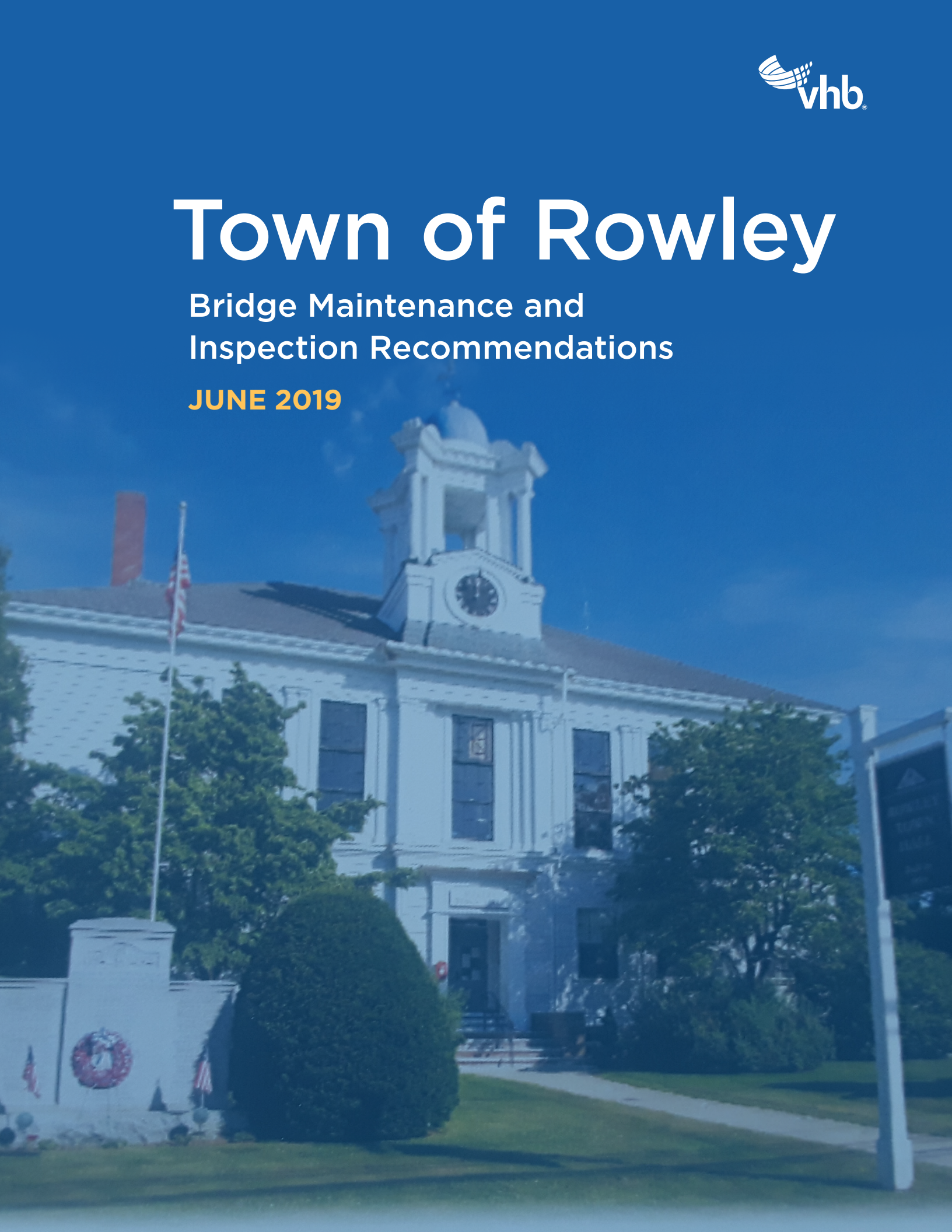
Town of Rowley

Bridge Maintenance and Inspection Recommendations

JUNE 2019



Bridge Maintenance

Bridge maintenance is critical to prolonging the life of structure components and, in turn, the structure itself thereby delaying and/or preventing costly repairs. This document describes various bridge components that can be maintained and contains procedures for performing the maintenance. Most of the maintenance procedures contained herein are intended to be performed by Town forces on a yearly basis.

The bridges in the Town of Rowley's inventory primarily consist of arch bridges or precast concrete frames. These types of structure are generally low maintenance and do not have components such as joints, bearings, or steel beams which are maintenance concerns for larger structures. Although these components are not presently found on any Town-owned bridges, maintenance recommendations are provided for reference in case future bridges constructed in the town have these components.

1. Deck

Bridge decks are typically concrete with an exposed wearing surface or concrete with an asphalt overlay. They are the most exposed component of a bridge and can deteriorate once deicing salts and water penetrate the surface through cracks and corrode the reinforcing. Freeze-thaw cycles can enlarge small cracks allowing more water to penetrate and accelerate the deterioration. Any areas where water ponds on the deck (due to potholes, clogged scuppers, surface depressions near curbs, moisture retaining debris, etc.) are especially susceptible.

Concrete deterioration occurs when the corroded reinforcement rusts and expands. The expansion of the rusting steel cracks the concrete below the surface (delamination) and eventually causes the outer portion of the concrete to break off (spalling). While cleaning the deck or any other concrete surface, evidence of exposed, rusting reinforcement or rust staining should be noted. This is a sign that deterioration is occurring and will lead to spalling of the concrete.

Maintenance Procedures

The deck should be cleaned of debris and litter at the end of each winter season at the same time the joints and scuppers are cleaned. Cleaning can be accomplished using a rotary broom or high pressure water.

Potholes in asphalt wearing surfaces should be patched with a cold patch material until a permanent repair can be made. Cold patch can also be used to temporarily patch concrete decks to improve the riding surface and prevent the pothole from expanding. However, the patch does not replace the structural function of the concrete and the deck should be scheduled for a concrete patch as soon as possible.

If the bottom of the deck is deteriorated to the point where concrete has delaminated (meaning top layer of concrete has separated from reinforcing steel and spalls (loose concrete) are forming, the loose concrete could fall onto motorists/pedestrians below. Loose concrete on the underside of the deck should be removed or planks installed between the beams to ensure debris does not fall and cause injury.

Other maintenance that can be performed to extend the service life of a concrete deck includes sealing of cracks and overlays. These options should be evaluated by a professional engineer and the work should be completed by a contractor.

2. Railing/Parapet

Railings generally refer to barriers at the edges of the bridge deck that consist of metal posts and horizontal rails. Parapets generally refer to barriers constructed entirely of concrete. Some railings are a combination of concrete bases and steel railing on top. Deterioration of concrete barriers is caused by the same factors as for the deck as described above. Salt laden water can be sprayed up onto the barrier. In addition, piles of snow from snow removal activities can pile up against the barriers and over time, contribute to deterioration. Deterioration results in delaminated or spalled concrete and corrosion of the reinforcing steel. The same environmental factors can cause deterioration of steel railings as well. Failure of the protective coating (paint or powder coating) can lead to rusting of the base metal causing section loss and could cause staining of the adjacent concrete. Bridge barriers are an important safety feature and therefore their integrity needs to be maintained.

Maintenance Procedures

Bridge railings should be cleaned using high pressure water at the same time as cleaning of the deck takes place. Any loose concrete should be removed so it does not fall into the travel lanes. Any dirt or debris at the curb line should be removed as this material can trap water against the concrete or portions of metal railing and cause deterioration. If the bridge rail is entirely metal or has a metal section on top of concrete barrier, the anchor bolts should be inspected. Any loose nuts should be tightened and any missing nuts should be replaced. If the protective coating (paint or powder coating) is missing, recoat the exposed metal using touch up paint. Prepare the surface by removing the surface rust and then apply a high-quality primer and paint intended for outdoor use on metals.

3. Superstructure

The superstructure consists of the beams, deck and bridge railing or parapet. Maintenance of the bridge deck and railings has been discussed previously so this section will focus on the beams. Bridge beams are typically either concrete or steel. Deterioration typically occurs at the abutments or piers in areas where the bridge joint has failed and water leaks on to the beam ends. Failure of the paint system of steel girders which exposes the bare steel can lead to deterioration. Therefore maintenance of the paint is critical to avoid costly steel repairs.

Maintenance Procedures

The end of the beams should be cleaned and debris removed at the end of each winter season at the same time the abutments are cleaned. Cleaning can be accomplished using high pressure water. In rare cases for bridges over water, high water can deposit sediment and debris on tops of beam flanges. This debris and sediment should be cleaned off soon after the high water event using high pressure water.

Paint failures should be addressed by spot priming and painting areas of exposed steel. Since most corrosion takes place at abutments or piers at locations of leaking joints, it may be cost effective to repaint the entire beam ends for a distance of 15’ from the abutment. If the paint system has failed at many locations along the girders, complete repainting may be required. Painting of bridge girders should be completed by a professional painting contractor.

4. Substructure

Bridge substructures consist of abutments and piers that support the superstructure. Typically substructure components are concrete. Deterioration of concrete substructures is mainly caused by either salt-laden water from the deck that leaks through the joints and runs down the substructure units and in part from salt spray thrown into the air by vehicles passing on the roadway beneath the bridge. Deterioration causes the concrete to delaminate and later spall. Falling concrete is especially dangerous if the face of the abutment or pier is near the roadway or a sidewalk.

Refer to discussion regarding deterioration of concrete reinforcing steel and its effect on the concrete itself under the Deck section of this document.

Maintenance Procedures

Substructures that are near a roadway or sidewalk should be cleaned using high pressure water at the end of each winter season. Washing will remove salt that has accumulated on the surface. Precautions should be taken when performing this cleaning since the high-pressure water could remove delaminated concrete and cause it to fall to the ground. Consideration should be given to applying a penetrating sealer which will help protect the concrete from future deterioration.

5. Vegetation

Trees and other vegetation can grow near bridge abutments and cause issues including damage to substructure, reduced sight distance for motorists, and obstruction of warning and/or informational signs. Large tree roots can shift concrete wingwalls or cause stone walls to collapse. Ivy or other vegetation growing on substructures can retain moisture and cause deterioration. If there is a large quantity of debris on the bridge deck surface, vegetation can grow on top of the bridge as well.

Maintenance Procedures

Vegetation should be cleared away from bridge abutments, wingwalls, and slopes as required. Any plants attached to the structure should be removed. In some cases, established trees or shrubs on a steep slope will actually serve to stabilize the ground due to the presence of the roots. In these cases, complete removal of the vegetation could have unintended consequences. In this circumstance, trimming of the tree or shrub would be more beneficial.

6. Drainage System

The drainage system (if present) consists of bridge scuppers cast in the deck at various locations along the curb. The scuppers collect water and direct into a piping system carrying the runoff to the ground. The system carries water from the roadway and prevents ponding of water on the deck. Standing water on the bridge deck is especially dangerous in cold weather where it can freeze and cause problems for the travelling public.

Typically the drainage system is mounted to bridge piers or abutments to carry the water to the ground. Leaking pipes can cause salt laden water to leak on to the concrete surfaces and cause deterioration such as delamination and spalling of the concrete.

Maintenance Procedures

Debris and litter tends to collect in scuppers and can partially or completely block the drainage system leading to the problems described above. The scuppers should be cleaned at the end of the winter season at the same time the deck and joints are cleaned. Grates should be removed and as much debris as possible removed and disposed of. Next use high pressure water to flush the scupper and drainage system. Some drainage systems have cleanouts beneath the structure. If accessible, these cleanouts should be used to properly flush the entire system. As with cleaning of the joints, the drainage system should be observed from below while being flushed with water to detect any leaks in the pipe system. As with joint cleaning, it may be cost effective to engage the fire department to help with flushing of the drainage system.

Broken or missing pipes should be replaced using the same size of pipe and material as the existing system. New sections of pipe can be connected to the existing sections using a flexible mechanical coupler. Any downspouts should extend below the bottom of the superstructure and be directed away from the substructure. Downspouts should also be directed away from the feature crossed by the structure.

7. Culverts

Culverts typically have spans of less than 20 ft. and are therefore classified differently from bridges. Culverts carry water under a roadway and their construction can consist of concrete (precast or cast-in-place), corrugated metal pipe, or stone. In the case of concrete or stone culverts, the bottom of the culvert can be concrete or a natural (dirt) bottom. Since culverts typically carry water which only flows with a high velocity during storm events, sediment can build-up in the bottom or at the ends of the structure. The accumulated sediment and debris can reduce the hydraulic capacity of the culvert and result in flooding during storm events.

Maintenance Procedures

Culverts should be periodically cleaned of accumulated debris and sediment to provide an unrestricted hydraulic opening. The frequency of cleaning will depend on many site specific factors such as flow velocity, stream geometry, culvert geometry, and stream bottom material. At a minimum, culverts should be observed just after a large storm event to determine if the culvert capacity is adequate. If flooding has been observed in areas that can be attributed to culvert capacity, the culvert in question should be evaluated to determine if the hydraulic opening has been reduced and sediment should be removed. Sediment can be completely removed from culverts with concrete floors. Care should be taken when cleaning a culvert with a natural floor to ensure the natural stream bed elevation is not lowered. Excavation of soil below the natural streambed could affect the structural integrity of the culvert.

8. Joints

Bridge joints allow the bridge to expand and contract with seasonal temperature variations. Joints are located at abutments and piers depending on the type of structure, span arrangement, and span length. Joints allow required movement while preventing water and deicing salts from reaching critical substructure and superstructure components below.

Due to their location, bridges joints are vulnerable to damage from a number of sources:

- Snowplows – snow plow blades can catch on misaligned parts of the joint and caused damage to the joint itself or concrete surrounding the joint.
- Vehicular Traffic – everyday traffic causes wear and damage to bridge joints especially for bridges without approach slabs where the pavement has settled just before the bridge. The bump increases the impact of the car tire or high pressure truck tire on the joint and concrete surrounding the joint.
- Bridge Movement – the seasonal bridge movement itself can damage the joint if components become misaligned from other factors listed above.
- Debris – Many joints contain a neoprene seal which can be damaged by debris being forced into the joint opening by traffic.

The failure of a bridge joint can lead to many other structural issues.

Substructure

- Abutment Backwall – water and deicing salts that penetrate the joint can run down on the face of backwall and penetrate the concrete through small cracks. This causes corrosion of the reinforcing steel and eventual delamination and spalling of concrete.
- Beam Seat/Pier Cap – Concrete deterioration can occur for the same reasons listed for Abutment Backwall. In addition, debris can collect on the beam seat and rest against the beams and bearings. Moisture can be retained in the debris and accelerate the corrosion of the superstructure components.

- **Superstructure**
  - Beams/Bearings – Water and deicing salts can cause deterioration of beam ends and bearings. Deterioration of these elements compromise safety of the travelling public by reducing the overall capacity of the structure. This deterioration typically necessitates costly repairs and could require complete superstructure replacement.

Maintenance Procedures

Joint maintenance should be performed in cool/cold weather after the last plowable snowfall event of the winter season. The joint will be at its widest position in cooler weather allowing for easier inspection and maintenance. In addition, this is most likely the period of time when the maximum amount of debris will be in the joint. Joint maintenance should be performed on an annual basis. Where cleaning with water is involved, it may be cost effective to have Town Fire Department personnel perform the work with firehoses.

Pavement Sawcut

- This type of joint is used for bridges with asphalt pavement over the deck and small movements at the abutments. It consists of a sawcut in the pavement at each end of the bridge to prevent the asphalt from cracking
- Loose or missing joint sealer should be replaced

Asphaltic Joints

- Asphaltic joints are characterized by a transverse strip of asphalt at the ends of the bridge deck. The asphalt protects the joint material underneath. These types of joints require little maintenance since the joint itself is protected.
- Loose or missing asphalt should be replaced.
- If possible, observe the backwall from underneath the bridge during cleaning with water to detect any leaks in the strip seal. If the joint is leaking, consider replacement of the joint.

If the joint has failed, repair and/or replacement plans should be developed by a professional engineer.

9. Bearings

Bridge bearings are located between the superstructure and the bridge supports (abutments and piers). The bearings allow the beam ends to rotate and allow the structure to expand and contract. As joints above the bearings leak, deicing salts mixed with water can cause corrosion of the bearing assemblies. In addition, debris washed through the joint can pile on and around bearing assemblies causing deterioration. Deteriorated bearings can seize and restrict bridge movement which can lead to many other structural issues with the bridge.

Maintenance Procedures

The bearings should be cleaned and debris removed at the end of each winter season at the same time the joints and scuppers are cleaned. Cleaning can be accomplished using high pressure water. If the amount of debris is significant, hand tools such as shovels and brushes may need to be used prior to washing with water.

Bridge Maintenance Summary

A proactive strategy of preventative bridge maintenance can prevent costly rehabilitation and can extend the service life of the structures. Water and de-icing salts, individually or in combination, cause deterioration to various bridge components. The deterioration can be slowed or preventing by cleaning bridge components, maintaining joints and deck drainage systems, and painting of steel members.

For additional information refer to the reference documents listed below.

Maintenance Manual for Roadways and Bridges, 4th Edition. American Association of State Highway Officials (AASHTO), 2007

Bridge Maintenance of Local Roads. National Association of County Engineers, 1995

Bridge Preservation Guide, Maintaining a State of Good Repair Using Cost Effective Investment Strategies. Federal Highway Administration (FHWA), 2011

NCHRP Synthesis 327, Cost-Effective Practices for Off-System and Local Interest Bridges, Transportation Research Board

Bridge Inspection

Town owned structures are divided into two categories: 1. Bridges/culverts with spans greater than 20 feet and 2. Bridges/culverts with spans of 20 feet or less. Structures in the first category are part of the National Bridge Inventory (NBI) and by law, are required to be inspected at a minimum of every 2 years. This interval can be reduced based on structure condition. MassDOT performs these inspections on behalf of the Town and provides completed inspection reports. The condition of the structure can easily be determined by reviewing the report. Structures with spans less than 20 feet are not part of the NBI and as a result, there are no requirements for inspection of these structures.

Regardless of length, a failure of any structure can result in personal injuries and/or major disruptions to the travelling public and require unexpected capital expenditures by the Town. It is recommended that these structures be inspected by a qualified bridge inspector at least at the same frequency as an NBI bridge (every 2 years). Just like for NBI structures, knowing the condition of the structure can help with planning for maintenance costs and ensure the safety of the travelling public.