

Bridge Assessment and Ranking

Town of Colrain

Colrain, MA

July 2018

DRAFT

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Chapter 1: Introduction

1.1 Subchapter 1.1

The purpose of this report was to provide Colrain with a greater understanding of the bridges and culverts owned by the community. This report also provides Colrain with specific information on their structures, how they became deficient, and steps to prevent further deterioration. This report and priority ranking gives Colrain options for preventative maintenance, repairs, and possible replacement of its municipally owned bridges and culverts. There are 33 MassDOT inventoried municipally owned structures within town limits (see Appendix A). BSC has initially ranked the 10 most critical bridges and culverts. Based on future meetings with Colrain the ranking will likely be adjusted to reflect additional community input.

The bridges and culverts chosen for this study were evaluated by their structural deficiencies, load postings, school bus routes, emergency services, and importance to the residences and businesses of the community. These 10 structures were priority ranked 1-10, with 1 being the most critical to the town's needs and the degree of structural deficiencies.

BSC reviewed available information on all 33 municipally owned structures consisting of MassDOT and BSC inspections reports. Under federal guidelines bridges with spans greater than or equal to 20-feet in length are required to be inspected biennially. Shorter span bridges (20-feet to 10-feet span) and culverts (under 10-feet span) are not held to the same inspection intervals. To gain a more complete understanding BSC Group also inspected the four culverts that have never been inspected by MassDOT.





Chapter 2: Results

It was determined that the four culverts investigated on June 19, 2018 had no major structural deficiencies. Current and previous inspection reports were then reviewed for municipally owned deficient structures. Table 1 below shows the structural assessment priority ranking from most critical to least critical. It should be noted that this list does not include bridges that are under design or in construction.

Table 1: Structural Assessment Priority Ranking

Priority Ranking	Bridge NO.	BIN	Over (Facility Carried)	Under (Facility Intersected)
1	C-18-029	5DY	Adamsville Rd.	Sanders Brook
2	C-18-033	0EW	Adamsville Rd.	Vincent Brook
3	C-18-038	0GN	N Catamount Hill Rd.	Taylor Brook
4	C-18-043	5E9	Stacy Rd.	Meadow Brook
5	C-18-019	0GW	White Lane	W. Branch N. River
6	C-18-037	0GG	Heath Rd.	Taylor Brook
7	C-18-032	5E1	Thompson Rd.	Spur Brook
8	C-18-008	0EY	Adamsville Rd.	North River
9	C-18-016	0GX	Heath Rd.	W. Branch N. River
10	C-18-036	0GE	Heath Rd.	Taylor Brook

Adamsville Road is classified as a rural major collector and has regional importance to both Vermont and Massachusetts. This road crosses seven bridges and culverts, with four structures in need of repair or replacement, one of which is currently being designed (C-18-035, Adamsville Road over Tissdell Brook). This road has an extensive truck detour route in excess of 20 miles [see figure 1]. It is recommended



that the structures along this route be maintained, repaired, and/or replaced as soon as possible.

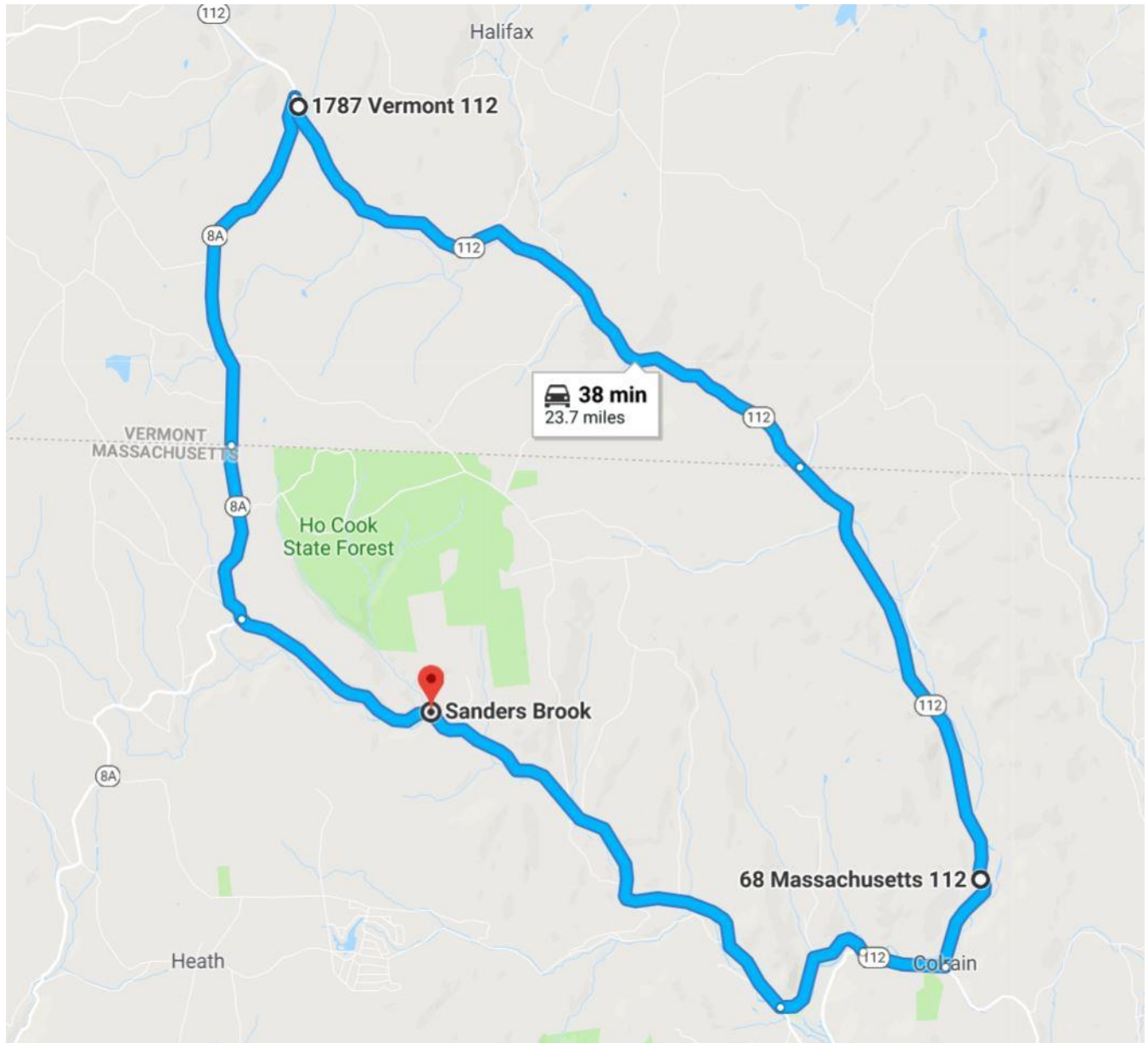


Figure 1 Adamsville Road Truck Detour Route



2.1 C-18-029 (59Y) Adamsville Road Over Sanders Brook

Description

This structure runs from east to west and is intersected by Sanders Brook flowing from North to South. The superstructure consists of a 15" thick concrete reinforced deck slab topped with bituminous concrete (asphalt) of an unknown thickness. The abutments and wingwalls are also reinforced concrete. This bridge is approximately 17 feet in length and carries two-way traffic. The bridge features concrete safety curbs on either side with steel pipe bridge railing and posts [see figure 1.1].

2.1.1 Deficiencies

The substructure received a number three (3) condition rating. See Table 2 for condition rating guide and defects corresponding to MassDOT official inspection reports.

The reason for the serious condition rating of a 3 is due to the severe scour along the abutments [see Figure 1.2-1.5]. The structure is being inspected annually due to the low condition rating. A further advancement of the scour could potentially result in a bridge closure. Both abutments have scour along the entire footing with depths up to 3 feet and widths up to 6 feet.

In addition to the scour of the abutments, the concrete shows various areas of scaling, honeycombing, and spalling [see Figure 1.6]. A significant area of concrete deterioration is at the south end near the footing, measuring approximately 4'x15" and up to 15" deep. In some of these areas rebar has been exposed with rusting and minor section loss.



Table 2: Condition Rating Guide

	CODE	CONDITION	DEFECTS
	N	NOT APPLICABLE	
G	9	EXCELLENT	Excellent Condition
G	8	NO PROBLEM NOTED	No problem noted.
G	7	GOOD	Some minor problems.
F	6	SATISFACTORY	Structural elements show some minor deterioration.
F	5	FAIR	All primary structural elements are sound but may have minor section loss.
P	4	POOR	Advanced section loss, deterioration, spalling or scour.
P	3	SERIOUS	Loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
C	2	CRITICAL	Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.
C	1	"IMMINENT" FAILURE	Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put it back in light use.
	0	FAILED	Out of service – beyond corrective action.



Figure 1.1 C-18-029 Roadway and Approach





Figure 1.2 C-18-029 Elevation



Figure 1.3 Scour Pocket at West Abutment



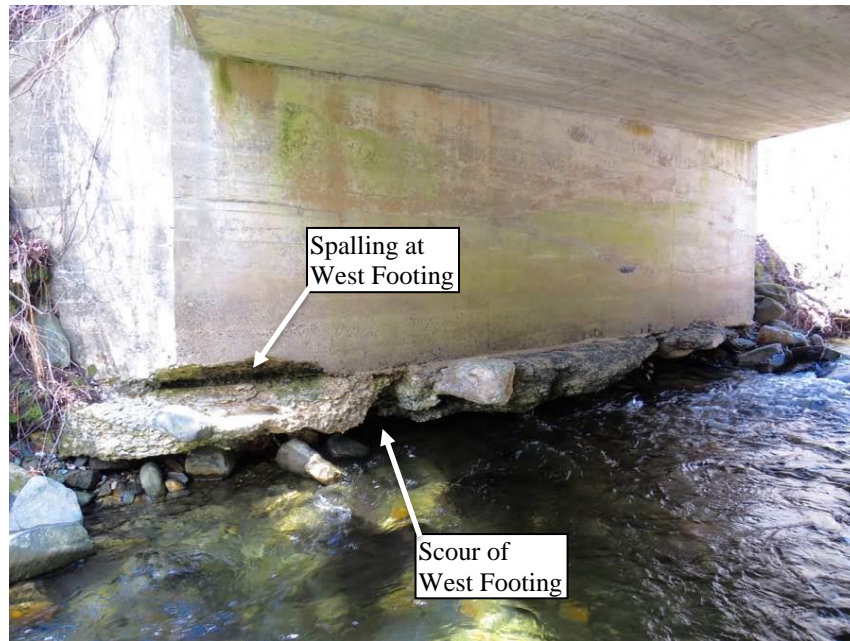


Figure 1.4 Scour Along the West Abutment



Figure 1.5 Scour and Spalling Along the East Footing





Deterioration of Concrete
Abutment and Wingwall

Figure 1.6 Typical Concrete Deterioration



2.1.2 Recommendations

Two alternatives have been proposed, one being a repair and the other being a replacement. Detailed engineering and cost analysis would need to be performed in order to determine if the repair option is viable.

A.) Repair

- Remove spalled and deteriorated concrete by removing loose areas until sound concrete is found.
- Replace rebar that is showing signs of section loss.
- Apply an epoxy bounding compound to the areas of concrete excavation and place new concrete in the areas that have been removed.
- Repair the existing footings by filling the voids with concrete.
- Excavate existing streambed material and construct scour protection in conformance with the MassDOT LRFD Bridge Manual.

B.) Replace

- Replace the bridge with a new structure.
- A larger span length would be proposed to accommodate the stream crossing standards to the maximum extent practicable and to reduce the potential for future scour.
- The existing abutments could be cut down and left in place as scour protection.
- Possible replacements for this structure would vary from precast rigid frames, precast arch, spread box beams on integral or stub abutments.



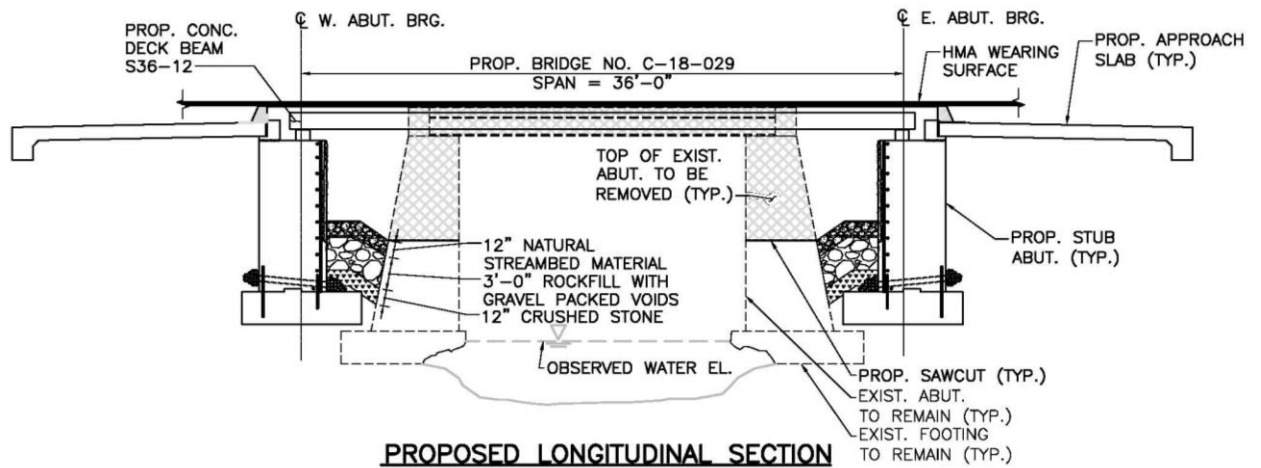


Figure 1.8 Option 2: Replacement – 36'-0" Span

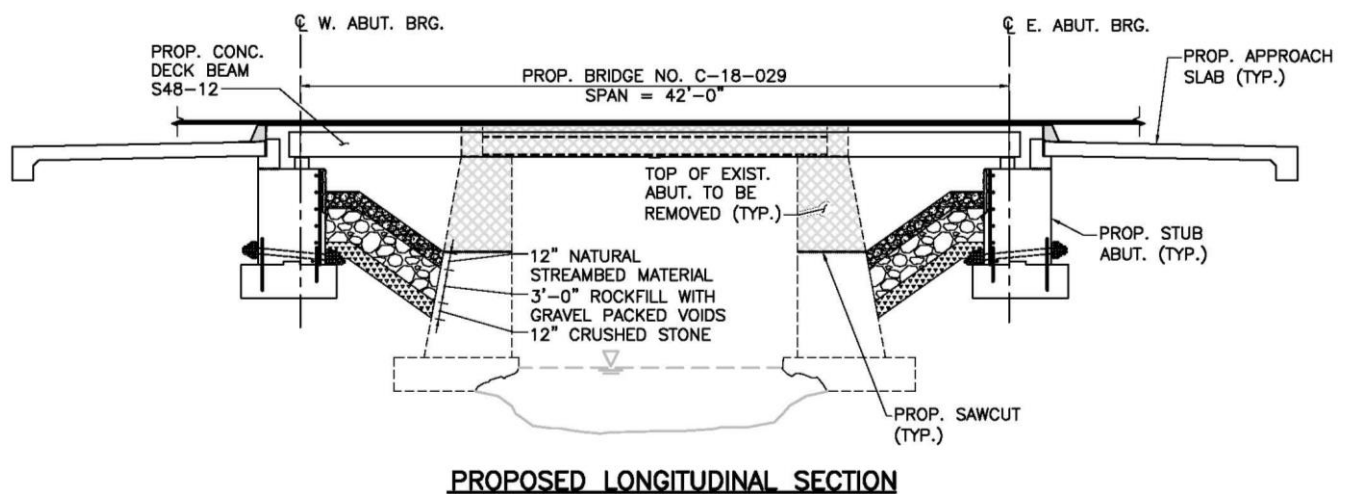


Figure 1.9 Option 3: Replacement – 42'-0" Span



2.2 C-18-033 (0EW) Adamsville Road Over Vincent Brook

Description

The structure runs east and west carrying Adamsville Road and spans over Vincent Brook, flowing from north to south.

This bridge superstructure consists of two exterior steel 21WF63 beams with five interior steel 21WF59 beams and a non-composite cast-in-place concrete deck approximately 23 feet in span length. The steel beams are supported by gravity abutments to the east and west. The bridge wearing surface is bituminous concrete and has concrete safety curbs on both sides. Supported by the curbs are steel pipe railings connected intermediately with steel posts [see Figures 2.1 and 2.2].

2.2.1 Deficiencies

The most current inspection report scores the superstructure with a condition rating of 4 and substructure 5. Deterioration and section loss to beam 7 [see Figures 2.3 and 2.4] has resulted in the installation of temporary concrete barriers to the south side of the roadway restricting travel to 14'-9" [see Figure 2.1]. The travel restriction only allows for alternating traffic.

Similarly, beam 1 also has section loss to its web and bottom flange at both ends of the beam [see Figures 2.5 and 2.6]. Unfortunately, this will lead to further travel restrictions or a bridge closure. The section loss is typically caused by road salt mixed with snow that gets plowed over the side of the bridge or salt laden water that infiltrates through cracks. Salt acts as a catalyst to accelerate the corrosion/rusting process of the steel members and steel reinforcement.

The substructure also has structural deficiencies. The southeast and southwest wingwalls have moderate to heavy concrete deterioration and spalling [see Figures 2.7 and 2.8]. The east and west abutments have cracking in the breastwall [see Figure 2.9].





Figure 2.1 C-18-033 General Roadway



Figure 2.2 C-18-033 General Elevation





Figure 2.3 Beam 7 Section Loss

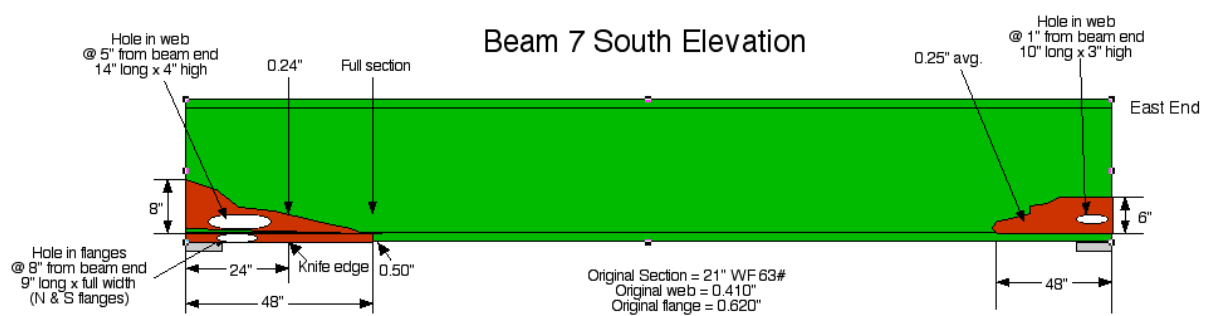


Figure 2.4 Sketch of Beam 7 Section Loss





Figure 2.5 Beam 1 Section Loss

Beam 1 - North Elevation

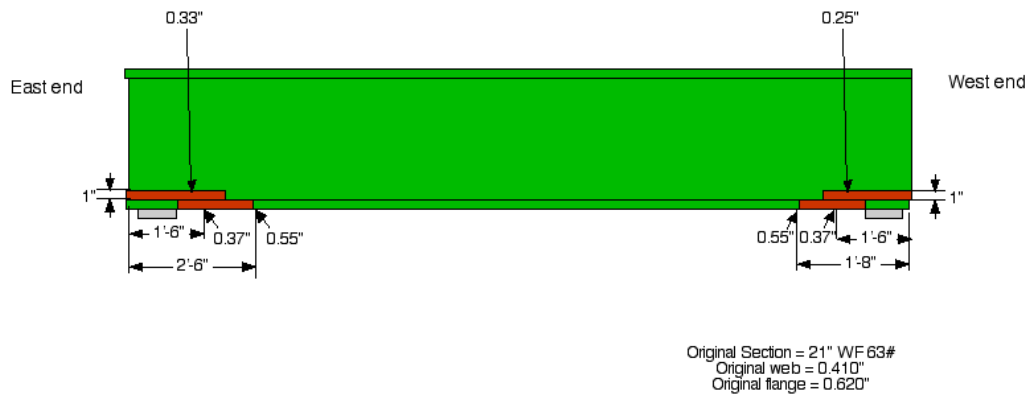


Figure 2.6 Sketch of Beam 1 Sketch of Section Loss



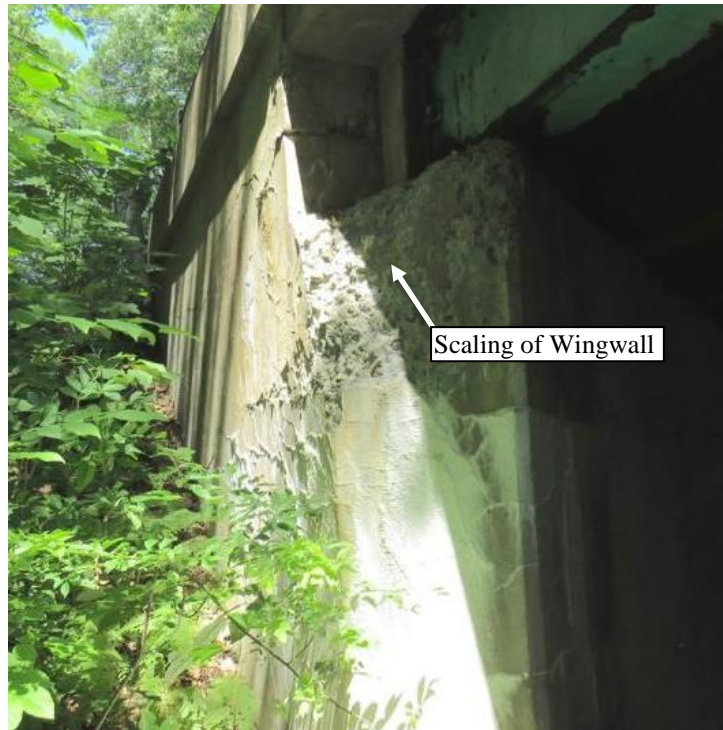


Figure 2.7 Scaling at Southwest Wingwall



Figure 2.8 Scaling at the Southeast Wingwall





Figure 2.9 Cracking at Abutment



2.2.2 Recommendations

As preventative maintenance it would be recommended to clean the bridge seat and beam ends. The cleaning should be done annually, typically in the spring. Cleaning will prolong the life of the bridge's superstructure and substructure. The bridge seat area shall be cleaned of any salt which is corrosive in nature to steel and concrete.

After steel repairs are complete it is recommended to have all the steel beams painted with a MassDOT approved primer and finished coat. Due to the age of the bridge it is very likely that the existing paint contains lead. The rust removal, containment, disposal and painting should be performed by a MassDOT prequalified bridge painting company. At a minimum the ends of the beams should be prepared and painted for approximately 4'-0"; the majority of the steel deterioration is located at the beam ends.

Possible Repairs:

There are two possible repair types for C-18-033, listed A and B below. Option A is the cheaper option and would facilitate barrier removal allowing full roadway travel. Option B, however, would allow for full roadway travel and extend the life of the bridge significantly. Additionally, safety improvements would also be made.

A.) Repair Fascia Beams

Option A would consist of repairing existing beam 1 and 7. This would be either done with a bolted or welded repair as shown in Figure 2.10 and Figure 2.11. In order to determine which repair type would be most suitable would require analysis and design.

Pros: Cheaper than option B, extends the life of the fascia beams by approximately 10 years, allows beam 7 to carry loads, and for the temporary concrete barriers to be removed for full roadway travel.

Cons: Only extends the life of the beams by a short period of time.

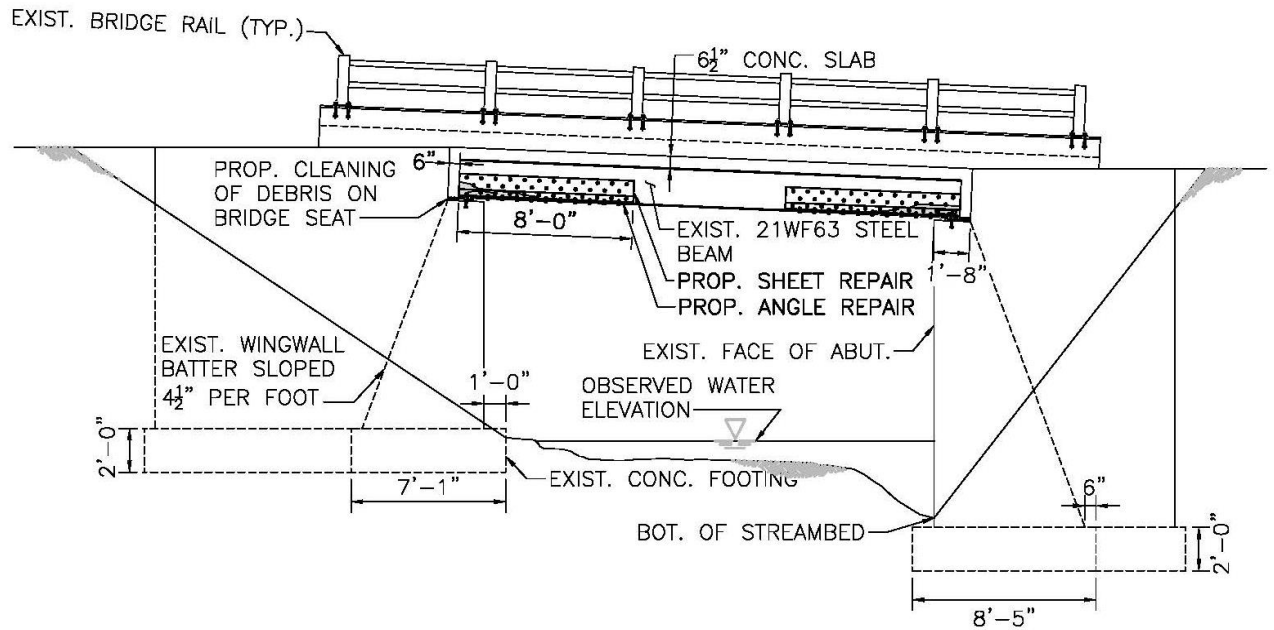
B.) Replace Fascia Beams

Option B consists of replacing beams 1 and 7 with galvanized steel beams. To replace the beams, existing portions of the bridge would need to be removed, such as areas of the concrete deck, safety curbs, and the two deteriorated fascia beams. Following beam and partial deck replacement, standard safety curbs would be installed with S3-TL4 railing with guardrail and transitions. Additionally, the bridge joint would be replaced.



Pros: The life of the bridge is extended by a longer period than option A, approximately 30 years, and several safety improvements will be implemented with the test rated railing, guardrail and transitions.

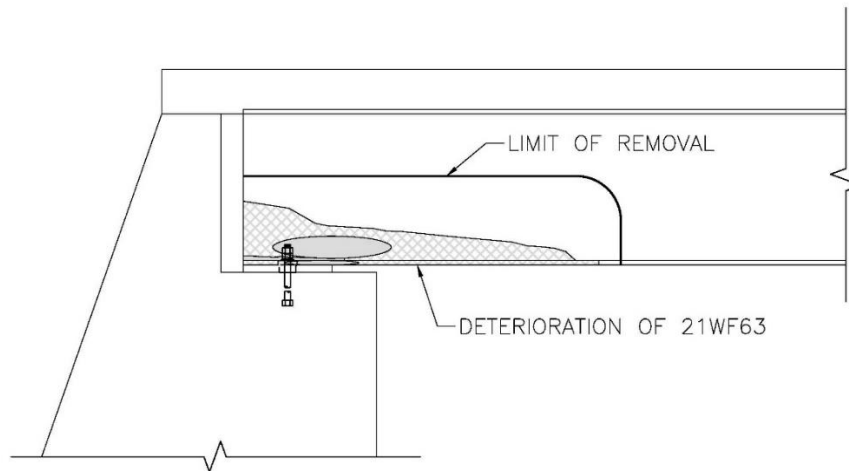
Cons: More expensive repair than option A. Would require the bridge to be fully closed during construction.



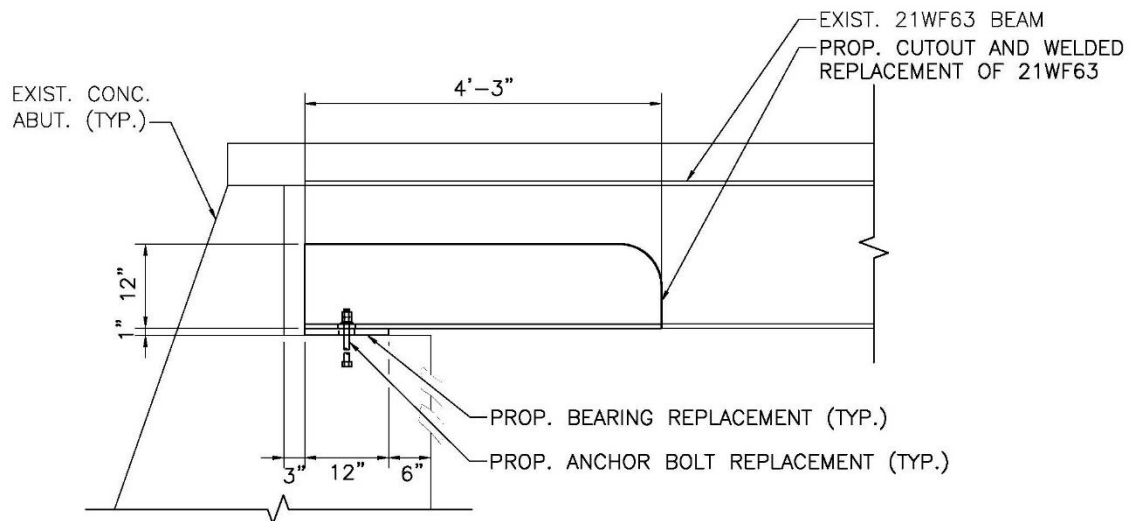
PROPOSED ELEVATION BOLTED REPAIR

Figure 2.10 Option A: Bolted Steel Repair to Ends of Fascia Beams





PROPOSED WELDED REPAIR LIMITS



PROPOSED BEAM WELDED REPAIR

Figure 2.11 Option B: Welded Steel Repair to Ends of Fascia Beams



2.3 C-18-038 (0GN) North Catamount Hill Road Over Taylor Brook

Description

North Catamount Hill Road runs north and south. It is intersected by Taylor Brook that flows from west to east. This structure was originally built in 1940 and the concrete deck was repaired in 1989. The bridge superstructure is a steel stringer and has a span length of approximately 69 feet. There are four stringers with a composite reinforced concrete deck. The steel superstructure is supported by stub concrete abutments with spread footings.

The bridge deck has a bituminous concrete wearing surface and concrete safety curbs on either side with AL-3 aluminum railings. The railings are connected to concrete transitions that were designed to transition steel W-beam guardrail continuously to bridge rail.

2.3.1 Deficiencies

The superstructure and substructure are in good shape. The most current inspection report rates both at 7. However, one of the concerns with this bridge is the significant erosion [see Figures 3.2 and 3.4]. The inspection report from March 2018 gives the channel and channel protection a condition rating of 4.

The amount of erosion is significant and if allowed to continue will result in serious problems and bridge closure. Due to the scour/erosion, the northeast abutment cap is completely undermined and one of the vertical columns of the stub abutment is exposed [see Figure 3.4]. Figure 3.5 shows the amount of cover the abutment had in 2002, which has since been removed. The north abutment is out of plumb and leaning forward towards the brook.

The north abutment is out of plumb by approximately 1 inch per every 2 feet of height. The north abutment has three out of eight anchor bolts sheared off [see Figure 3.3] and all of the sole plates have shifted towards the backwall up to 1½" ± on the north side. On the south abutment, four out of eight anchor bolts have sheared off and one is loose. Sole plates on the south abutment have shifted up to 4" ±. The 2002 report also list anchor bolts being sheared off with the problem growing over the years.

The concrete guardrail transitions are designed to be connected to bridge rail and guardrail at each approach. The approach guardrail has steel terminal ends and cannot be connected properly to the transitions [see Figure 3.6]. This is a safety concern because the transitions and guardrail are designed to act together.





Figure 3.1 C-18-038 General Roadway and Approach



Figure 3.2 Elevation and Erosion





Figure 3.3 Typical Sheared Anchor Bolt



Figure 3.4 Erosion and Exposed Footing Column at The North Abutment





Figure 3.5 North Abutment in 2002



Figure 3.6 Typical Guardrail at Transition



2.3.2 Recommendations

It is recommended to repair and replace the embankment as soon as possible. Repair should consist of riprap, crushed stone, and geotextile fabric. Riprap should contain stone that conforms to M2.02.0 as described in the materials section of the MassDOT standard specifications. MassDOT standards should be followed as shown in Figure 3.7. A minimum height of 3'-0" riprap is recommended. During riprap installation it is important that the existing abutment not be undermined or disturbed.

Colrain has experienced large storm events, like hurricane Irene, which have the ability to quickly erode and washout bridges. It is recommended that the channel be armored in accordance with MassDOT standards, see Figure 3.8 for specifications and stone sizes. One storm event could completely undermine the abutments leading to the bridge's failure. Repairing the channels to prevent this would be highly beneficial to the town. An environmental permit to work within the channel is required.

Based on reviewing the existing substructure drawings, it appears that the leaning of the abutments could be a combination of minimalistic design and the removal of material in front of the abutment. Testing and analysis would help determine the cause of the movement. Unfortunately, there are no easy repairs to effectively straighten the abutments. However, it is likely that the addition of riprap would help to reduce the progress of future abutment movement.



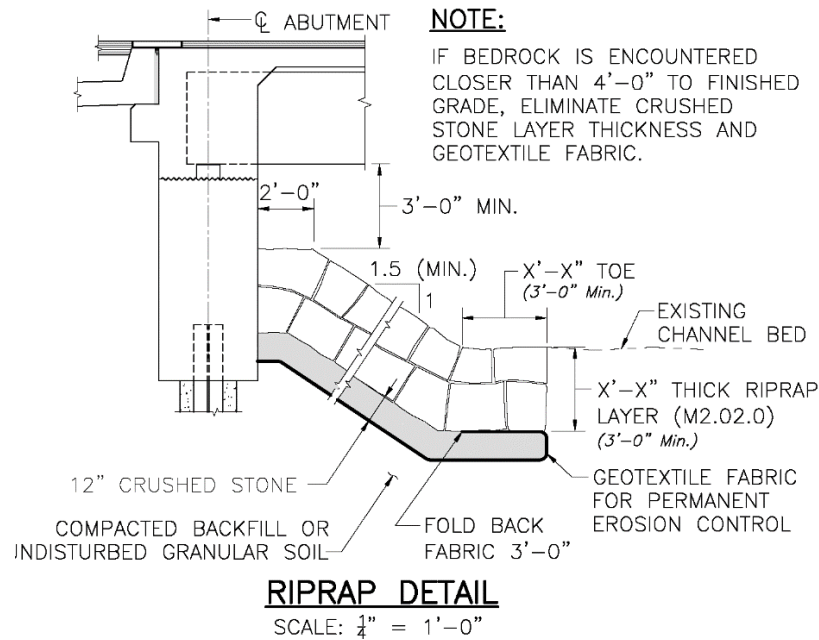


Figure 3.7 MassDOT Standard Detail 2.4.1

M2.02.2 Dumped Riprap.

Stone used for dumped riprap shall be hard, durable, angular in shape, resistant to weathering and shall meet the gradation requirement specified. Neither breadth nor thickness of a single stone should be less than one-third its length. Rounded stone or boulders will not be accepted unless authorized by special provisions.

Stone shall be free from overburden, spoil, shale, and organic material and shall meet the following gradation requirement specified:

Size of Stone	Maximum Percent of Total Weight Smaller Than Given Size
400 lb.	100
300 lb.	80
200 lb.	50
*25 lb.	10

*No more than 5% by weight shall pass a 2 in. sieve.

Figure 3.8 MassDOT Dumped Riprap Specification



2.4 C-18-043 (5E9) Stacy Road Over Meadow Brook

Description

Stacy Road travels east and west over Meadow Brook, which flows north to south. Structure C-18-043 is a single span steel beam structure approximately 22 feet in span length. This structure was built in 1940.

The superstructure consists of four CB21x59 steel beams and is supported by concrete gravity abutments to the east and west. The bridge has a 6½" cast in place concrete deck. The deck consists of transverse and longitudinal reinforcing bars. The primary reinforcing has approximately 1" of cover. See Appendix B for the recent inspection report and existing sketches.

2.4.1 Deficiencies

The most recent inspection report, dated April 2, 2018, gives the superstructure a condition rating of 5, and the substructure and deck both a 6-condition rating. Overall the bridge is in satisfactory condition.

To the south, the channel has debris and trash. The deck shows spalling and scaling approximately 2 inches in depth [see Figures 4.2-4.4]. The spalling is possibly caused by poor concrete quality and/or minimal rebar cover. Typically, reinforcement has a minimum cover of 2 inches to completely encapsulate the rebar within the concrete.

The superstructure has areas of complete paint failure to the fascia beams. At both facias and interior beam ends there is steel deterioration in the areas of paint failure [see Figure 4.5].

The concrete abutments have some cracking [see Figure 4.6]. There is a scour pocket at the southeast corner approximately 5 feet in diameter [see Figure 4.7]. However, currently the scour has not undermined the abutment's footing.





Figure 4.1 C-18-043 Roadway and Approach



Figure 4.2 C-18-043 Elevation





Figure 4.3 Spalling and Exposed Rebar at Overhang



Figure 4.4 Concrete Deck Spalling with Exposed Rebar



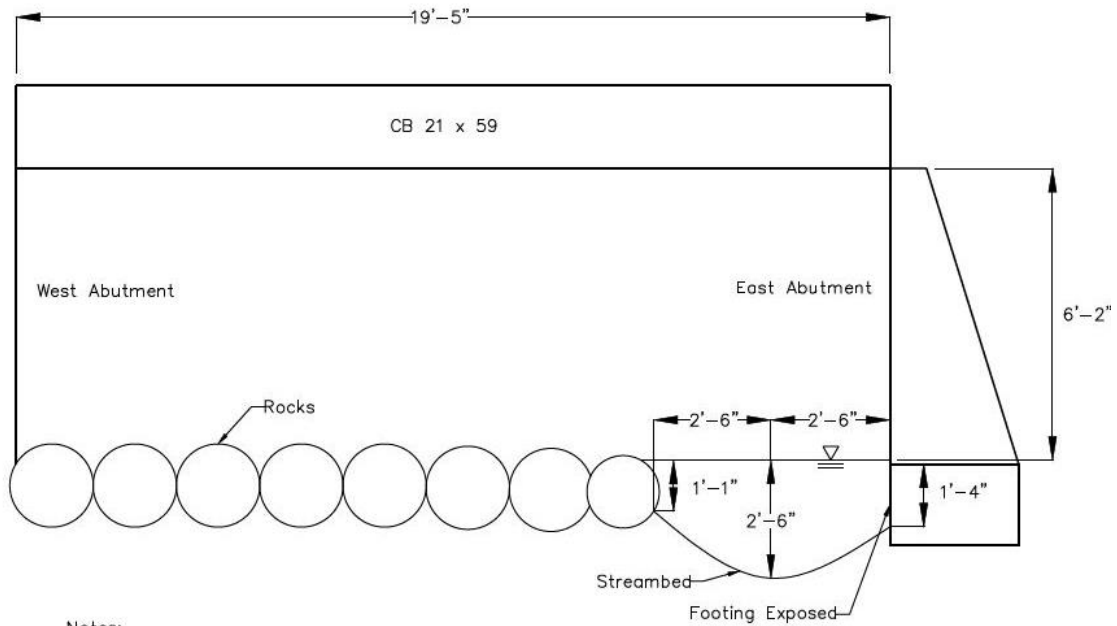


Figure 4.5 Typical Paint Failure and Steel Deterioration



Figure 4.6 Cracking at the East Abutment





Notes:

1. Drawing not to scale.
2. All measurements taken at the fascia.
3. All measurements taken along the skewed span.
4. Channel Profile checked on 4/2/2018.
5. Water depth over the footing was 1" at the time of inspection; no undermining was found.
6. Rocks and soil above the waterline in the west side of the channel; no flow was observed in the channel at these locations.

Figure 4.7 Scour Detail at East Abutment



2.4.2 Recommendations

As preventative maintenance it would be recommended to clean the bridge seat and beam ends. The cleaning should be done annually, typically in the spring. The section loss is typically caused by road salt mixed with snow that gets plowed over the side of the bridge or salt laden water that infiltrates through cracks. Salt acts as a catalyst to accelerate the corrosion/rusting process. Cleaning this area will prolong the life of the bridge's superstructure and substructure.

It is recommended to have all the steel beams painted with a MassDOT approved primer and finished coat. Due to the age of the bridge the existing paint very likely contains lead. The rust removal, containment, disposal and painting should be performed by a MassDOT prequalified bridge painting company. At a minimum the ends of the beams should be prepared and painted for approximately 4'-0".

Cracking at the concrete abutments and deck should be monitored annually to ensure the problem is not getting worse, however, no immediate attention is needed.

Scour pocket at the east abutment should be repaired as soon as possible to prevent further scour/undermining. Scour repairs should consist of riprap, crushed stone, and geotextile fabric. Riprap should contain stone that conforms to M2.02.0 as described in the materials section of the MassDOT standard specifications. MassDOT standards should be followed as shown in Figure 3.7. A minimum height of 3'-0" riprap is recommended with gravel packed voids.

It is recommended that the channel be armored in accordance with MassDOT standards, see Figure 3.8 for specifications and stone sizes. One storm event could completely undermine the abutments leading to the bridges failure. Repairing the channels to prevent this would be highly beneficial to the town. An environmental permit to work within the channel is required.



2.5 C-18-019 (0GW) White Lane Over West Branch North River

Description

This longer span bridge is a concrete arch/frame. The structure carries White Lane Road running east and west and is intersected by West Branch North River which flows north to south. The clear span of the bridge is approximately 70 feet and was constructed in 1937. Very few repairs have been made to the bridge and is mostly, if not entirely, original.

This structure carries alternating two-way traffic. The roadway surface is an exposed concrete deck which is part of the concrete frame. The approach to the west is a gravel roadway and to the east is bituminous concrete (asphalt). The bridge has concrete safety curbs, railings and posts which terminate into stone transitions.

2.5.1 Deficiencies

Structurally this bridge is in fair to satisfactory condition with rankings of 5's and 6's in the most recent MassDOT inspection report. However, the curbs and railings have extreme deterioration with section loss up to 100% [see Figure 5.4]. There are missing sections of rail that provide little protection for vehicles or pedestrians from falling off the bridge [see Figure 5.5].

The exposed concrete bridge deck also has various areas of concrete deterioration up to 3 inches deep. The stone southeast transition has stones that have fallen and been randomly reset.





Figure 5.1 C-18-019 Wearing Surface and Approach



Figure 5.2 C-18-019 Typical Underside





Figure 5.3 C-18-019 Elevation





Figure 5.4 Deteriorated Railings and Curbs





Figure 5.5 Missing Railings with Exposed Rebar



Figure 5.6 Railing Transition with Loose Stones



2.5.2 Recommendations

It is recommended that the bridge railings are repaired and/or replaced as soon as possible. Concrete deterioration is often caused from roadway salt and freeze thaw conditions during winter and early spring months. Fortunately, the concrete deck deterioration has had limited visible effects on the overall arch structure.

A.) *Minimum*

Option A: Replace/repair the substandard curbs, bridge rail and stone transitions in-kind.

B.) *Safety Upgrades*

Option B: Remove the existing curbs, railings, and posts. Install crash tested bridge rail and transitions. Concrete testing, design and analysis would be required to determine the feasibility of this option. If feasible, it is recommended to upgrade the safety curbs, railing and transitions.

C.) *Safety Upgrades and Extend Service Life*

Option C: Remove the existing curbs, railings, and posts. Install crash tested bridge rail and transitions as highlighted in option B. It would also be proposed to remove and replace any delaminated and deteriorated concrete, specifically on the bridge deck. Due to the low posted vehicular weight limit the installation of a concrete or a bituminous concrete wearing surface is not recommended due to the additional dead load.

This would be the costliest option, but the safest for vehicles and pedestrians and will also extend the service life of the bridge.



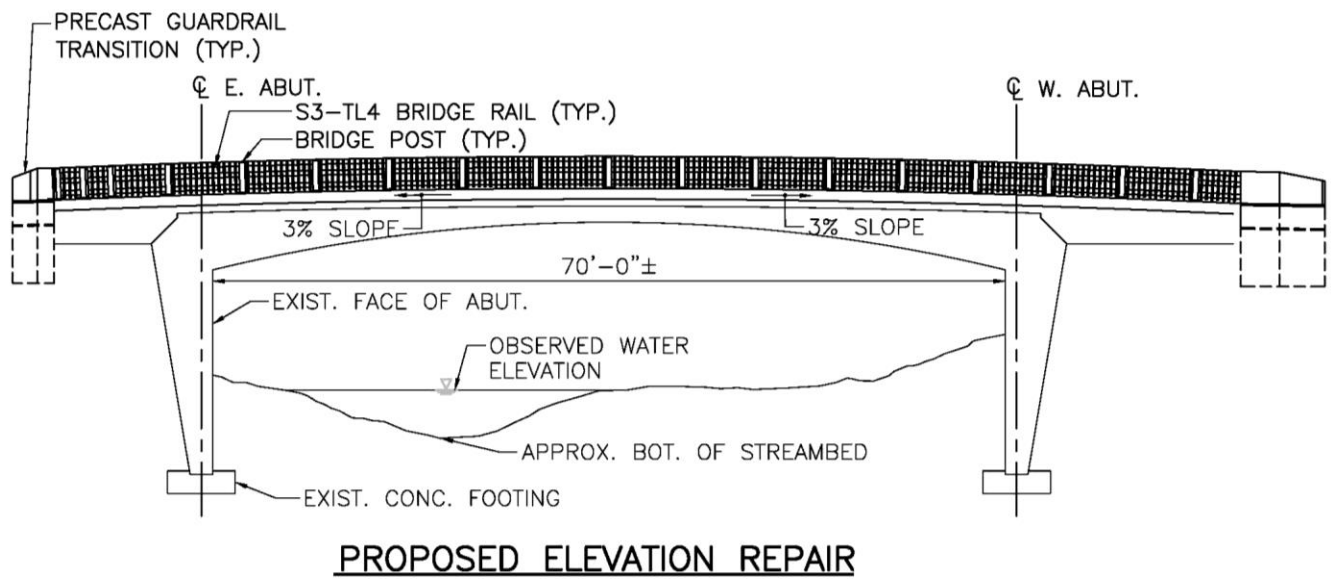


Figure 5.7 Railing and Curb Repair



2.6 C-18-037 (0GG) Heath Road Over Taylor Brook

Description

This structure carries Heath Road running east and west and spans over Taylor Brook flowing from south to north at the bridge. The superstructure has five steel beams with a composite reinforced concrete deck topped with bituminous concrete [see Figure 6.1]. The span of the steel superstructure is 25 feet.

The superstructure sits on bearing devices which are supported by concrete abutments. The abutments have an open bridge seat with bearings and exposed beam ends. This structure was built in 1939 and modifications have been made to prevent scour and erosion. Sheet piles have been installed in front of the east abutment footing [see Figure 6.4]. Also, gabion walls have been installed adjacent to the wingwalls to secure the roadway embankment.

Steel posts are fastened to concrete curbs which support steel pipe bridge rail.

2.6.1 Deficiencies

Complete paint failure at the beam ends and bearing devices are exposing bare steel to structural members [see Figure 6.2]. Beam ends are starting to rust with the heaviest occurring at the beam ends.

There is a damaged/detached bridge railing at the northeast corner [see Figure 6.5] which is a hazard. Guardrail at the east approach is missing or has been removed [see Figure 6.1].

On the upstream end to the west a gabion wall is tipping and will eventually fall into the brook. This will lead to erosion and scour of the slope, embankment and channel [see figure 6.3].

The east approach pavement has heavy cracking and settlement [see figure 6.1].





Figure 6.1 Roadway and Approach



Figure 6.2 Typical Underside





Figure 6.3 Southwest Gabion Wall Tipping and Falling



Figure 6.4 Sheet Piles at the East Abutment





Figure 6.5 Damaged Bridge Rail



2.6.2 Recommendations

This structure has several deficiencies. Fortunately, the repairs would be relatively inexpensive if they are addressed before the structure faces further deterioration.

Repairs - that should be addressed immediately:

- Repair the gabion wall at the upstream end to sit plumb and prevent bank erosion.
- Repair the bridge rail. Typically, there is a sleeve that aligns the two pipes together from the inside. Rethread or reweld the rail in kind.
- Replace the missing guardrail at the east approach.

Preservation - As preventative maintenance it would be recommended to clean the bridge seat and beam ends. The cleaning should be done annually, typically in the spring. The section loss is typically caused by road salt mixed with snow that gets plowed over the side of the bridge or salt laden water that infiltrates through cracks. Salt acts as a catalyst to accelerate the corrosion/rusting process. Cleaning this area will prolong the life of the bridge's superstructure and substructure.

It is recommended to have all the steel beams painted with a MassDOT approved primer and finished coat. Due to the age of the bridge the existing paint very likely contains lead. The rust removal, containment, disposal and painting should be performed by a MassDOT prequalified bridge painting company. At a minimum the ends of the beams should be prepared and painted for approximately 4'-0".

It would be proposed to strip the bituminous concrete (asphalt) off the bridge deck and any existing membrane proofing. Remove and replace any deteriorated or delaminated concrete. Install a membrane water proofing to protect the concrete deck and topped with bituminous concrete. This would extend the life of the superstructure significantly, reducing salt and water infiltrating to the bridge deck and bridge seat preserving the beam ends, bearing devices and substructure.

Safety upgrades - Addition of a standard crash tested system that includes standard bridge rail, concrete transitions and guardrail at the approaches. Design and analysis would be needed to determine if the existing safety curb could be retrofit with new bridge rail. New safety curbs could be installed to accept the standard bridge rail, but the demolition and construction would have a substantial cost.



2.7 C-18-032 (5E1) Thompson Road Over Spur Brook

Description

This is a small bridge carrying Thompson Road running east and west intersecting Spur Brook which flows from south to north at the bridge. The bridge has a clear span of approximately 10 feet. The structure is entirely made of reinforced concrete. The concrete deck slab rests directly on the abutment bridge seat.

The structure features two-way travel with a bituminous concrete (asphalt) wearing surface. To the north and south there are small curbs that are barely exposed, possibly from multiple roadway resurfacing. There is no bridge rail on this structure and no guardrail at either approach [see Figure 7.1].

2.7.1 Deficiencies

C-18-032 is in satisfactory to fair condition and has only one listed inspection report dated November 7, 2016. Structural deficiencies are within the substructure. Where the southeast wingwall meets with the abutment there is concrete deterioration, spalling and cracking [see Figure 7.3].

There is a crack at the corner of the northeast wingwall and abutment face. Possibly caused by substructure movement and minimal reinforcement. The top of the wingwall has up to 6 inches of horizontal displacement [see Figure 7.4].

The concrete deck slab has areas of spalling up to 10 inches deep and areas of exposed rebar.





Figure 7.1 C-18-032 Roadway and Approach



Figure 7.2 C-18-032 Elevation





Figure 7.3 Deterioration and Spalling at the Southeast Wingwall and Abutment



Figure 7.4 Cracking and Displacement at the Northeast Wingwall



2.7.2 Recommendations

The southeast concrete can be repaired by removing loose concrete to sound/solid concrete and removing and replacing exposed deteriorated rebar. An epoxy bounding compound should be used at the interface of existing and new concrete.

Unfortunately, the northeast wingwall corner would likely require replacement. Since the bridge is under 20 feet in span and not on the NBIS data base it is not required to be inspected by MassDOT biannually. It would be advisable for Colrain to monitor the northeast wingwall annually after freeze thaw conditions in the spring. Measurements and data with photographs should be kept on file to determine if the condition of the wingwall is worsening. All other concrete spalling, cracking and rebar deterioration should be monitored if no repairs are made.

Safety improvements could be made to this structure by adding railings on the bridge and at the approaches.



2.8 C-18-008 (0EY) Adamsville Road Over North River

Description

This structure runs east to west carrying Adamsville Road spanning over the North River which flows from north to south. The superstructure consists of two pinned steel overhead arches connected to 12 floor beams. The floor beams are topped with a reinforced concrete deck. Ends of the overhead arch sit on concrete abutments.

The roadway is bituminous concrete and carries two-way travel. To the downstream side is a concrete sidewalk and to the upstream side is a concrete safety curb. Cast into the sidewalk and safety curb are 12 vertical members per side connected to the ends of each floor beam. Parallel to the curb and sidewalk is bridge rail.

The east and west abutments have counterfort ribs and are accessible through manhole covers. Both areas are confined spaces and proper training should be attended prior to entering these areas. At both curb lines there are drains for roadway surface water.

2.8.1 Deficiencies

There are extensive areas of paint failure including but not limited to: the overhead arches, vertical supports, bridge rail, and floor beams [see Figures 8.1, 8.4, 8.5, 8.8, 8.9 and 8.10].

The sidewalk has areas of concrete deterioration with areas of scaling up to 20 feet in length [see Figure 8.5]. There is also concrete deterioration at the curbs and some areas have exposed rebar, map cracking, scaling and delamination. Under the sidewalk there are areas of efflorescence and cracking [see Figure 8.4].

Both fascia beams have large areas of concrete spalling, efflorescence, cracking, exposed rebar and deterioration [see Figures 8.6 and 8.7].

On the upstream side there is missing and bent railing balusters [see Figure 8.8]. There is also collision damage at the west overhead arch from an oversized truck [see Figure 8.9].

There is broken bituminous concrete around the bridge joint and areas of concrete spalling [see Figure 8.3].



Most of the deck drains are plugged from buildup of debris and vegetation growing along the curb lines.



Figure 8.1 C-18-008 Roadway and Approach



Figure 8.2 C-18-008 Typical Underside





Figure 8.3 Cracking and Settlement at Bridge Joint



Figure 8.4 Efflorescence and Cracking Under Sidewalk





Figure 8.5 Deterioration to Concrete at Sidewalk and Curb



Figure 8.6 Typical Spalling at Fascia





Figure 8.7 Spalling with Exposed Rebar at Fascia



Figure 8.8 Missing and Bent Railing Balusters





Figure 8.9 Collision Damage to West Portal



Figure 8.10 Typical Paint Failure to Floor Beam



2.8.2 Recommendations

Annual preventative maintenance for this structure would be to unclog any deck drains. Standing water can infiltrate structural members leading to gradual rusting and deterioration. These drains are also critical during freeze thaw months to allow for the shedding of water and salt as quickly as possible.

Bent and missing railing balusters should be replaced in kind. Deteriorating concrete at the sidewalk and safety curb ends should be removed and repaired.

The existing deck joint can be replaced with a new strip seal joint. This would prolong the life of the arches and the bridge seat. Older broken-down joints lead to water and salt infiltration quickly deteriorating structural members.

Areas of concrete spalling, cracking, and efflorescence should be monitored annually at a minimum.

The options for this bridge including preservation or replacement and are listed as A and B below. Both options, however, would be costly. BSC Group performed the current bridge rating for MassDOT back in 2008. The control elements of the rating, which dictated the low vehicular load posting, were the floorbeams. Strengthening the floorbeams would be complicated, costly, time consuming and require the removal of the concrete deck.

A.) Bridge preservation and repair

Bridge preservation would consist of repairing any areas of loose or deteriorated concrete. Painting all steel elements. Removing the bituminous concrete, deck joint, membrane waterproofing and any areas of concrete deck deterioration.

The collision damage would also be repaired. New membrane waterproofing would be installed over the bridge deck with new bituminous concrete and a new expansion joint.

B.) Replacement

Option B would be a bridge replacement. This option would be much more expensive than option A. Possible superstructure types would be galvanized steel (beam or plate girder), spread box beams, NEBT beams, and Next F beams. These superstructures would likely be supported by integral abutments on steel H-piles. A



substructure would be chosen after boring logs and the recommendations of a geotechnical engineer. Due to the high cost of both preservation and replacement it is recommended that Colrain seek assistance from MassDOT. The first step would be working with MassDOT, senators and representatives to get the project on the State Transportation Improvement Program (STIP).



2.9 C-18-016 (0GX) Heath Road Over West Branch North River

Description

This structure spans over the West Branch North River flowing from north to south and spanning east and west. The bridge was constructed in 1937 and has an approximate clear span of 82 feet. C-18-016 is made of reinforced concrete and each vertical leg sits on a concrete footing. Since the structure was built, sheet piles were installed in front of the abutments to prevent scour [see Figure 9.3].

The wearing surface consists of bituminous concrete (asphalt) and is approximately 24 feet wide. The structure is open for two-way travel from east and west. To the north and south is reinforced concrete curbs, posts and railings.

2.9.1 Deficiencies

Structurally, this bridge is in fair to good condition with rankings of 6's and 7's in the most recent MassDOT inspection report. However, the curbs and railings have extreme deterioration and section loss of 100% in some areas [see Figures 9.5]. Sections of the missing bridge rail have no barrier for pedestrians between the roadway surface and the river.

There are two longitudinal cracks at construction joints to the underside of the concrete frame. The cracks are the full length of the structure and approximately 1/16" wide. Both cracks have active leakage and areas of efflorescence.

The roadway wearing surface has large cracks and potholes exposing the concrete deck [see Figure 9.4].





Figure 9.1 C-18-016 Roadway and Approach



Figure 9.2 C-18-016 Elevation



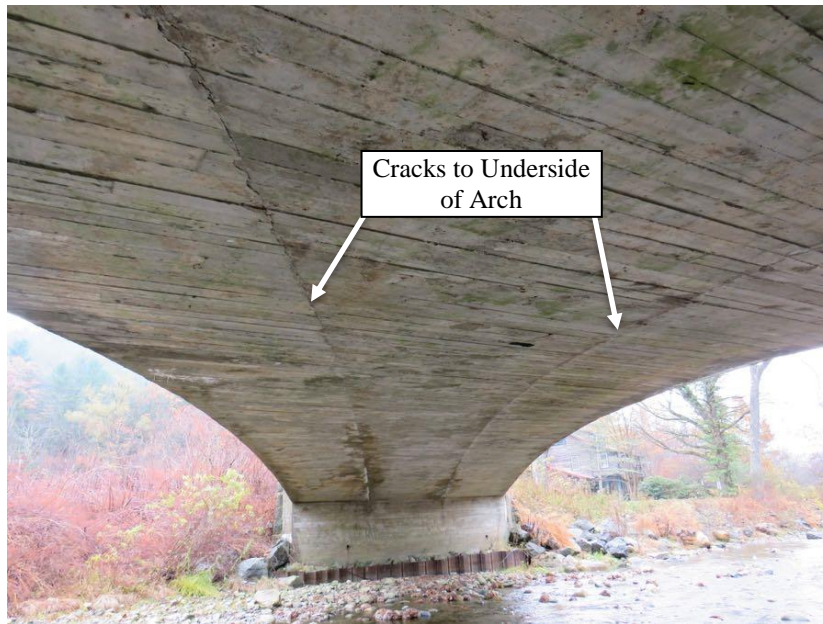


Figure 9.3 C-18-016 Typical Underside



Figure 9.4 Broken Bituminous Concrete and Settlement at Bridge Deck



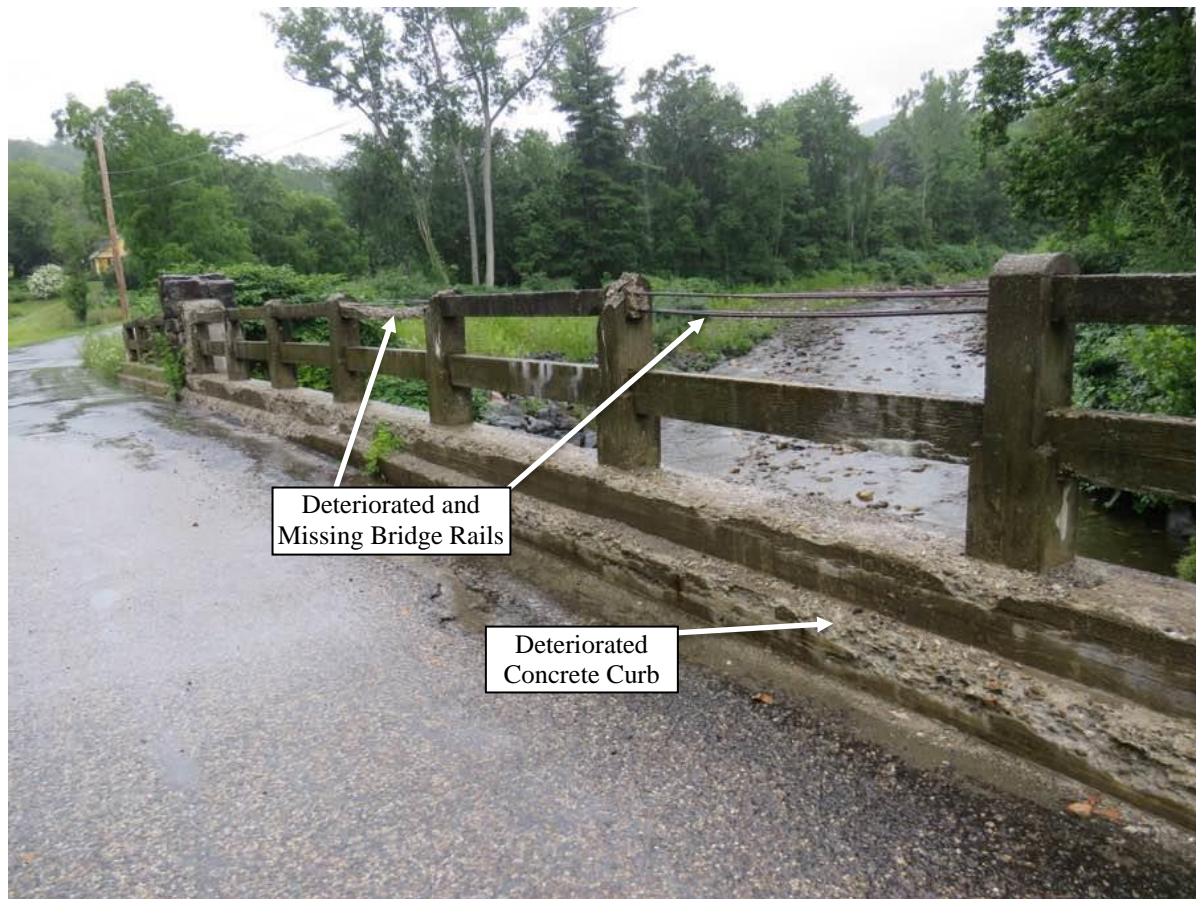


Figure 9.5 Typical Concrete Deterioration to Bridge Rail and Curb up to 100%



2.9.2 Recommendations

It is recommended that the bridge railings are repaired and/or replaced as soon as possible.

A.) Minimum

Option A: Replace/repair the substandard curbs, bridge rail and stone transitions in-kind.

B) Safety Upgrades

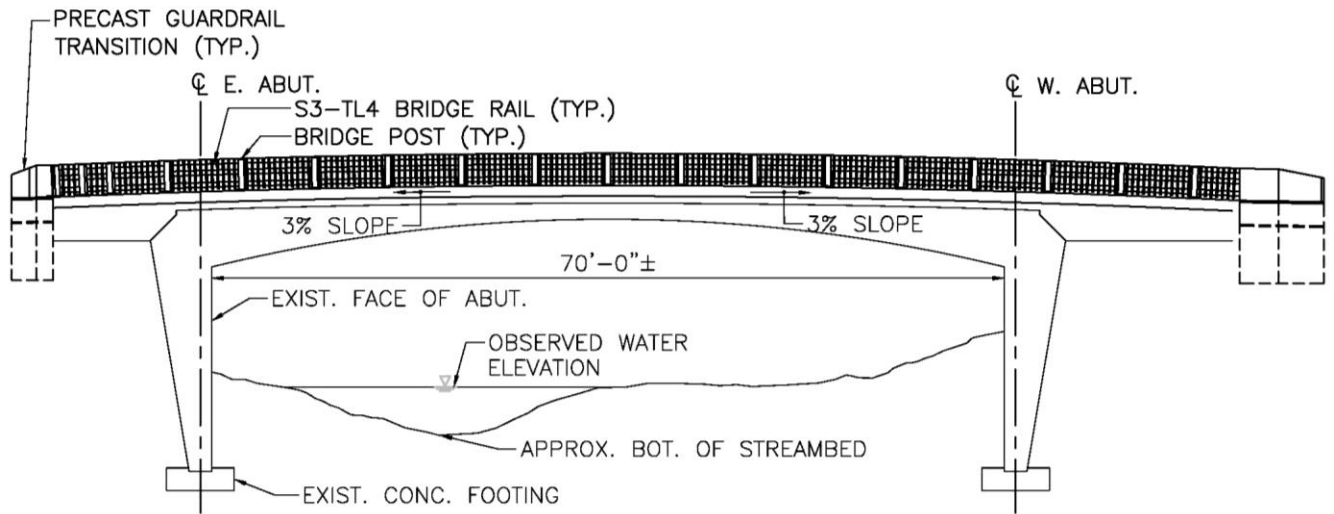
Option B: Remove the existing curbs, railings, and posts. Install crash tested bridge rail and transitions. Concrete testing, design and analysis would be required to determine the feasibility of this option. If feasible it is recommended to upgrade the safety curbs, railing and transitions.

C.) Safety Upgrades and Extend Service Life

Option C: Remove the existing curbs, railings, and posts. Install crash tested bridge rail and transitions, highlighted in option B, with the addition of concrete deck repairs. It would be proposed to remove and replace any delaminated and deteriorated concrete. Install new membrane waterproofing, bituminous concrete and bridge joints.

This would be the costliest option, but the safest for vehicles and pedestrians and extend the service life of the bridge.





PROPOSED ELEVATION REPAIR

Figure 9.6 Railing and Curb Repair



2.10 C-18-036 (0GE) Heath Road Over Taylor Brook

Description

This bridge carries Health Road running from east to west and is open to one lane alternating two-way travel. The structure was built in 1939 and is intersected by Taylor Brook which flows from north to south. The steel superstructure rests on steel bearings which are supported by reinforced concrete abutments [see Figure 10.2]. Sheet piles were also installed in front of both abutments to prevent undermining of the substructure.

Five steel beams support a non-composite concrete deck that is topped with bituminous concrete. The roadway has cast in place concrete curbs and steel pipe railings intermediately connected with steel posts [see Figure 10.1].

2.10.1 Deficiencies

MassDOT's most recent inspection was performed in August of 2016. Overall the structure is in good condition for its age with condition ratings of 7's and 6's. However, there are some deficiencies and steps that can be made to prevent the deficiencies from progressing.

The steel superstructure and bearing devices have various areas of moderate paint failure, rusting and pitting [see Figure 10.2]. One of the interior beam's anchor bolts has sheared off.

To the northeast, the top section of bridge rail is bent [see Figure 10.3].

The abutments and wingwalls have areas of concrete spalling and deterioration [see Figure 10.4]. The largest area of spalling is at the south wingwalls up to 8'x4'x16" deep. The abutments also have random areas of cracking and scaling.





Figure 10.1 C-18-036 Roadway and Approach



Figure 10.2 C-18-036 Typical Underside





Figure 10.3 Bent Rail at Northeast Approach





Figure 10.4 **Typical Concrete Deterioration to South Wingwall**



2.10.2 Recommendations

As preventative maintenance it would be recommended to clean the bridge seat and beam ends. The cleaning should be done annually, typically in the spring. Cleaning this area will prolong the life of the bridge's superstructure and substructure. The bridge seat area shall be cleaned of any salt which is corrosive in nature.

All the steel beams should be painted with a MassDOT approved primer and finished coat. Due to the age of the bridge the existing paint very likely contains lead. The rust removal, containment, disposal and painting should be performed by a MassDOT prequalified bridge painting company. At a minimum the ends of the beams should be prepared and painted for approximately 4'-0".

The bent rail should be realigned or replaced. However, with no concrete transitions and approach guardrail the railing is a safety hazard. The railings have a blunt end which vehicles can become impaled on during a crash. It is recommended to upgrade and install a MassDOT standard railing system.

Deteriorated concrete can be cleaned and removed to sound concrete. These areas can be formed and repaired. An epoxy bounding compound should be used where new concrete will be placed. Rebar shall be drilled and grouted where larger areas of concrete repair are needed.





Chapter 3: Conclusion

BSC has investigated the available information for all 33 of the town owned bridges and culverts documented in MassDOT's Master List. Ten of the most critical structures were ranked. The ranking is to provide Colrain with a greater understanding of the severity of the deficiencies of their bridges. The 10 ranked bridges have various deterioration, spans, lengths, widths and materials.

The report presented recommended maintenance as well as possible repairs and replacement options. It should be noted that the possible repair and replacement options would require analysis and design before being implemented.

BSC has worked extensively with Colrain to secure grant funding for bridge replacement projects. We understand the financial restraints that the Town is confronted with. We are hopeful this report will assist Colrain in pursuing additional grants and seeking MassDOT's technical and financial assistance. BSC will gladly assist Colrain on future grant applications as well as discussions with MassDOT.





Chapter 4: References

MADOT BMS Client [Computer software on CD-ROM]. (n.d.).

massDOT Bridges Web Application. (n.d.). Retrieved from
<http://massdot.maps.arcgis.com/apps/webappviewer/index.html?id=d42ae2ac2cb640ac992f763570ce10ed>

Part II: Conventional Construction. (n.d.). Retrieved from
<http://www.massdot.state.ma.us/highway/DoingBusinessWithUs/ManualsPublicationsForms/LRFDBridgeManual2013Edition/PartIIandPartIIIStandardDetails/PartIIConventionalConstruction.aspx>

Standard Specifications for Highways and Bridges. (n.d.). Retrieved from
<https://www.mass.gov/files/documents/2018/01/16/88StandardSpecifications.pdf>





Appendix A:

Maps Bridge Inventory List



Appendix-B: Repair Sketches



Appendix-C: Inspection Reports



Appendix-D:

Existing Bridge Plans
