

## EXECUTIVE SUMMARY

*Churchill Engineering, Inc (CEI) inspected the bridge located on Brook Road spanning the Beaver Dam Brook within the Town of Plymouth, Massachusetts on February 19, 2010. Previous Structures Inspection Field Reports were completed on April, 12 1999 by Beta Group, Inc. and by the Massachusetts Department of Public Works January 17, 1990. Copies of both reports were made available Churchill Engineering, Inc. prior to conducting the inspection and are included within this report.*

*The bridge is considered in fair/poor condition. The superstructure is considered in satisfactory condition although the deck and the substructure are considered in fair to poor condition respectively. Significant deficiencies include apparent settlement or Northwest corner of West breast wall and apparent movement of Northwest wingwall. In addition the bridge railing is provided by guard rail unsupported along the length of the bridge. Support for the railing is provided by guard rail post along the transitions. The approximate 12 foot length of unsupported bridge railing is not considered to provide adequate protection to vehicular traffic. Along the southern edge of the bridge exists 7" diameter pipe, assumed to be a water main. Due to the unsupported nature of the bridge railing, the utility is not considered adequately protected from vehicular traffic. Vegetation growth, including a 30" diameter tree at the Northeast Wing Wall, is heavy along each of the wing walls where roots from the vegetation are suspected to have penetrated into the joints of the masonry walls. The width of the bridge is approximately 17' 4", and as a result the limited width restricts the bridge support to one lane of traffic.*

*Recommendations by CEI include the following:*

- *Annual assessment of the condition of the structure*
- *Installation of Deformation Monitoring Points (DMP) to monitor and record apparent movement of substructure.*
- *Removal of trees and other vegetation along the wingwalls.*
- *Rechinking and repointing of masonry breast and wing walls.*
- *Repair of pavement at West Approach*
- *Design and implementation of remedial repairs to secure bridge railing to superstructure or revised bridge railing secured at each abutment.*
- *Repair of guard rail along approaches*

## PREFACE

The assessment of the general condition of the bridge is based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of this report unless reported otherwise.

In reviewing this report, it should be realized that the reported condition of the bridge is based on observations of field conditions at the time of inspection, along with data available to the inspection team.

It is critical to note that the condition of the bridge depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the bridge will continue to represent the condition of the bridge at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

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*Authorized/Licensed Professional's Signature*

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Figure 1: Locus Plan

## APPENDICES

- Appendix A: Photographs
- Appendix B: Structures Inspection Field Report
- Appendix C: Previous Reports and References

## SECTION 1

### 1.0 DESCRIPTION OF PROJECT

#### 1.1 General

##### 1.1.1 Authority

The Town of Plymouth Massachusetts has retained Churchill Engineering, Inc. to perform a visual inspection and develop a conditions assessment report for the bridge which carries Brook Road over the Beaver Dam Brook in Plymouth, Massachusetts.

##### 1.1.2 Purpose of Work

The purpose of this investigation is to inspect and assess the present condition of the bridge and appurtenant structures in accordance with Federal Highway Administration (FHWA) National Bridge Inspection Standards (NBIS).

The investigation is divided into three parts: 1) obtain and review available reports, investigations, and data previously submitted to the owner pertaining to the bridge and appurtenant structures; 2) perform a visual inspection of the bridge; 3) prepare and submit a final report presenting a condition assessment of the bridge, including recommendations and remedial repairs.

#### 1.2 Description of Project

##### 1.2.1 Location

The Bridge is located on Brook Road spanning Beaver Dam Brook, within the Town of Plymouth, Massachusetts. The bridge is at Latitude 41.9229 N degrees and Longitude -70.5628W degrees.

##### 1.2.2 Owner/Maintainer

The owner of the bridge is the Town of Plymouth, Massachusetts. The point of contact concerning the bridge is the Town Engineer, Mr. Sid Kashi PE, and can be contacted at 11 Lincoln Street Plymouth, MA 02360. The bridge is maintained by the Town of Plymouth's Department of Public Works and can be contacted at this same address.

##### 1.2.3 Description of the Bridge

The bridge is a single span of approximately 11'-6" spanning Beaver Dam Brook. The date of construction is unknown and there were no plans for the structure available to CEI at the time of inspection. The superstructure consists of 8 longitudinal concrete encased steel girders / stringers supporting a concrete deck. The width of the concrete deck is approximately 17'-4" supporting a single lane of traffic. The wearing surface on the deck consists of approximately 1" of bituminous concrete pavement. The bridge also carries a 7" diameter pipe along the southern edge, assumed by be a water main. The end of the girders, bearings and bridge seat are encased in concrete and

obscured from view. The substructure is dry laid masonry with chinking and mortared joints forming breast walls and wing walls. Two deformation monitoring points are located on both the southeast and southwest wing walls.

## SECTION 2

### 2.0 INSPECTION

#### 2.1 Visual Inspection

The bridge was inspected on February 19, 2010. At the time of the inspection, the weather was clear and in the 40's. No significant rainfall had occurred the week prior to the inspection. Hence, water level within Beaver Dam Brook was considered seasonal normal pool. Photographs to document the current conditions of the bridge were taken during the inspection and are included in Appendix A. Underwater areas were not inspected. A copy of the structures field inspection report is included in Appendix B.

#### 2.2 Superstructure

The interior girders / stringers were found to be in satisfactory condition with surface pitting up to 1/8" and approximately 3/16 of flange width remaining. Both North and South facia girders were also found to be in satisfactory condition but suffer from slightly greater section loss and laminar oxidation. This condition appears to have resulted from greater exposure to the elements. The concrete encasement of the girders / stringers has spalled from below the bottom flange typical for all members. The deck appeared in fair condition between the girders/ stringers with no significant defects beyond the spalling noted above. In general, sounding of the underside deck yielded the concrete sound with no voids, delimitations or other deficiencies noted.

#### 2.3 Substructure

The substructure was found to be in poor condition. The West abutment was found to have numerous chincking stones and mortar within the joints missing typically within the lower 3 feet of the breast wall. Voids with the breast wall measured up to 22 inches in depth.. The bridge seat has filled with concrete below the girders / stringers with a crack observed below the 4<sup>th</sup> girder / stringer from the south edge of the deck. The Northwest corner of the West breast wall appears to have settled and displaced approximately ¾ inch to the North. Within 2 – 3 feet +/- of the Northwest corner of the breast wall is noted to have large voids, cracked stones, missing chinking stones and mortar throughout the full height of the breast wall. It at this corner the largest voids are noted including the void measured to be 22 inches deep. The Northwest wing wall was also found to suffer from the apparent settlement and resulting displacement as with the Northwest corner on the breast wall. The Northwest wing wall was observed to be leaning towards to the North with several large stones displaced approximately 8 – 13 inches northward. The Southwest wing wall was found to be missing chincking stones and mortar similar to the Northwest wall. However, any settlement and displacement of the wall appears to be minor.

The East abutment was found to be in similar condition to the West abutment. In general deficiencies include cracked stones, missing chinking and mortar. This condition is noted within the lower 3 feet of the breast wall. The bridge seat at the East abutment is also filled with concrete similar to the West, although no cracks were noted. The severity of structural distress due to settlement and displacement of the East breast wall was not noted or considered minor. Both wing walls flanking the East abutment were found to be missing chinking, mortar patches and minor dislodgment of stones. Heavy vegetation growth was noted along the width walls flanking both

abutments. Roots of the vegetation growth were observed adjacent or into the masonry joints including a 30 inch diameter tree at the Northwest wing wall.

#### 2.4 Channel and Channel Protection

Channel and channel protection were considered in satisfactory condition. Beaver Dam Brook is a meandering stream flowing below the bridge carrying Brook Road at a medium velocity. No significant rain events occurred within a week of the inspection. Hence, the water surface elevation at the time of the inspection was considered at seasonal normal pool. The banks of unlined channel both up and downstream of the structure were noted to exhibit minor erosion although stream aggradation and channel misalignment were not observed. Signs of channel scour or other streambed degradation were not observed and probing below the substructure did not yield signs of undermining.

#### 2.5 Approaches

The approaches to the bridge were considered in poor condition. The east approach pavement exhibited alligator cracking with no roadway settlement noted. The West approach pavement severely cracked with areas of pavement failure. Approximately 1 inch of settlement was noted at the Northwest interface between the bridge deck and approach. Previous inspection reports indicate that warning and regulatory signs were obstructed by foliage. However, this condition was not noted at the time of inspection due to the seasonal lack of foliage.

#### 2.6 Traffic Safety

The bridge railing is provided by steel guard rail section unsupported along the approximate 12' length of the structure. The current support condition of the bridge rail is not considered to provide adequate protection for vehicular traffic. Additionally, the utility located along the southern edge of the deck is also not considered to be adequately protected vehicular impact. Approach guardrails and end treatments are present although the guard rail posts appear out of plumb or otherwise misaligned, particularly along the Northwest wing walls. Hence, they not considered to comply with current standards or provide adequate protection to vehicular traffic on the bridge.

The northern guard rail at the East approach near the end treatment is also damaged.

## SECTION 3

### 3.0 ASSESSMENT & RECOMMENDATIONS

#### 3.1 General Assessment

In general, the bridge carrying Brook Road over the Beaver dam Brook is in Fair condition. Assessments of individual elements of the structure are presented above. The following recommendations are provided to address deficiencies noted above to allow for the continued use of the structure.

- The April 12, 1999 inspection report recommended an annual inspection of the bridge be conducted. CEI concurs with this recommendation based upon the advanced condition of some of the deficiencies noted within the inspection report.
- Based upon the advanced age of the structure, Brook Road over Beaver Dam Brook is nearing or may have exceeded its expected useful life cycle. In addition, this structure is of limited width, restricted in allowable live loading and lacks a pedestrian walkway. Improvements to bring this structure into compliance with current design standards are considered beyond the scope of remedial repairs. Correction of the above deficiencies would appear to require complete replacement of the structure. Hence, the Town of Plymouth may find it advantageous to consider such needs in their capital planning.

#### 3.2 Substructure

- Apparent settlement and displacement of substructure elements should be monitored for continued movement. Misalignment of guard rail elements, particularly along the Northwest wing wall, appears to be a result of this movement. CEI suggests installation of deformation monitoring points and development of a deformation monitoring program to record movements of the structure and to determine the rate at which the movement is occurring. Determination of the rate of movement and any acceleration in the rate of movement may provide advance warning of major structural failure and resulting life safety issues.
- Removal of trees and other vegetation around the substructure elements should be completed to prevent further degradation of the masonry components elements leading to potential life safety issues. Particular attention should be given to remove the root system of the trees and vegetation that may have infiltrated the masonry joints.
- Repointing and replacement of missing chinking within masonry elements to prevent further degradation of the substructure.

#### 3.3 Approaches

- Repair of the failed pavement of the West approach is recommended. The settlement noted during the inspection at the Northern edge of the West approach appears to be a result of movement of the Northwest wing wall and West abutment. This movement may be continuing resulting in repairs to the pavement to be ineffective. CEI recommends continued monitoring of the condition.

- Seasonal vegetation obscuring warning and regulatory signage for the bridge should be evaluated and removed if necessary. Although vegetation was not noted to obscure signage in this report, previous inspection reports noted this deficiency.

#### 3.4 Traffic Safety

- The bridge rail should be evaluated for conformance with current AASHTO standards. CEI recommends a revised bridge rail design be developed and secured to the superstructure. The approach guard rail should be reviewed for compatibility with the revised bridge rail.
- If the current approach guard rail is determined to be compatible with the revised bridge rail, then the damage to the guard rail on the Northern side of the East Approach should be repaired.

#### 3.5 Cost Estimate

• Annual Inspection	\$ 3,000.00
• Deformation Monitoring Program (annually)`	\$ 35,500.00
• Remedial Repairs	
○ Vegetation Removal	\$ 2,000.00
○ Masonry Repairs	
■ Engineering	\$ 2,500.00
■ Construction	\$ 11,000.00
○ Bridge Rail	
■ Bridge Rail Post Design	\$ 1,500.00
■ Bridge and Approach Guard Rail	\$ 25,083.00
○ Pavement Repairs	\$ 9,920.00
• Complete Replacement	
○ Engineering	\$ 200,000.00
○ Construction	\$1,620,000.00



**Figure 3 East Approach**



**Figure 4 West Approach**



**Figure 5 Bridge Deck**



**Figure 6 Girders (viewed from underside of bridge deck)**



**Figure 7 East Abutment**



**Figure 8 West Abutment**



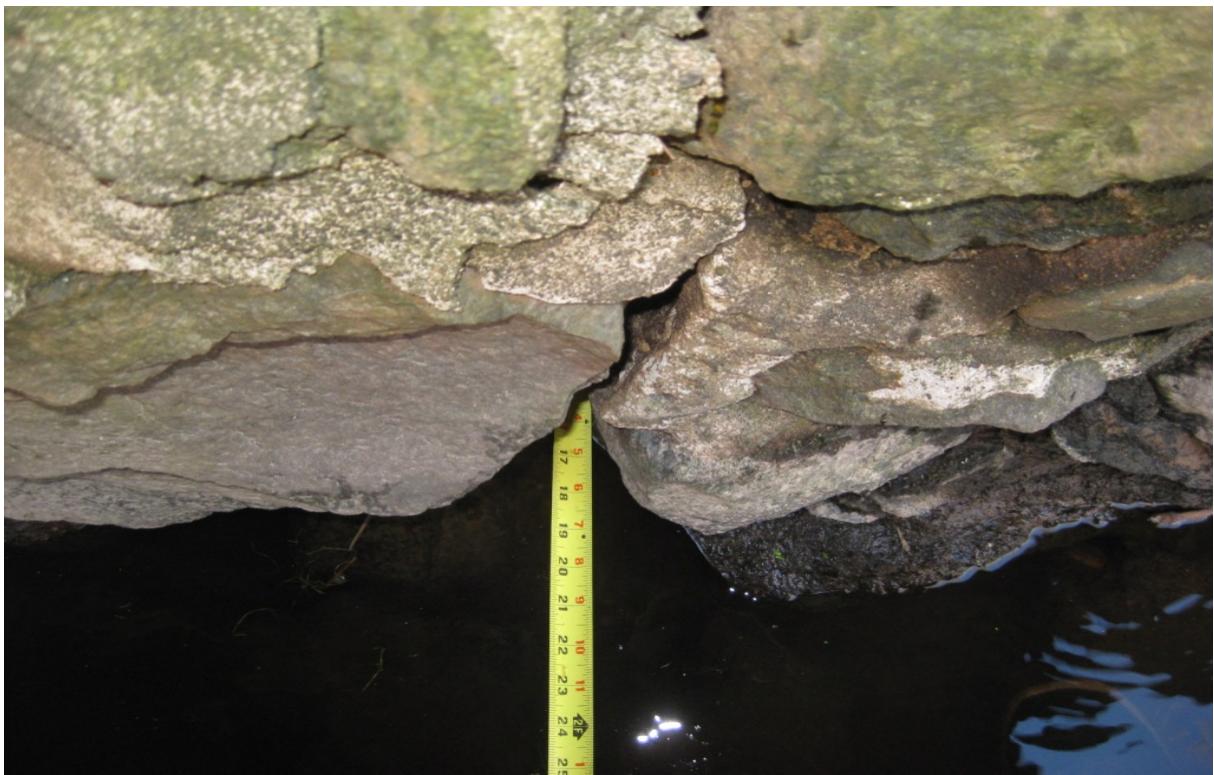
**Figure 9 Crack in West Abutment Bridge Seat (below girder 4)**



**Figure 10 Lateral Displacement North End West Breast Wall**



**Figure 11 Settlement and Lateral Movement North West Wing Wall**



**Figure 12 Void West Breast Wall**



**Figure 13 South East Wing Wall**



**Figure 14 North East Wing Wall**



**Figure 15 Unsupported North Bridge Rail**



**Figure 16 Unsupported South Bridge Rail**



**Figure 17 Pavement Failure West Approach**



**Figure 18 Settlement North Side West Approach**



**Figure 19 Utility South Edge Bridge Deck**



**Figure 20 Vegetation North Elevation (looking West)**



**Figure 21 Vegetation South Elevation (looking West)**



**Figure 22 Damaged Guard Rail East Approach North Side**



**APPENDIX B**  
**Structures Inspection Field Report**

**APPENDIX C**  
**Previous Reports and References**

## **PREVIOUS REPORTS AND REFERENCES**

The following is a list of reports that were located during the file review, or were referenced in previous reports.

- 1. Culvert Inspection Report, by Beta Group April 12, 1999.*
- 2. Structures Field Inspection Report, by Massachusetts Dept. of Public Works January 17, 1990*