PRELIMINARY STRUCTURES REPORT

September 2017

Bruce Freeman Rail Trail Project

Bridge No. S-31-007(XXX)

Proposed Bikepath over Hop Brook
Sudbury, Massachusetts

PREPARED FOR:

PREPARED BY:

vhb

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Abandoned Railroad Bridge over Hop Brook
PRELIMINARY STRUCTURES REPORT

A. PROJECT OBJECTIVE

The Bruce Freeman Rail Trail (BFRT) Project will convert the abandoned rail corridor to a bike trail for the Town of Sudbury, MA, thus extending the existing portion of the BFRT north to the Sudbury/Concord town line. As part of this effort, the existing abandoned railroad bridge spanning over Hop Brook will be rehabilitated for use as a multi-use pedestrian/bike trail bridge. VHB is working with the Town to finalize the design of the bridge. As a first step, the bridge has been inspected and the necessary modifications identified to transform it from its current abandoned state to a multi-use crossing over Hop Brook.

B. PURPOSE

The purpose of this report is to document the existing conditions obtained through a visual inspection. This report also describes any repairs necessary for rehabilitation of the structure for use as a pedestrian bridge over Hop Brook as part of the Bruce Freeman Rail Trail Project.

C. FIELD SURVEY OF EXISTING STRUCTURE

The existing abandoned railroad bridge was inspected on May 26, 2016 by VHB Structural Engineers. Weather during the inspection was partly cloudy with the temperature around 85 degrees. The bridge is a single simple-span deck plate girder structure over Hop Brook in Sudbury, MA. The span is approximately 26.83 feet, and is oriented north to south. The bridge crosses Hop Brook at a 90 degree angle (no skew).

The clearance under the bridge to the water at the time of inspection was 7′-7″ to the fascia girders and 7′-3″ to the interior girders.

The existing structure is a riveted steel deck plate girder superstructure supported on granite block stone masonry abutments. The structure is comprised of four steel built up girders, nested in two groups. The girders are spaced at 2′-0″, 3′-0″, and 2′-0″ from west to east respectively. There are built up channel diaphragms at 1/3 points along the bridge along with lateral bracing of the top flange. The existing

bridge originally carried a single railroad track. See Appendix C Figures 1 & 2 for an elevation and typical cross section of the existing structure.

The built up girders are in satisfactory condition, with only surface rusting and minor pitting. The paint system has completely failed, and only minor flakes remain. The bracing and rivet heads are also in satisfactory condition with less than 5% loss. Although the timber ties and rails were not evaluated during the site visit as they will be removed for the rehabilitation of the bridge, it is noted that the ties were moderately rotted, some more than half the way through. There is no noted collision damage to the superstructure.

The bearings at both abutments appear to be in generally satisfactory condition with minor rust and debris present and do not need to be replaced. The bearings sit directly on steel built up bolsters which sit on the stone bridge seats.

Both abutments are in satisfactory condition. Some of the pointing is missing on the abutment faces and wingwalls, mostly near the waterline. There are no obvious signs of settlement.

D. RECOMMENDED REPAIRS

As seen from the photographic documentation in Appendix B, the abandoned railroad bridge over Hop Brook is in overall satisfactory condition. The following details the work required prior to the construction of the new pedestrian deck and railing system.

Substructure:

- Clean and Repoint stone masonry missing joints at abutments and wingwalls.
- Monitor abutments for potential scour

Superstructure:

- Remove all railroad ties and track.
- Remove all existing paint.
- Paint all steel elements.
- Jack superstructure for horizontal shift for proposed path alignment and replace bearings.

E. MATERIAL SAMPLING AND TESTING

Material testing and sampling was not conducted on the existing structure. The plaque on the side of the bridge indicates that the bridge was constructed in 1893. Due to the age of the structure, all paint on the existing superstructure is assumed to contain lead. According to "AISC – Historical Record Dimensions and Properties" for 1873 to 1952 for bridges constructed around 1900, the Structural Steel has a minimum yield point of 32,000 psi and the Rivet Steel is 30,000 psi.

F. PRELIMINARY STEEL SUPERSTRUCTURE EVALUATION

The original design live load is unknown. The repurposing of the structure as a pedestrian bridge and an H10 truck loading intended as an occasional emergency vehicle will present a significantly reduced live load as compared to typical railroad loading in the early 1900's. It is anticipated that the existing steel structure, which is in good shape, can carry the required pedestrian and emergency vehicle loading. However, a comparative analysis will be performed during the final design phase to confirm this.

G. PRELIMINARY SEISMIC ANALYSIS AND RECOMMENDATIONS

Since this bridge is not a critical or essential bridge, seismic retrofit is not recommended.

H. GEOTECHNICAL EVALUATION

A geotechnical investigation was not performed at the time of this report. An investigation in the future will include samples taken from the railroad embankment and several probes behind each abutment to establish soil conditions and estimate the shape of the back of the abutment. It is anticipated that the proposed loading for the rail trail will be significantly less than the historic railroad loading. However, a comparative analysis will be performed during the final design phase to confirm this.

I. HYDRAULIC EVALUATION

The channel alignment is poor, however there are no obvious signs of settlement at the abutments. There is a possible scour hole in the northwest corner of the channel, but no other signs of scour. The channel velocity is slow to moderate and there is moderate amounts of debris in the channel. There are some silt deposits in the northeast and southwest corners due to the alignment.

The hydraulic opening will not change due to the proposed improvements and repairs to the existing bridge structure. Therefore, a hydraulic investigation is not proposed.

J. RECOMMENDED MODIFICATIONS

The existing structure will allow for a 14 foot wide travel way within new bridge railings. However, the existing bridge does not line up with the centerline of the proposed path as it currently sits on the abutments. Therefore, the existing bridge will be picked and moved 1 foot to the West to better suit the path alignment. The existing abutments appear to have sufficient space to allow for this movement. After the removal of the existing railroad ties and rail, a new deck can be supported directly on the existing steel stringers. The new deck could be timber, steel, or concrete. Based on keeping with the rural area of the project as well as continuity among local structures, a timber deck and railing system is recommended. The timber deck and floorbeams can be supported directly on the existing steel stringer top flanges.

Bicycle railing will be required on both sides of the new deck. The railings must be a minimum of 42 in high. All design will be in accordance with the 2014 AASHTO LRFD Bridge Design Specifications, with 2015 interims. See Appendix C Figure C-3 for the proposed bridge cross section.

K. PRELIMINARY COST ESTIMATE

Based on the proposed rehabilitation detailed in this report and the new timber deck and railings, the estimated cost for the bridge work is $340,000, which includes a 25% contingency. The detailed preliminary cost estimate is provided in Appendix D.

APPENDICES

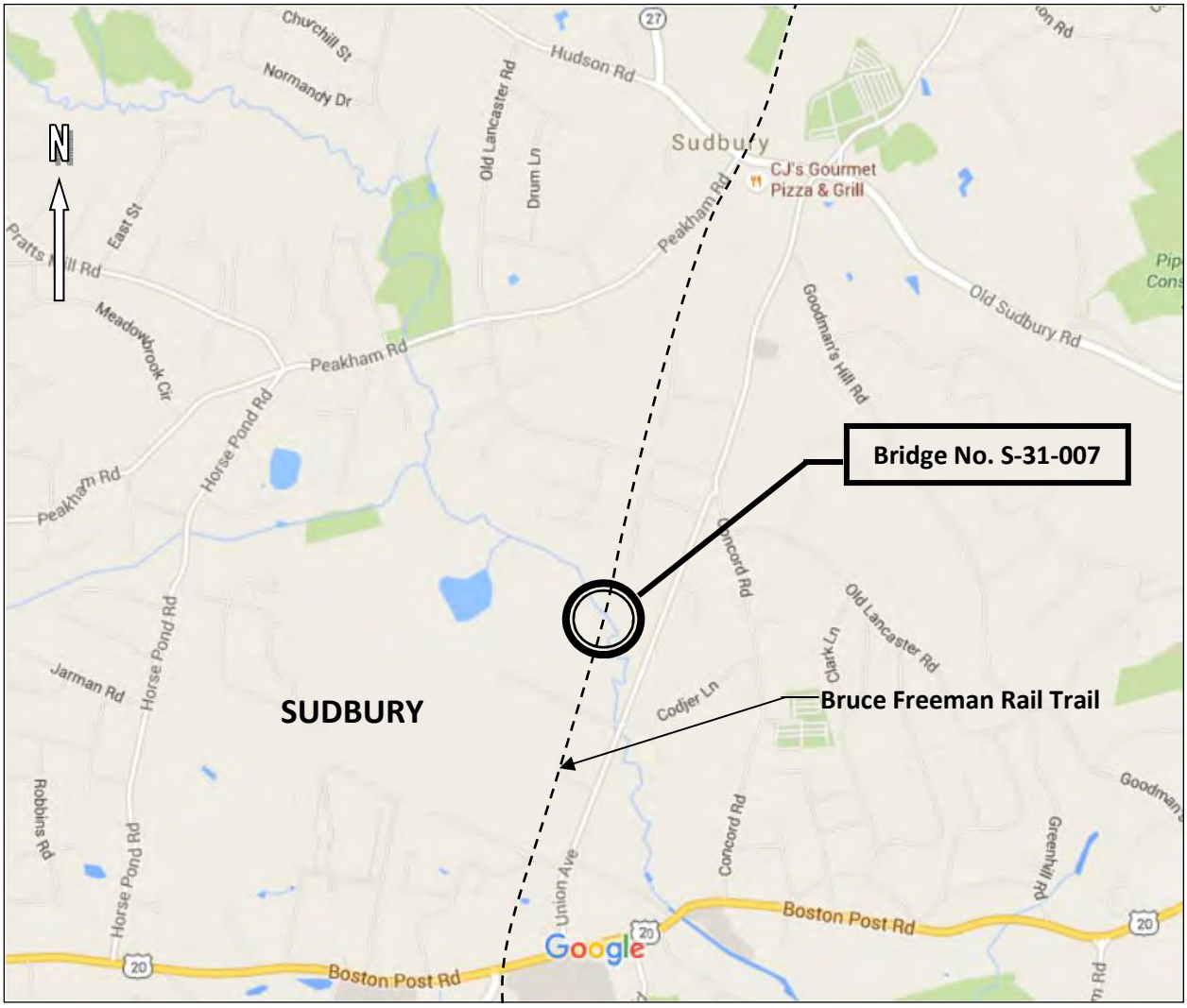
Appendix A: Location Map

Appendix B: Photographic Documentation of Bridge

Appendix C: Figures

Appendix D: Preliminary Structures Cost Estimate

Appendix A Location Map



PROJECT LOCATION MAP

Proposed Bruce Freeman Rail Trail over Hop Brook

Appendix B Photographic Documentation of Bridge

Photo 1: North Approach (Looking North)

Photo 2: South Approach (Looking South)

Photo 3: Channel (Looking West of the Bridge)

Photo 4: Channel (Looking East of the Bridge)

Photo 5: South Abutment

Photo 6: North Abutment

Photo 7: Northwest Wingwall

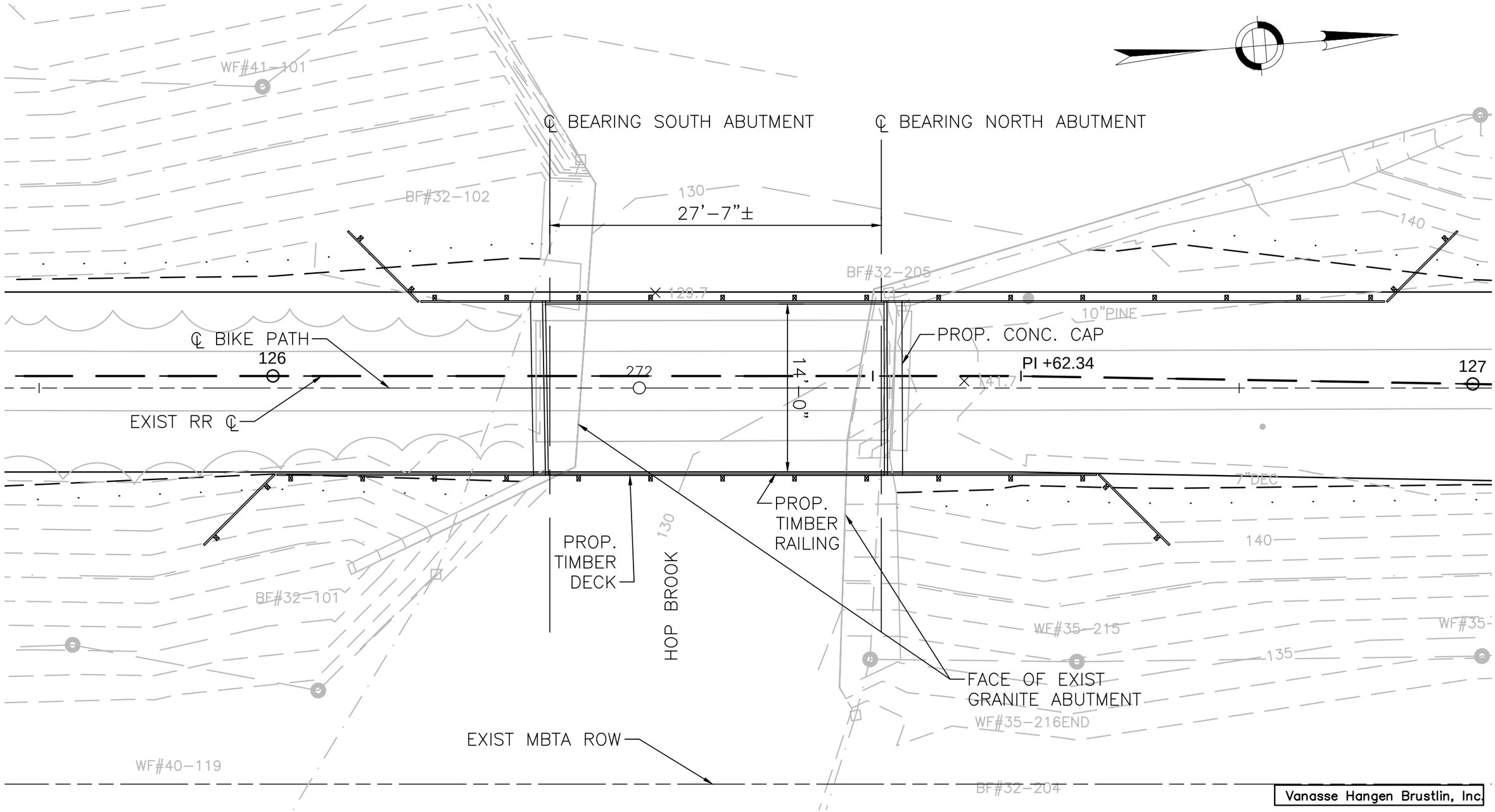
Photo 8: Southeast Wingwall

Photo 9: Typical Framing

Photo 10: Typical Steel Condition

Photo 11: Typical Bearing Assemblies

Appendix C: Figures



GENERAL PLAN

SCALE: 1" = 8'

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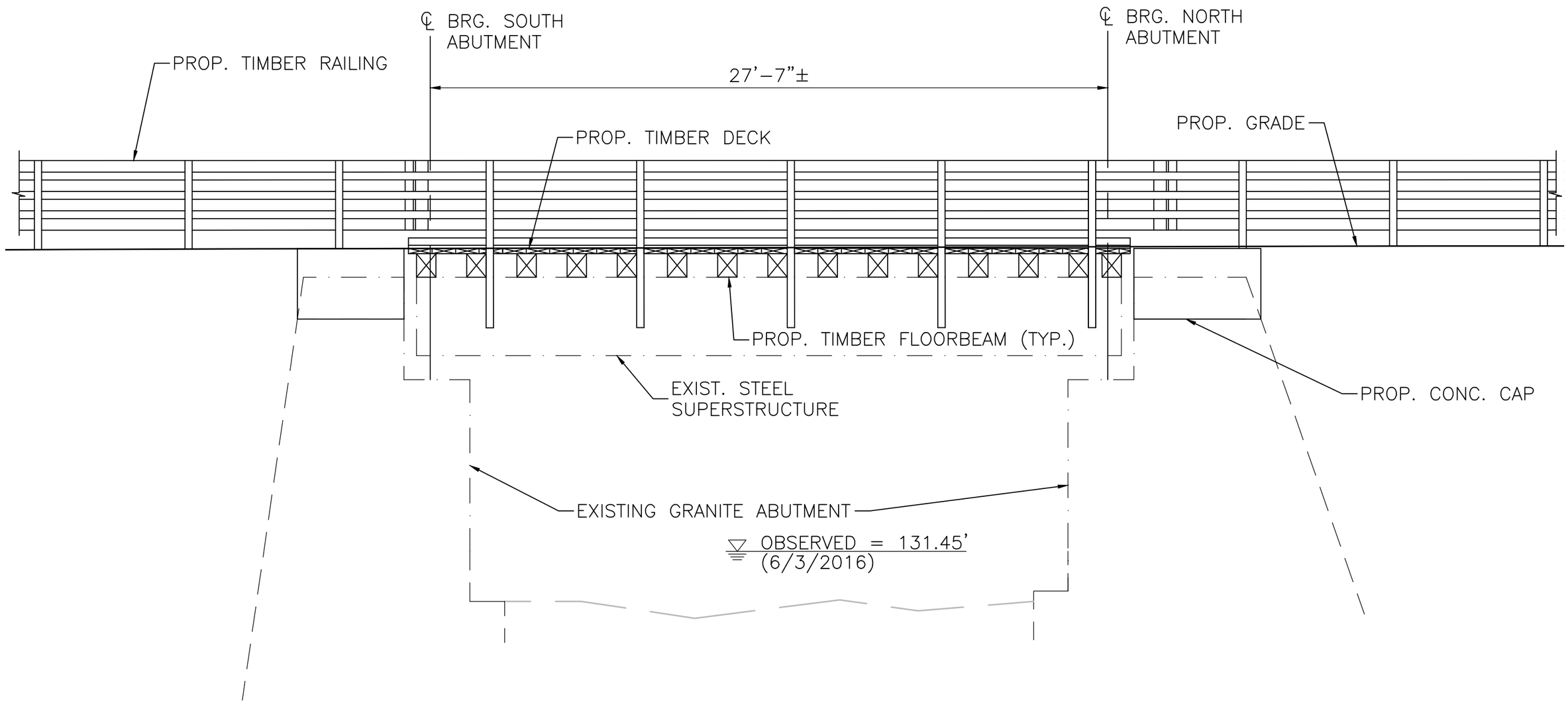
Figure C–1

GENERAL PLAN
Bruce Freeman Rail Trail
over Hop Brook
Sudbury, MA



ELEVATION

SCALE: 1" = 4'

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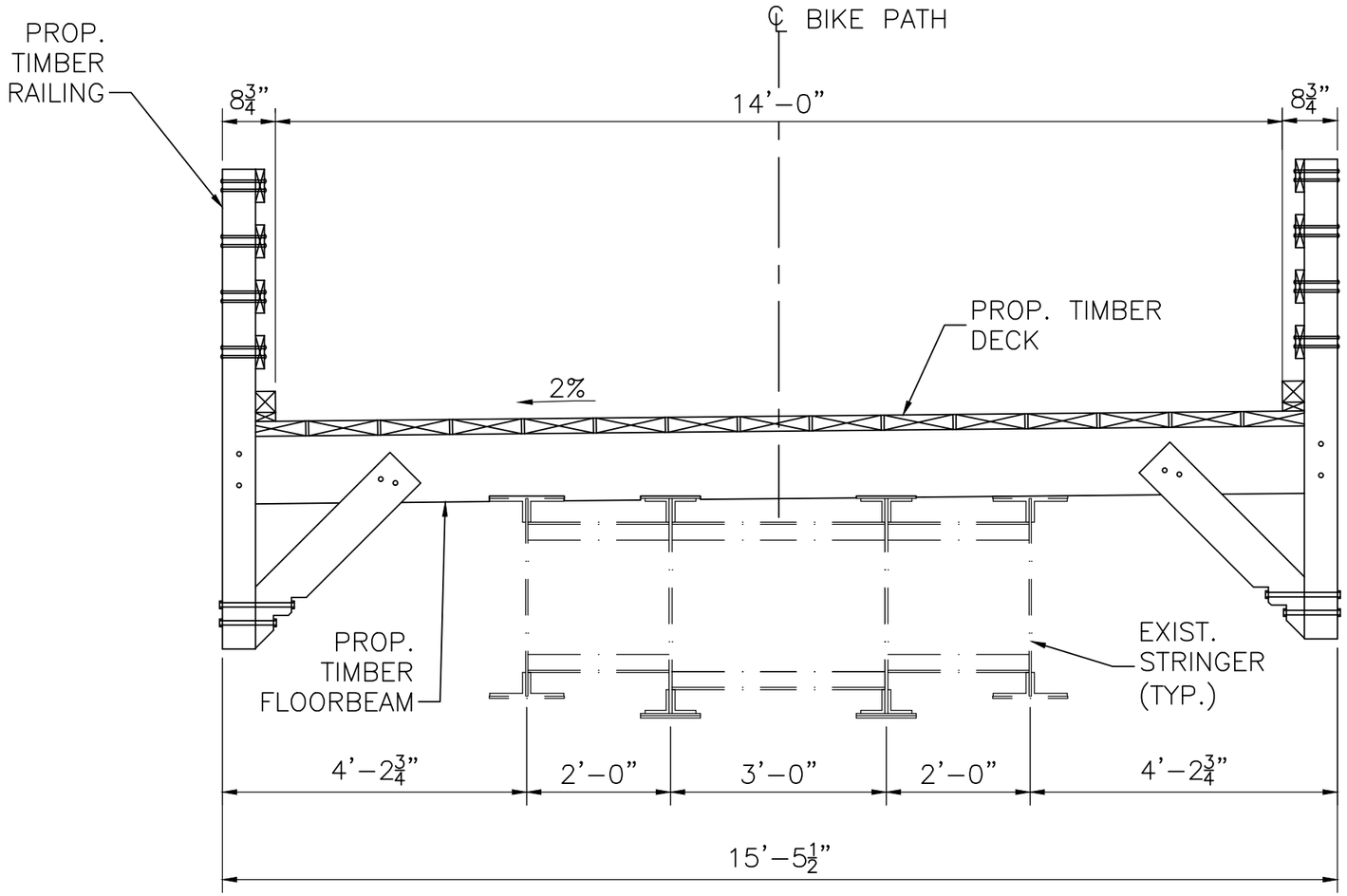
Figure C–2

ELEVATION
Bruce Freeman Rail Trail
over Hop Brook
Sudbury, MA



TYPICAL SECTION

SCALE: ½" = 1'–0"

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Figure C–3

TYPICAL SECTION
Bruce Freeman Rail Trail
over Hop Brook
Sudbury, MA

Appendix D: Preliminary Structures Cost Estimate

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Computations

Project	BFRT	Project #	12984.00
Location	Sudbury, MA	Sheet	
Calculated By	KMR	Date	9/5/2017
Checked By	SK	Date	9/6/2017
Title	Hop Brook Preliminary Estimate		

Item	Quantity	Units	Unit Cost	Cost
Cement for Pointing	40	BAG	$250	$10,000
Backwall modifications: 4000PSI, 1.5", 565 Cement Concrete	20	CY	$1,000	$20,000
Steel Reinforcement for Structures - Epoxy Coated	3000	LB	$2.65	$7,950
Alteration to Bridge Structure No. S-31-007	1	LS	$217,800	$217,800
Temporary Protective Shielding	1	LS	$10,800	$10,800

Sub Total =		$266,550
25% Contingency =	$	66,638
Total =	$	333,188
Say =	**$**	**340,000**

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Project	Columbia Greenway	Project #	6846.02
Location	Westfield, MA	Sheet	
Calculated By	KMR	Date	5/29/2013
Checked By	SK	Date	9/6/2017
Title	Elm Street Bridge - Prelim Cost Estimate		

Item # **690.91** **Cement for Pointing** **BAG**

Pointing Quantity = 40 bags (assumed)

From MassDOT online bid application for item #908., use $250/bag

Cost = $250.00 /bag
Total = $10,000

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Computations

Project	BFRT	Project #	12984.00
Location	Sudbury, MA	Sheet	
Calculated By	KMR	Date	6/20/2017
Checked By	SK	Date	9/6/2017
Title	Hop Brook Preliminary Estimate		

Item # 901. **Backwall modifications: 4000PSI, 1.5", 565 Cement Concrete** EA

Build up backwall to new proposed grade

New conc Height =	35	in	(estimate based on timber deck thickness of 15", 12" beam & 3" deck and
Width=	3	ft	replacing 20" existing concrete cap)
Length =	17	ft	(14' clear path)
# Backwalls =	2		
	20	**CY**	

From MassDOT online bid application for item #901., use $1000/CY

Cost = $1,000.00 /EA
Total = $20,000

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Computations

Project	BFRT	Project #	12984.00
Location	Sudbury, MA	Sheet	
Calculated By	KMR	Date	6/20/2017
Checked By	SK	Date	9/6/2017
Title	Hop Brook Preliminary Estimate		

Item # 910.1 **Steel Reinforcement for Structures - Epoxy Coated** LB

4000PSI 1.5" 565 20 CY

Weight of Steel = **3000 LB** *Assume 150# of reinforcing steel per cubic yard of concrete.*

From MassDOT online bid application for item #910.1, use $2.65/LB

Cost = $2.65 /LB

Total = $7,950

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Project	BFRT	Project #	12984.00
Location	Sudbury, MA	Sheet	
Calculated By	KMR	Date	6/20/2017
Checked By	SK	Date	9/6/2017
Title	Hop Brook Preliminary Estimate		

Item # 992.1 **Alteration to Bridge Structure No. S-31-007** **LS**

Item	Quantity	Units	Unit Cost	Cost
Jacking Superstructure	1	LS	$40,000	$40,000
Drill & Grout Dowels	80	EA	$48	$3,800
Elastomeric Bearings w/ Anchor Bolts	8	EA	$3,000	$24,000
New Timber Deck & Railing System	1	LS	$82,000	$82,000
Clean (Full Removal) and Paint Steel Bridge No. S-31-007	1	LS	$68,000	$68,000

Total Lump Sum from Bridge Items = $217,800.00

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Project	BFRT	Project #	12984.00
Location	Sudbury, MA	Sheet	
Calculated By	KMR	Date	6/20/2017
Checked By	SK	Date	9/6/2017
Title	Hop Brook Preliminary Estimate		

Item # 106.87 **Jacking Superstructure** **LS**

Jacking and shoring of superstructure for bearing replacement and horizontal shift.

Locations = 8 (4 stringers, 2 abutments)

Use Unit Cost = $5,000.00 /Location

Say = $40,000.00

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Computations

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Checked By	SK	Date	9/6/2017
Title	Hop Brook Preliminary Estimate		

Item # 912.5 **Drill & Grout Dowels** EA

Assume #5s - 3'-0" Long @ 12" O.C. F&B of Backwall

Spacing Bars =	12	in
Length Backwall =	17	ft
# Backwalls =	2	
Total Number Bars =	72	
Say =	**80**	

From MassDOT online bid application for item #912.5, use $47.50/EA

Cost =	$47.50	/EA
Total =	**$3,800**	

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Checked By	SK	Date	9/6/2017
Title	Hop Brook Preliminary Estimate		

Item # 921. **Elastomeric Bearings w/ Anchor Bolts** EA

Replace existing stringer bearings.

Bearings = **8**

Cost = $3,000.00 /EA
Total = $24,000

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Computations

Project	**BFRT**	Project #	**12984.00**
Location	**Sudbury, MA**	Sheet	
Calculated By	**KMR**	Date	**6/20/2017**
Checked By	**SK**	Date	**9/6/2017**
Title	**Hop Brook Preliminary Estimate**		

Item # **New Timber Deck & Railing System** **LS**

Bridge Length =	35	ft	(back of backwall to back of backwall)
Bridge Width =	14	ft	
Total Area =	490	SF	

From Blackstone Greenway canvas of bids in 2012:

Area =	490	SF	
Price =	$167.00	/SF	(For Bridge No. B-13-030, similar beam spacing)
Total =	**$81,830**		
Say =	**$82,000**		Note: Ipe was used for the Blackstone project for the deck and railings, so ignore inflation to offset the cost between Ipe & SYP

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Vanasse Hangen Brustlin, Inc.

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Checked By	SK	Date	9/6/2017
Title	Hop Brook Preliminary Estimate		

Item # **961.201** **Clean (Full Removal) and Paint Steel Bridge No. S-31-007** **LS**

Per Span

Ext Stringers

Web		
Member Depth	2.75	ft
Member Length	28	ft
Area of Face	77	sf
Faces	4	(2 per stringer)
Area =	308	sf
Flanges		
Member Width	12.6	in
Member Depth	0.375	in
Member Length	28	ft
Area of face	30	sf
Faces	8	(4 per stringer)
Area =	242	sf

Int Stringers

Web		
Member Depth	3.0520833	ft
Member Length	28	ft
Area of Face	85.458333	sf
Faces	4	(2 per stringer)
Area =	341.83333	sf
Flanges		
Member Width	10	in
Member Depth	0.75	in
Member Length	28	ft
Area of face	25	sf
Faces	8	(4 per stringer)
Area =	201	sf

Ext Built Up Channels

Web		
Member Depth	2.0833333	ft
Member Length	2	ft
Area of Face	4.1666667	sf
Faces	16	(2 per channel, 8 channels)
Area =	66.666667	sf
Flanges		
Member Width	4	in
Member Depth	0.375	in
Member Length	2	ft
Area of face	1	sf
Faces	32	(4 per channel, 8 chennels)
Area =	23	sf

Int Built Up Channels

Web		
Member Depth	2.3333333	ft
Member Length	3	ft
Area of Face	7	sf
Faces	8	(2 per channel, 4 channels)

Area =	56	sf

Flanges		
Member Width	4	in
Member Depth	0.375	in
Member Length	3	ft
Area of face	1	sf
Faces	16	(4 per channel, 4 channels)
Area =	18	sf

Top Flange Bracing

Diagonal		
Leg 1	3.5	in
Leg 2	3.5	in
Length	9.5	ft
Area per brace	33.25	sf
# braces	3	
Area =	100	sf

Subtotal =	1356	sf
Add 25% For Misc Steel =	339	sf
Grand Total =	1700	sf

Cost

Assume the existing paint contains lead.

Painting Cost - Based on estimate of $4/SF to paint the Court Street parking garage, use 10$/SF because this structure is over water.

Deleading - Use $30/SF to delead based on estimate for the Longfellow Bridge.

Surface Preparation Cost =	$30.00 /SF
Paint =	$10.00 /SF
Total =	**$68,000 LS**

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Item # 994.1 **Temporary Protective Shielding** LS

Protect waterway from debris/contamination

Width Sheilding =	20	ft	
Length Bridge =	24	ft	(clearance between abutments)
SF Shielding =	480		

From MassDOT online bid application for item #994.1, use $22.50/SF

Cost =	$22.50	/SF	(use max for over water)
Total =	**$10,800**		
Say =	**$10,800**		