual X Common

Types of Materials:

List Special Features and Modifications:

originally had timber stringers and deck, steel grid deck put in 1939

LAW.902

BRIDGES PREVIOUSLY REVIEWED BY M.H.C. -- CONCURRENCE REAFFIRMED

	Municipality	On/Over	Br. Dept. No.
Bridge:	Lawrence	Union St. / Merrimack R.	L-4-3

has previously been reviewed by the Massachusetts Historical Commission and was determined to be: Potentially eligible

on 9/18/80.

After a review of all known bridges of comparable structural type identified in the M.D.P.W. statewide computerized database, the M.D.P.W. now reaffirms its concurrence with that initial determination.

Summary statement of significance:

The oldest of 21 Warren through truss bridges identified in the MDPW database; one of only 8 (out of 194) metal truss bridges in the MDPW database to include 5 or more spans; built by an important Massachusetts bridge-building firm (Boston Bridge Works); and an integral part, both visually and historically, of the historic mill city of Lawrence. One of the earliest riveted truss bridges in the database

Statement prepared by: S. J. Roper, MDPW Historic Bridges Specialist

Date: 2/25/86

URBAN SYSTEMS

HISTORIC BRIDGE INVENTORY & EVALUATION

LAW.902

DUCK BRIDGE

Date: 5/19/80

Municipality LAWRENCE S.H. ___ N.S.H. X

Street Name & Route # UNION ST.

Over MERRIMACK RIVER

Street Name & Route # ___

Bridge No. L-4-3 Bridge Key # 895-514-002 100 Dist. 5

CRITERIA FOR DETERMINATION OF HISTORIC SIGNIFICANCE

I. Builders Contribution

Quantity

Unknown --- Several ___ (1-10) Many ___ (10 or more)

Name of Builder: BOSTON BRIDGE WORKS

Designer: ---

Plaque: Yes X No. ___

II. AGE: Pre 1850 ___ 1850-1900 1887-1888 1900-1930 ___

III. TECHNICAL

Bridge type (Steel truss) ~~Double intersection~~ Warren through truss

Bridge Width 49.0

Total Length of Bridge 610.1

Number of Spans: 5 Span Lengths 126'-8" 114.0, 114.0, 114.0, 126

Patented: Yes ___ No ___ Unknown X

Load Carrying Capacity: Adequate ___ Inadequate ___

Configuration: Unique ___ Unusual X Common ___

Types of Materials:

List Special Features and Modifications:

LAW. 902

IV. ENVIRONMENTAL

Aesthetics: Unusual _____ Good _____ Common ✓
Site Integrity: Retained ✓ Violated _____
History of Bridge and Area:

See Attached sheets

V. ECONOMICS

Owner: Municipal _____ County _____ State ✓ Federal _____

R.R. _____

What is your recommendation?
Maintenance ✓ Replacement _____ Rehabilitation _____
Are materials available for Rehabilitation: Yes _____ No _____
Is structure scheduled for replacement? Yes _____ No _____

VI. PHOTOS - INDICATE SHOTS TAKEN

1. Setting
2. Builders Plaque
3. 3/4 View
4. Thru View
5. Under View
6. Elevation
7. Joint & Connections
8. Machinery
9. Decorative Features

VII. COMMENTS & CONCLUSIONS

1. In your judgement, does this bridge have historic value? Yes ___ No ___
2. Please explain your answer to #1

3. Additional Comments required on back of page.

Preparer: Wayne Rachor
Title: asst Environmental
Date of Survey: 5/12/80

INCLUDE TOPO SHEET SHOWING LOCATION

Original copy is filed in 067AX 1942

LAW 902

DUCK BRIDGE AND APPROACHES R.R.E. 1942

By Chapter 266 of the Acts of 1854 George L. Davis and other were incorporated as the proprietors of Lawrence Bridge and autho ized to erect a bridge at Union Street which either the County Co missioners or the City of Lawrence might purchase after five year provided they purchased or offered to purchase Andover Bridge. In 1854 also the County Commissioners laid out Union Street "to the southerly end of said bridge" four rods wide, the center line coinciding with the center line of the bridge then being erected.

In 1856 it appeared that the city of Lawrence in building th road had neglected filling a portion of said road "near the new bridge", and the county did the work and ordered the city to reimburse it in the sum of $899.80.

By authority of Chapter 309 of the Acts of 1868 the County Commissioners laid out the Lawrence Bridge as a public highway, ordered damages paid and ordered the city to maintain the bridge.

Chapter 299 of the Acts of 1887 authorized the city of Lawrence to borrow a sum of money not exceeding $75,000 to reconstruct the Union Street Bridge. It is not known what records there may be in the city of Lawrence relating to the rebuilding of the bridge at this time. There are no records in the county files, but in 1888 the County Commissioners under authority of Chapter 106 of the Acts of 1888 reimbursed the city of Lawrence a part of the cost of the bridge. It was thereafter maintained by the city until 1910 when full control was placed in the County Commissioners by authority of Chapter 434 of the Acts of that year (which related to both Duck Bridge and Falls Bridge) and

provided that "The County Commissioners of the county of Essex shall have full control of both bridges and shall" etc. The abutment wall on the south side now forms a part of a continuous wall on which the buildings both up and down stream are supported, whether there are, or ever were, wing walls extending back inland is not apparent, and we have no records to show it. On the north side the building east of the bridge extends considerably further out into the stream, but here also there is nothing to indicate whether there are, or ever were, other wing walls.

By Chapter 314 of the Acts of 1939 the County Commissioners were authorized to rebuild the roadway floor to consist of an open steel grid or mesh floor, and this was done.

See also Highway Index for action by the County Commissioners previous to 1910, and Bridge Schedule for record of contracts, agreements, etc. since that date.

Copy

LAW. 902

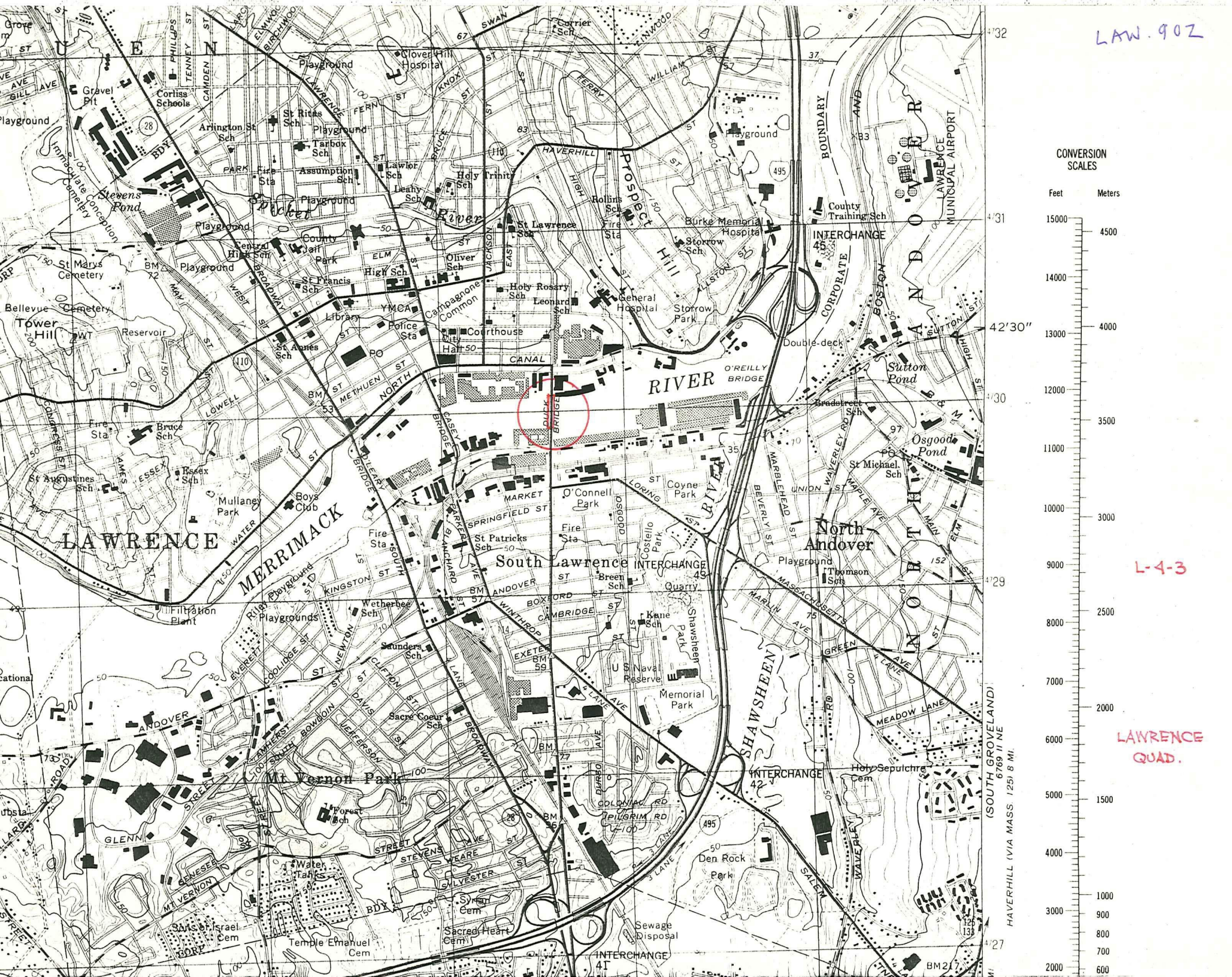
DUCK BRIDGE

Load capacity and posting

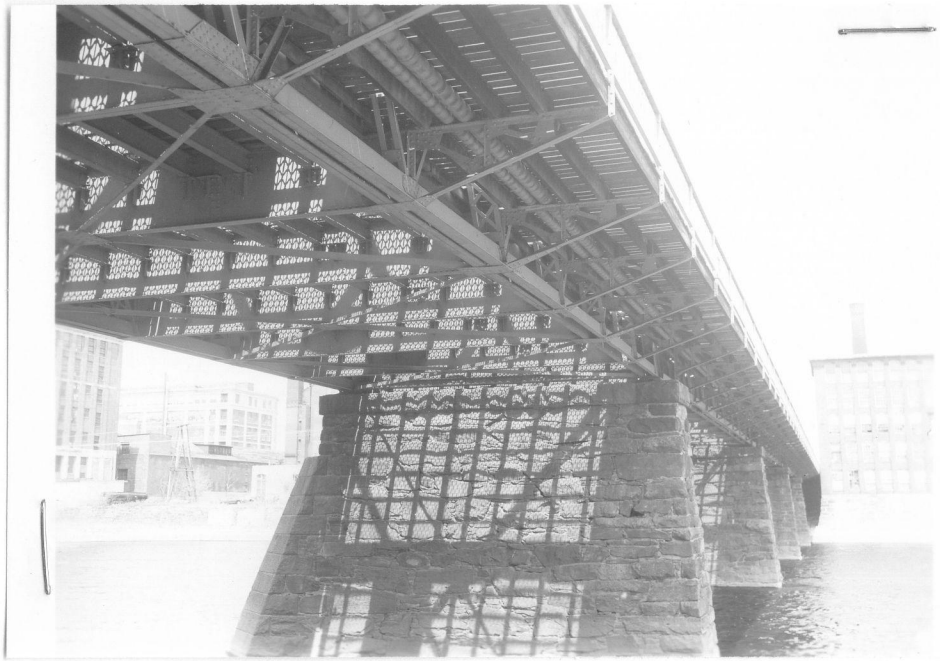
There is no information in the county files as to the load capacity for which the bridge was originally designed. The trusses and floor beams, except for repairs, are as originally built, but the original wooden stringers have been replaced by steel stringers and the roadway deck is now of the steel grid type.

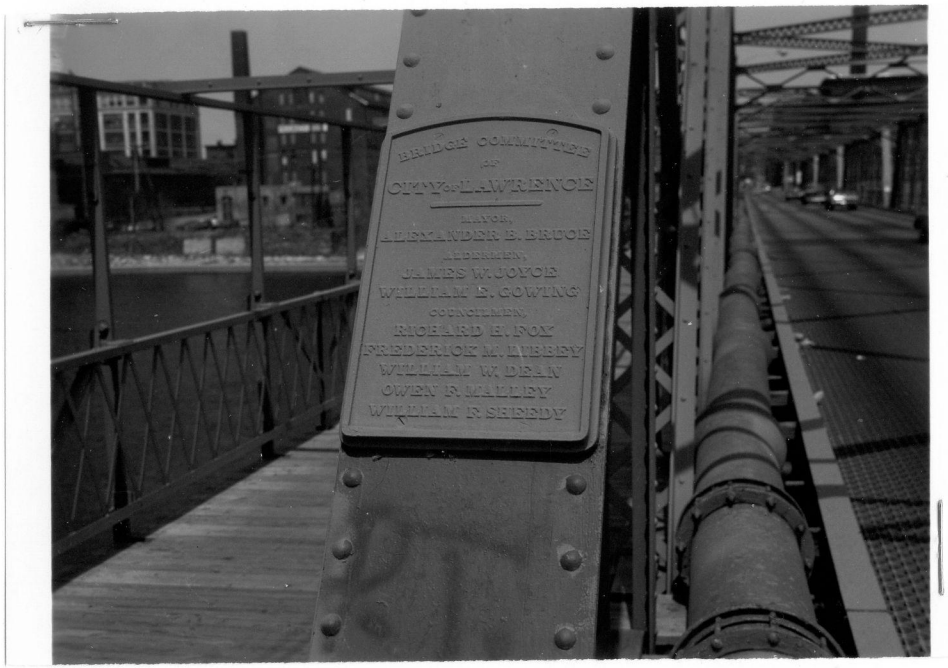
Reports of George F. Swain, LL D., are on file in 067C in 1920 when the original wooden stringers were still there and in 1928 when it was proposed to replace a part of them by steel stringers, and there is a report relating to the sidewalks by J. R. Worcester in 1933 in 067C. It is believed that the roadway is good for the fourteen ton load allowed by law, and the bridge is not posted. (See vote of County Commissioners March 2, 1934).

1942


LAW. 902
CONVERSION SCALES
Feet
Meters
42'30"
LAWRENCE
MERRIMACK
RIVER
South Lawrence
North Andover
Mt Vernon Park
Stevens Pond
Sutton Pond
Osgood Pond
Tower Hill
Prospect Hill
Shawsheen River
INTERCHANGE 45
INTERCHANGE 42
INTERCHANGE 41
L-4-3
LAWRENCE QUAD.
HAVERHILL (VIA MASS. 125) 8 MI.
(SOUTH GROVELAND) 6769 II NE

NO DATE, CA. 1980





NO DATE, CA. 1980

HAER INVENTORY

1. NAME OF STRUCTURE: Union Street Bridge (Duck Bridge)
2. DATE: 1888
3. NATURE OF STRUCTURE: Bridge
4. INDUSTRIAL CLASSIFICATION: 602
5. LOCATION: STREET & NUMBER: between Union & South Union Streets
CITY OR TOWN: Lawrence
COUNTY: Essex
STATE: MA
6. USGS QUAD MAP & UTM GRID REF.: Lawrence
19.323060. 473000
7. OWNER OF PROPERTY
ADDRESS

8. CONDITION: [X] EXCELLENT [ ] GOOD [ ] FAIR [ ] DETERIORATED [ ] RUINS [ ] UNEXPOSED [X] ALTERED [X] ACCESSIBLE TO PUBLIC

9. DESCRIPTION & BACKGROUND HISTORY: NUMBER OF STRUCTURES; DIMENSIONS; FABRIC; STRUCTURE & FORM; SURVIVING MACHINERY, FITTINGS AND EQUIPMENT; APPROX. AREA OF SITE; ALTERATIONS; PRESENT USE; ENGINEER/ ARCHITECT/DESIGNER; IMPORTANT EVENTS & INDIVIDUALS.

The Union Street bridge was built in 1888 by the Boston Bridge Works. The designer was George L. Vose. It was intended for foot and wheeled traffic between north and south Lawrence, across the Merrimack. It is a through, Parallel chord, riveted, double intersection Warren truss bridge, with 5 spans each of 135 feet in length, four granite block, cutwater style piers, and two granite block pier abutments. The piers were probably constructed for an earlier bridge during the 1850s. The bridge is of lattice and plate girder construction. Each span has 9 panels. The floor was probably originally of wood, but is now a steel lattice deck. The upper lateral system is a double intersection Warren truss. The lower system has iron or steel plate girders and plate girder stringers. The pedestrian hand rails are attractive lattices which duplicate the truss style.

10. PHOTOGRAPHS & SKETCH MAP ON REVERSE SIDE.

11. RELATED SOURCES OF INFORMATION: HISTORICAL REFERENCES (PUBLISHED ARTICLES, MANUSCRIPTS, REPORTS, DRAWINGS, PHOTO GRAPHIC RECORDS)
CONTACTS: (NAMES & ADDRESSES OF ANYONE WITH EYE-WITNESS ACCOUNTS OR RELEVANT INFORMATION); TAPE RECORDINGS.

Essex Company Records - MVTM

12. DANGER OF DEMOLITION OR DAMAGE [ ] YES [X] NO
NATURE OF THREAT:

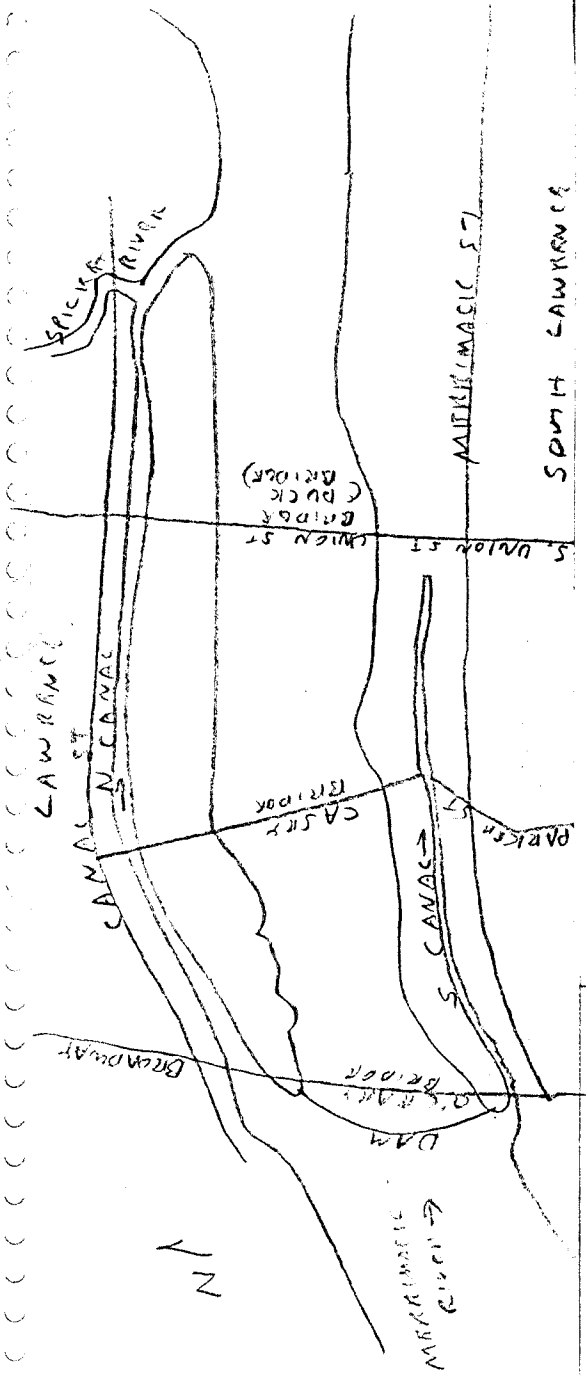
13. PRIORITY: 3

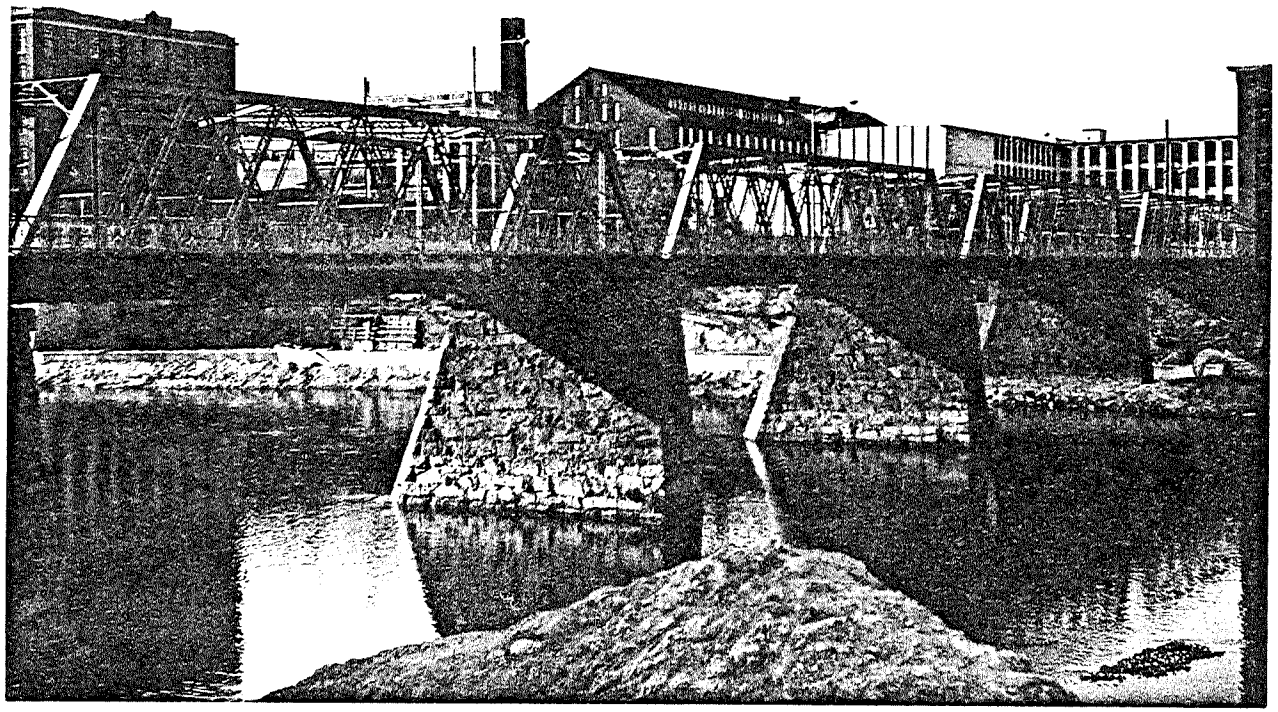
14. EXISTING SURVEYS AND DATES: [ ] NHL [ ] NR [ ] HAER [ ] HABS [ ] STATE [ ] COUNTY [ ] LOCAL [ ] OTHER

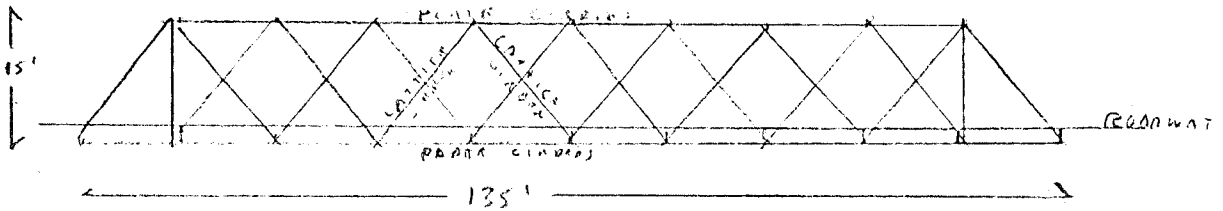
15. INVENTORIED BY: YOUR NAME: Peter M. Molloy
ADDRESS: 800 Mass. Ave., North Andover, MA
AFFILIATION: Merrimack Valley Textile Museum
DATE: 12/8/75

PLEASE RETURN TO THE HISTORIC AMERICAN ENGINEERING RECORD, NATIONAL PARK SERVICE, WASHINGTON, DC 20240

P30618X


SPICKET RIVER
MERRIMACK ST
SOUTH LAWRENCE
S UNION ST (UNION ST BRIDGE (DUCK BRIDGE))
CANAL
N CANAL
CANAL ST
PARISH
S CANAL
BROADWAY
DAM
MERRIMACK RIVER
N




15'
135'
ROADWAY
ROAD CINDERS

DETERMINATION OF ELIGIBILITY (MHC OPINION) LAW 902

TO: Sally Z

FROM: B. H Smith

DATE: 7/5/86

RETURN TO REVIEWER BY _____ (DATE)

TOWN: LAWRENCE

PROPERTY: L-4-3 Union St. over Merrimack River
(NAME AND ADDRESS)

1. Does this property meet the criteria for NR eligibility?

☒ YES MHC - eligible 9/18/80

☐ NO

A. Criteria
   a. events
   b. lives
   c. characteristics
   d. information

B. Local _____ State _____ National _____

2. Statement of Significance: OR Why not eligible?

1888 - 5 SPAN DOUBLE intersection WARREN through truss oldest known WARREN through truss in MASS. AND an integral part both visually & Historically of the mill city of Lawrence

Built by "Boston Bridge Works"

☐ DOE LETTER WRITTEN

FILED IN ER FILE _____

_____ (DATE)

DPW letter sent 9/18/80

LAW.902

DETERMINATION OF ELIGIBILITY (MHC OPINION)

TO: VKL

RETURN TO REVIEWER BY _____ (DATE)

FROM: phs

DATE: 8.27.80

TOWN: LAWRENCE

PROPERTY: Bridge # L-4-3 / Union St. over Merrimack River [Duck Bridge]
(NAME AND ADDRESS)

1. Does this property meet the criteria for NR eligibility?

☐ YES

☐ NO

MHC Inventory form missing from file

A. Criteria
   a. events
   b. lives
   c. characteristics
   d. information

B. Local_____ State_____ National_____

Eligible by inference

2. Statement of Significance: OR Why not eligible?

This is a 5-span Warren through truss across the Merrimack River, Built by the Boston Bridge Works in 1888 complete with bridge plates and identified consulting engineer, G. L. Vose. The bridge is typical of through truss bridges being built at the time by a major bridge building firm. Its relative position with relation to other through truss bridges in the area cannot at present be stated; however, MHC feels that ~~would like to see~~ a survey of surviving bridges across the Merrimack between New Hampshire and the sea would indicate that this is an important structure.

☐ DOE LETTER WRITTEN

FILED IN ER FILE_____

_____ (DATE)

LAW.902

Groton	G-14-4	Fitch Bridge Rd. over Nashua River

1898 one span bridge is the third oldest of its type in the state. Built by the Berlin Iron Bridge Company, it is set in a picturesque wooded rural area. The bridge retains integrity with only minor alterations. Determined potentially eligible by the MHC November 23, 1982.

Lawrence	L-4-3	Union St. over Merrimack River

1888 five span bridge is the oldest known Warren through truss in Massachusetts and is an integral part both visually and historically of the mill city of Lawrence.

Montague	M-28-17	Eleventh St. over power canal

Rare 1916 three span bridge is a unique triple barreled Warren through truss. There is no upper lateral bracing on the center roadway section. This bridge may be one of a kind.

Worcester	W-44-140	Providence & Worcester R.R. over Southbridge St.

1910 one span Warren truss is an outstanding example of an unusual type of design.

The following bridge does not appear to be eligible for the National Register of Historic Places.

Boston	B-16-164	Babson St. over Amtrak R.R.

If you have any further questions, please feel free to contact William Smith at this office.

Sincerely,

Valerie Talmage

Valerie A. Talmage
Executive Director
State Historic Preservation Officer
Massachusetts Historical Commission

cc: Mr. Robert McDonagh, MDPW
c/o Mr. Frank Bracaglia

VAT/WS/dr

W>
LAW.902

The Commonwealth of Massachusetts

Office of the Secretary of State
Michael Joseph Connolly, Secretary

Massachusetts Historical Commission
Valerie A. Talmage
Executive Director
State Historic Preservation Officer

January 6, 1987

Mr. James A. Walsh
Division Administrator
Federal Highway Administration
Transportation Systems Center
55 Broadway - 10th Floor
Cambridge, MA 02142

ATTN: Mr. H. Pearlman

RE: Warren Through Metal Bridges

Dear Mr. Walsh:

The Massachusetts Historical Commission staff has reviewed the historic bridge inventory forms prepared by the Massachusetts Department of Public Works. The MHC concurs with the preliminary findings of the MDPW that the following bridges appear to meet criteria for listing in the National Register of Historic Places.

Single-Intersection Warren Through Trusses

Florida/Rowe F-5-1/R-10-5 Rowe RD over Deerfield River

1916 unaltered two span bridge is the third oldest of its type in the state. On an historic crossing leading to the former Hoosac Tunnel station on the B & M R.R., the bridge remains today in a very picturesque rural setting.

Holyoke H-21-32 B & M R.R. over Lyman St.

1928 one span bridge is notable for its skew and sliding bearing in its approach span. Located within the Holyoke Canal System National Register Historic District.

Westfield	W-25-10	N. Elm St. over Westfield River

1938 two span with polygonal upper chords. Is in virtually untouched condition. Designed by Fay, Spofford & Thorndike.

The following bridges do not appear to be eligible for the National Register of Historic Places.

Athol	A-15-7	Exchange St. over Millers River
Boston	B-16-232	I-93 over Charles River
Cambridge	C-1-20	Alewife Brook Pkwy. over B & M R.R.

MHC determined not eligible January 30, 1981.

Fall River/Somerset	F-2-58/S-16-8	I-95 over Taunton River

MHC determined not eligible May 20, 1986.

Great Barrington	G-11-2	Division St. over Housatonic River
Great Barrington	G-11-8	Brookstone Rd. over Housatonic River
Lawrence	L-4-22	So. Union St. over B & M R.R.
Lee	L-5-11	Center St. over Housatonic River

MHC determined not eligible July 7, 1980.

Ludlow/Wilbraham	L-16-3/W-35-1	Miller St. over Chicopee River
Malden	M-1-5	Mountain Ave. over MBTA
Northfield	N-22-14	East Northfield Rd. over B & M R.R.

Double-Intersection Warren Through Trusses

The following bridge was listed as a contributing element in the Turners Falls National Register Historic District May 10, 1982.

Montague	M-28-16	Sixth St. over power canal

The following bridges appear to be eligible for the National Register of Historic Places.

Buckland/Shelburne	B-28-22/S-11-1	Bridge St. over Deerfield River

1890 three span bridge is the second oldest Warren through truss in Massachusetts. Significant architectural details include latticed railing/ portal bracing and builders plate. A visual landmark and an integral part of an historic village. Determined eligible by the Acting Keeper of the National Register December 17, 1981.

Duck Bridge (Union Street Bridge)
Spanning the Merrimack River on Union Street
Lawrence
Essex County
Massachusetts

HAER No. MA-104

PHOTOGRAPHS
WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Department of the Interior
Washington, DC 20013-7127

HISTORIC AMERICAN ENGINEERING RECORD

DUCK BRIDGE
(UNION STREET BRIDGE, LAWRENCE BRIDGE)
HAER No. MA-104

Location:	Spanning the Merrimack River on Union Street, Lawrence, Essex County, Massachusetts UTM: Lawrence, Mass. Quad. 19/472999/3236100
Date of Construction:	1888
Structural Type:	Five-span double-intersection Warren through truss bridge
Engineer:	George L. Vose, Consulting Engineer
Fabricator/ Builder:	Boston Bridge Works, Cambridge, Massachusetts
Previous Owner:	City of Lawrence, Massachusetts
Present Owner:	Massachusetts Department of Public Works, Boston
Use:	Vehicular and pedestrian bridge
Significance:	The Duck Bridge is the oldest double-intersection Warren through truss in the state under Massachusetts Department of Public Works purview, and is one of the state's oldest all-riveted bridges. It was built by a significant late-nineteenth century bridge company, the Boston Bridge Works. The bridge is an integral part, both visually and historically, of the dramatic industrial landscape of the City of Lawrence, Massachusetts.
Project Information:	Documentation of the Duck Bridge is part of the Massachusetts Historic Bridge Recording Project, conducted during the summer of 1990 under the co-sponsorship of HABS/HAER and the Massachusetts Department of Public Works, in cooperation with the Massachusetts Historical Commission. John Healey, HAER Historian, August 1990

Description

The Duck Bridge spans the Merrimack River close to the site of the Duck Mills. It connects the communities of Lawrence and South Lawrence at a point where both banks of the river are flanked by an extensive array of textile mills. The canals to the north and south are bridged nearby. These crossings have long been referred to as the Duck Bridge or Bridges. The main Duck Bridge, a five-span double-intersection Warren through truss, replaced an earlier timber bridge at this location in 1888.

The two bankside spans, utilizing the original piers (which have been raised) and abutments are 168'-8" long, and are subdivided into ten panels each. The three central spans are all 114'-0" in length, and are comprised of nine panels each. The panels in all the trusses measure 12'-8" in width. The overall height of the truss is 21'-7¼". The width across the center line of the chords is 31'-6", and the overall width including the two outrigger sidewalks is 49'-6".[1] The trusses are of the double-intersection Warren pattern, a style sometimes called "lattice" in the nineteenth century.

The upper chord and inclined endposts are inverted troughs made of an 18" top plate and two 13½" side plates connected by continuous angles. A second plate is added to the top between the first and second panel points. The side plates are about 10¼" apart. The bottoms of the side plates are connected with a single lattice, whose bars are bent at the ends for single rivet connections. The top chord is in four segments, connected by external splice plates. At the hip there is a short, bent plate on top and the side plates are connected by gusset plates, the inside ones being much larger because they also connect the web members. The inclined endposts, which slope at 60 degrees, are similar to the top chord, except that the side plates are ½" wider.

The lower chord is made of two inverted T sections, each comprised of a 13½" stem plate and two angles. In the shorter trusses, the segments are spliced by a pair of plates for the stem, and two angles plus a plate across the bottom for the chord angles. The stem plates of the bottom chords fit inside the side plates of the endposts and are riveted to them. The trusses rest on bearing plates, and are secured to them by small side clips. Nests of eight rollers are used at the expansion ends of the trusses.

The web compression members are made of two angles which toe out and are connected by double lacing bars. The tension members are also double angles, but these toe in and are connected by batten plates. The webs are riveted directly to the vertical plates of the chords; the outstanding legs of the compression members are connected to them by lug angles. The web members are connected where the tension member passes inside the angles of the one carrying compression. The compression angles range from 6"x4" to 3"x3", while the tension angles vary from 5"x3½" to 3"x3".

The lateral bracing of the upper chord follows the Warren pattern. There are five panels in the longer trusses, each being equal in size to two panels of the main trusses. The shorter trusses have six panels, a bracing panel equals one-and-a-half main truss panels. The bracing members are comprised of two pairs of angles, 9½" back-to-back, connected with a single

system of lacing bars. The portal bracing is a single Warren truss.

The transverse floor beams are built-up with a web plate and four angles, 3'-2½" deep at the trusses and 3'-6" deep at midspan. The beams are flush bottom with the lower chords and a horizontal plate connects them, as well as the lower chord bracing. The lower chord bracing is single angles, 4"x3", forming X's in every panel. The sidewalks are carried on trussed extensions to the floor beams. The railings are latticed, with cast iron rosettes, and the endposts are elaborate castings.[2]

Bridge Specifications

The committee in charge of the Duck Bridge chose Engineer George L. Vose of Boston "to prepare the general plan, and the specifications showing just what kind of bridge it was proposed to have."[3] The specifications drawn up were most particular; the bridge was to have two spans of 123', and three spans of 110'-36/100"; the spans were to be of wrought-iron riveted lattice construction, with the trusses spaced 30' apart. The bridge was to be a through truss with "the roadway resting on the lower chords," and a clear headroom of 15'. The weight of each span was around 200 tons. Of the materials used in the bridge "all wrought iron is to be tough fibrous, uniform in quality, free from blisters, flaws or other imperfections." It was to have an ultimate tensile strength of 46,000 lbs./sq.in., and an elastic limit of not less than 23,000 lbs./sq.in., while no iron less than ¼" was to be used in the structure. The bridge was to be built to carry "a general load of 80 lbs./sq.ft. on any part of the roadway or sidewalks." Vose suggested that such a load was "hardly possible ... except by packing a mass of picked men all over the bridge as close as they can stand." A considerable safety factor appears to have been built into the design as Vose continues "this load is only one fifth part of that which would break the bridge down." The floor was to carry "a concentrated load of 16 tons on 4 wheel." At these loads the members were to be proportioned and arranged so that "the maximum strains must not exceed 10,000 lbs./sq.in. of the net section for general tension members." Compression members were to be proportioned according to an empirical formula relating length and cross-section to a maximum permitted strain. Members "subject to alternate strains of tension and compression" were to be "proportioned to resist both strains." The lateral bracing system was to be "proportioned for a wind pressure of 30 lbs./sq.ft." Portal bracing was to be installed, and be "capable of carrying the upper wind strains to the abutments." Specifications for the proportioning of compression members, and of riveting pitch, shearing and bearing capacity are included, together with numerous other matters of detail. References in the text suggest that the specifications were accompanied by plans drafted by Vose.[4]

Boston Bridge Works

Boston Bridge Works evolved from the failed National Bridge & Iron Works of Boston. David Andrews, one-time employee of the now bankrupt concern, bought the plant of his erstwhile employers in 1876. He did not, however, use

their East Boston shops, moving the equipment to a new location in Cambridge. Initially trading under the proprietor's own name, the company became known as the Boston Bridge Works in 1879. Andrews had received both a practical engineering machine shop apprenticeship and a measure of formal engineering training at Dartmouth College. During the early 1870s he was employed by C.H. Parker at National Bridge, where he distinguished himself in design work for that company. He was particularly noted for his innovative approach to the design of Boston's Union Station. It is unclear whether Andrews was in National Bridge's employ at the time of their bankruptcy.

Andrews does not appear to have continued production of National Bridge's stock product, the Parker Patent Truss. It appears that from an early date he made a decision to specialize in bridges of Warren or Pratt configuration. The company's oldest surviving bridge, constructed in 1878, located on Main Street in Framingham, Massachusetts, is an all-riveted Warren truss, though its bowstring chord is perhaps a vestige of National Bridge shop practice.

By the mid 1880s the company had sufficient financial security to expand their capacity to 5,000 tons. The company's reputation for efficient production and competent workmanship impressed George Vose, who had implored the City of Lawrence to be "mindful to the character of the builder, [and] to the style of his work."[5]

Earlier Bridges at Lawrence

The City of Lawrence developed rapidly following the formation of the Essex Company in 1845. The company was founded by a group of Boston businessmen, keen to emulate the success of Lowell. To this end they impounded the waters of the Merrimack River behind the Great Dam, and built to the north and south of the river two parallel power canals. The provision of water power supplied the catalyst for the rapid development of a thriving textile industry, that was to provide the economic base upon which the city was founded.

Prior to this period the banks of the river were bound by the townships of Andover, to the south, and Methuen to the north. The two were first connected by a bridge in 1793. In that year the "proprietors of Andover Bridge" were given powers to construct a crossing and charge tolls for its use. The timber structure was completed by November of that year, and occupied the site of the present railroad bridge. In common with many of its contemporaries it was rebuilt many times, and relocated at the site of the present O'Leary Bridge.

In 1854 George Davis and George Cabot were incorporated as the proprietors of Lawrence Bridge. In that year an Act (Chapter 265) was passed allowing them to build a new toll bridge to span the river at the eastern end of the Lawrence. For some reason, the authorization to construct this bridge was turned over to the county, and during October of that same year, the Essex County Commissioners laid out Union Street "to the southerly edge of said bridge." The bridge was constructed between 1854 and 1855. Its four covered, lattice timber spans rested on stone abutments and piers. The three piers of

the bridge were to be built by a contractor under the direction of the Essex Company's engineer. The piers were to be founded on the natural bed of the river, and protected from scour by loose stones placed around their base.[6] The structure was 612' long and 40' wide, and was said to have cost about $50,000.[7] Under an Act of 1868 (Chapter 299) the County Commissioners laid out Lawrence Bridge as a public highway, charging the city with the structure's maintenance.[8]

During the years 1885 and 1886 the following works were undertaken: the deck was replanked, the suspension trusses repaired, and minor works undertaken on the walkways and rails. It was proposed that "a pitched roof should be built on the road guard instead of the present flat one."[9] However, the condition of the bridge seems to have been a matter of local concern. Although it had been repeatedly examined and pronounced safe, it was said to have been unsafe for years and was considered "a structure of known weakness admitted to be dangerous."[10]

On May 4, 1887, the Merrimack was reported to be spanned by "an arch of flames."[11] A fire broke out on Duck Bridge during the afternoon of that day. At 5:45 p.m. "a small wreathe of smoke" was noted coming from the roadway at the first pier from the south abutment. Within minutes it was reported that "a mass of flames shot up from the west coping [of the pier]." Fanned by a northwesterly wind the whole southern section was reported to be "a seething mass of flames [and] a solid barrier of fire nearly 100' high." By 6:00 p.m. only two spans remained standing and the fire was spreading across them, "the boards [of the housing] falling off to reveal the burning lattice work." By 6:17 the remaining spans fell. City and mill fire brigades were in early attendance.[12]

The City Council acted promptly to replace the structure. On the day following the fire a Special Committee was appointed and authorized to: "procure plans and estimate for rebuilding the bridge, ... employ experts and engineers, ... [and] consider the expediency of building a temporary bridge." The Mayor was authorized to petition the Legislature for authority to issue bonds not to exceed $75,000 to pay for a new bridge. Under Chapter 299 of the Acts of 1887 such authority was granted. The old bridge said to have been worth $28,000, but the structure was not insured.

A temporary trestle bridge was built on the piles driven 3' into the river bed. Misfortune seems to have befallen the city during the early summer of 1887, for on June 24, 1887, storm waters broke the log booms at Lowell and Chelmsford Dams. A "100-log drive" swept over Lawrence Dam and became trapped beneath the temporary bridge. As the waters rose the bridge was lifted and half of it swept away. Remarkably the wayward half was recovered from Newburyport to be towed upstream and reinstated![13]

George L. Vose

The Committee appointed George L. Vose as consulting engineer to the City. Vose appears to have been something of a crusading figure in the business of bridge contracting. As Professor of Civil Engineering at Massachusetts Institute of Technology he corresponded in strong terms

concerning the Aiken Street Bridge (HAER No. MA-106) contract in the neighboring city of Lowell. He advised the Mayor of Lawrence against the "false idea of economy" that might risk "disaster." He warned the Mayor of "the many companies" who would build a bridge according to the town's budget, with the consequence that "there are hundreds of bridges ... which await only some extra heavy load ... to break down." It was his intention to ensure that Lawrence was provided with a bridge "that will certainly be safe under all possible conditions." Recalling Lowell's experience over the Aiken Street Bridge contract, Vose advised the Bridge Committee that in order to "avoid such a fizzle as that here" they should deal with "safe, reliable companies, they who take pride in their work, and who transact their business on a firm basis." Vose advised the city against indiscriminate letting of the contract. He suggested that instead of following the the usual practice of "advertizing for proposals, and allowing all sorts of companies good bad and indifferent to send allsorts of plans at all sorts of prices" he should "prepare a general plan, and the specifications, showing just what kind of bridge it was proposed to have." He proposed to submit his plans to only "half a dozen of the most reliable companies" who would bid "a fair price for doing the work."[14]

Construction of Duck Bridge

The Special Bridge Committee heeded Vose's advice. Vose, in consultation with City Engineer Marble, devised plans and asked six bridge companies to bid on them. It was decided to shorten the central spans of the bridges, rendering the central pier redundant. It was agreed to build two new piers to either side ofthe center of the river, and to rebuild the new bankside piers and the abutments to a higher level to accept the new iron superstructure. It was to be the responsibility of the City Engineer to oversee this work. The bridge design was to be a latticed wrought iron truss. (Presumably Vose's plan depicted the form now classified as a double-intersection Warren truss.)

At the Special Bridge Committee meeting of June 27, 1887, Vose informed those present of the replies he had received from the six companies from whom he had requested bids: the Union Bridge Company of New York could not build the bridge that season; the Keystone Bridge Company of Pittsburgh was too busy to build in the time required; the Philadelphia Bridge Company did not build highway bridges at that time of the year, and in any case, could not do so that season; the Rochester Bridge Company quoted the lowest price of $35,000, but stated that they could not complete in the time required; the Boston Bridge Works furnished the next lowest bid at $39,790, but would not be able to finish until February of the following year; the Niagara Company of Buffalo quoted a price of $44,650, for completion by the end of the year. At the same meeting it was resolved that "there forthwith be built by contract an iron bridge." Having considered the bids the Committee met on July 27, 1887, to award the contracts for the ironwork. It was moved and accepted that the Boston Bridge Company be awarded the contract, that the bridge completed by February 1, 1888, and that a penalty of $50 per day be imposed for any delay. The contract was signed by D.H. Andrews on August 6, 1887, although the

penalty clause was excluded.[15]

While the arrangements for the ironwork were being finalized, the bids for the masonry work were considered. At a meeting of the Special Bridge Committee on July 12, 1887, the contract was awarded to local contractors Trumball, Cheney, Moulton & O'Mahoney, who bid $14,737. Although a lower bid of $13,826 was received, it was rejected on the basis of it being made "for a Boston firm." Two other companies tendered bids of $15,323 and $15,798. The successful company calculated their offer on the basis of the following costings: cut stone granite masonry $24.50; rubble masonry $5.75; rip-rap (loose stone at the foot of the structure) 75¢. The contract called for the construction of of two new piers. As the river bed was composed of compacted boulders and gravel pile driving was not possible and the piers were to be founded on a rubble stone foundation, excavated 1' into the river bed. Of the three old piers, the middle one was to be removed and the stone used in the new works, while the remaining two were to be extended at nose and tail, and built up to the elevation of the new bridge. Likewise the old abutments were to be raised and widened. Coursed granite cutwaters were to be built on the upstream face of the piers. The piers were to be capped by dressing copings. Elsewhere rubble masonry was to suffice. The successful company was expected to complete the work within twelve weeks, the structure being ready to receive the ironwork by October 4, 1887. A penalty of $25 per day was to be imposed for any delay.[16]

Details of the bridge's construction are slight, although the completion of the masonry work appears to have been considerably delayed. The old piers seem to have required much attention, the City Engineer speaking of the "four new piers" in his report on the bridge.[17] It was not until mid-December that the masonry was reported to have been completed. By this date an extension railway had been built to the southern end of the bridge works, and it was reported that "seven car loads of lumber, to be used in the staging has arrived from the iron works, but the iron is not expected before February." Upon arrival it was to be "put-up in about four weeks ... if river conditions were favorable."[18] It would seem that while awaiting the arrival of the ironwork the bridge builders were busy erecting the falsework (staging) on which the ironwork would be assembled. Progress must have been interrupted, when on January 8, 1888, a freight train carrying timber suffered brake failure, and two cars fell into the river while a third was left hanging from the abutment.[19] It is not recorded when bridge erection began, however the bridge works promised the City that material would arrive at the site to allow construction to commence before January 15, 1888.[20] The bridge would appear to have been substantially complete by March 15, 1888, when the trusses were being painted. On this date, D.H. Andrews advised the city that the bridge might be "opened to travel on the following Saturday."[21]

On March 24, 1888, Vose made his final inspection of the bridge, expressing his satisfaction he recommended the City to make final payments to Boston Bridge Works.[22] City Engineer Marble pronounced his satisfaction with the completed bridge, having checked the dimensions of all members, and carried out a load test of March 30, 1888. A deflection of ⅛" was noted as "three double dump carts loaded with gravel, passing three abreast across the

the bridge." The test load was said to be 83½ tons.[23] Vose in his correspondence of March 24, 1888, had suggested that little was to be gained by such tests. He advised the Mayor that "for a test to be meaningful its effect must be known, particularly has any part been overstrained by loading during testing" he reaffirmed his conviction that the "best test of quality was computation from plans, and the character of the builder."

The final account for the bridge amounted to $64,220.22. Boston Bridge Works received $39,790 in three payments. The masonry contractor received $18,534.09, the total cost of the masonry amounting to $21,712.31 including materials and superintendence. Vose received his usual fee of 1 percent of the bridge contractor's fee. The Essex Bridge Company received a nominal payment for the additional obstruction to river flow caused by the additional pier. Essex County Commissioners, under the authority of the Chapter 106 of the Acts of 1888, were empowered to reimburse the city for 25 percent of their expenditure on the bridge. The county contribution became a matter for contoversy for a short time, Essex refusing to make payment as in their haste to rebuild the bridge the City had omitted to consult with the County over their plans. This diplomatic oversight was however soon forgotten and the payment made. Those monies provided by the City were raised by $2,000 and $1,000 yielding 4 percent over their fifteen-year term.[24]

As part of the overall improvements to Union Street it was considered opportune to renew the adjacent North and South Canal Bridges as part of the main river crossing project. To this end, Boston Bridge Works provided a Warren truss and a plate girder bridge for the North and South Canals respectively. The Moseley iron bridge over the South Canal was relocated to carry Parker Street over the South Canal. The main bridge has only required the usual renewal of decking in the ensuing years. In 1914 both stringers and deck were renewed, the shelf brackets being upgraded at this time. In 1939 the wooden deck system was replaced in steel employing I-beam stringers and a steel grid deck. In 1910 the bridge was transferred to the authority of Essex County, who passed it to the state on January 1, 1966.

ENDNOTES

1. Original plans for Duck Bridge, 1887, located at the Office of the City Engineer, Lawrence, Massachusetts.

2. Ibid., "Details of Floor."

3. Letter from Vose to Mayor Mack, March 24, 1888. The letter explains at great length the process by which the City contracted for the bridge. Located in the files of the City Engineer, Lawrence City Hall.

4. Original plans and specifications for Duck Bridge, 1887; and, Letter from Vose to Mayor Mack, March 24, 1888.

5. Vose to Mayor Mack, March 24, 1888.

6. Specifications for Duck Bridge piers, 1855. Located in the files of the City Engineer, Lawrence City Hall.

7. Lawrence American, May 6, 1887.

8. "Lawrence up to Date, 1845-1895."

9. Report of Superintendent of Public Property, Lawrence City Book 1886-87.

10. "The Lawrence American Congratulates Itself on the Burning of Duck Bridge," Lawrence American, May 10, 1887.

11. "Gone at Last Report of Destruction of Duck Bridge," Lawrence American, May 6, 1887.

12. Ibid.

13. Lawrence American, July 1, 1887; and, City Engineer's Report, Lawrence City Books 1887-88, p. 26.

14. Lawrence American, July 1, 1887; and, Letter from Vose to Mayor Mack.

15. Lawrence American, July 1 and 22, 1887. The original contract between Boston Bridge Works and the City is located at the City Engineer's Office, Lawrence City Hall.

16. Lawrence American, July 15, 1887.

17. City Engineer's Report, Lawrence City Book 1887-88, p. 27.

18. "The New Bridge," Lawrence American, December 16, 1887.

19. Lawrence American, January 13, 1888.

20. Mayor's Address, Lawrence City Book 1887-88, p. 19.

21. Letter from Andrews to Mayor Mack, March 15, 1888.

22. Vose to Mayor Mack, March 24, 1888.

23. Letter from Marble to Mayor Mack, April 13, 1888.

24. Lawrence City Books 1887-88, pp. 23, 28 and 56; and 1888-89, pp. 293-94.

BIBLIOGRAPHY

Duck Bridge files, located in the Office of the City Engineer, Lawrence City Hall.

Lawrence American, Lawrence, Massachusetts, 1887-88.

Lawrence City Book, 1886-87 and 1887-88.

"Lawrence Up To Date, 1845-1895."

Original plans for Duck Bridge, 1887, located in the Office of the City Engineer, Lawrence City Hall.

HISTORIC AMERICAN ENGINEERING RECORD

INDEX TO PHOTOGRAPHS

Duck Bridge (Union Street Bridge) HAER No. MA-104
Spanning the Merrimack River on Union Street
Lawrence
Essex County
Massachusetts

Martin Stupich, Photographer, Summer 1990

MA-104-1 General view from north river bank, looking southeast

MA-104-2 General view from north river bank, showing two northern spans, looking east

MA-104-3 Oblique view from north river bank, showing central and southern spans, looking southeast

MA-104-4 General view of north portal from roadway, looking south

MA-104-5 Elevation of north portal from roadway, looking south

MA-104-6 Elevation of north portal from roadway, looking south

MA-104-7 Detail of north truss from roadway, showing truss geometry, looking southwest

MA-104-8 Detail of north truss from roadway, showing truss geometry and connections, looking northeast

MA-104-9 Detail of builder's plate on northwest endpost, looking southeast

MA-104-10 Detail of west pedestrian walkway with windbreak, from north portal end, looking south

MA-104-11 Detail of east pedestrian walkway with railing, from north portal end, looking south

MA-104-12 Detail of underside of deck from south river bank, looking north

MA-104-13 Detail of masonry pier, looking north

MA-104-14 Detail of bearing shoe connections at south abutment, looking southeast

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

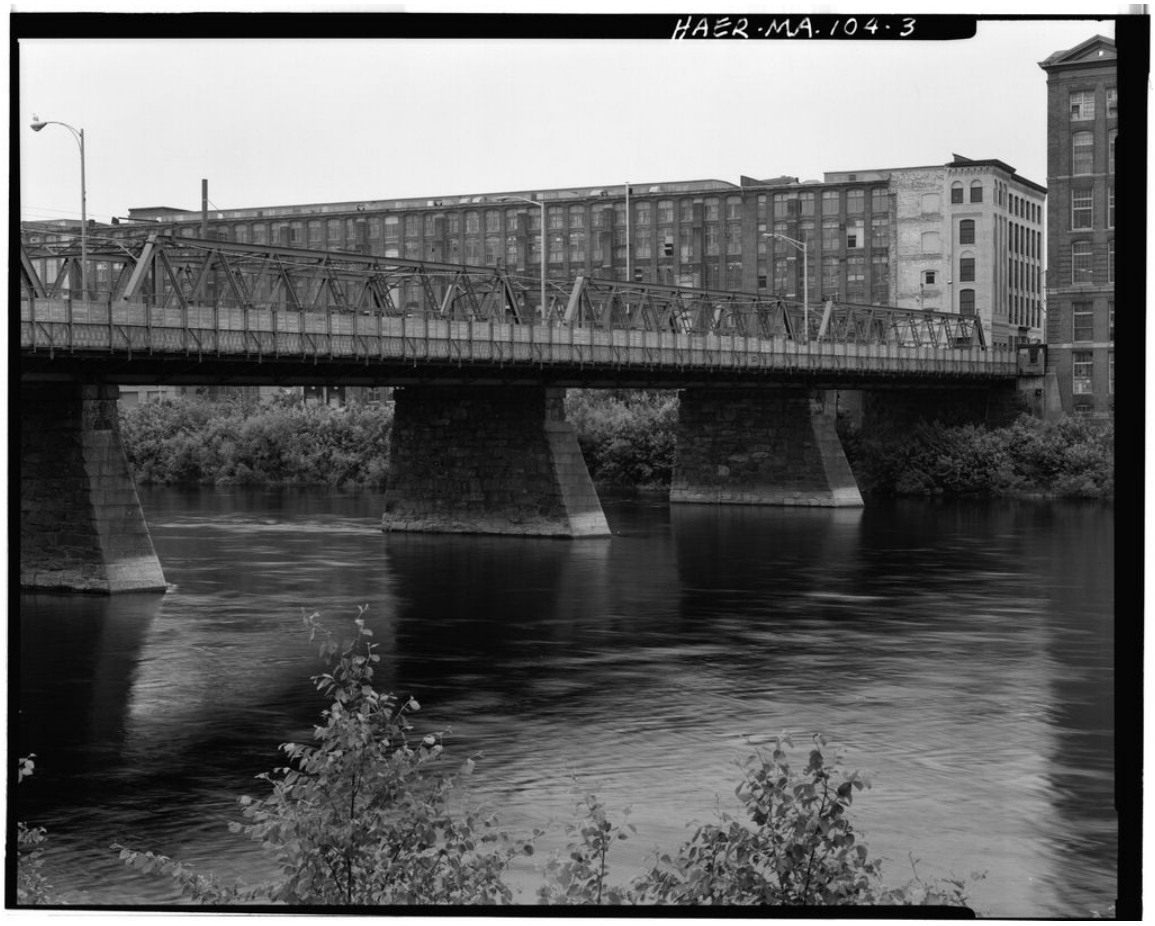
HAER No. MA-104-1

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

HAER No. MA-104-2

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

HAER No. MA-104-3



HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

HAER No. MA-104-4

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

HAER No. MA-104-5

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

HAER No. MA-104-6

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

HAER No. MA-104-7

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

HAER No. MA-104-8

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

HAER No. MA-104-9

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

HAER No. MA-104-10

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

HAER No. MA-104-11

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

HAER No. MA-104-12

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

HAER No. MA-104-13

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

HAER No. MA-104-14