
TO: Town of Plainfield, Vermont
FROM: Jessica Louisos, PE & Roy Schiff, PE, PhD, Milone & MacBroom
RE: Benefit Cost Analysis – Brook Road Bridge #21 Replacement
DATE: 3/25/2021
MMI #: 4438-14

Replacement of a bridge on Brook Road has been proposed over Great Brook to mitigate road and structure flooding and erosion damages. These improvements were identified and analyzed with hydraulic modeling in the Great Brook Bridge Alternatives Analysis completed by Milone & MacBroom in February 2016. The selected preferred alternative has been advanced to final design completed by VHB, with assistance by Milone & MacBroom, in February 2021.

A FEMA Benefit Cost Analysis (BCA) has been performed to explore if the avoided damages (i.e., the project benefits) outweigh the cost of the proposed bridge (i.e., the project costs). In other words, the BCA is performed to determine if the Benefit Cost Ratio is larger than 1.0 and the project makes sound financial sense.

The FEMA Benefit-Cost Calculator version 6.0 was used to estimate benefits. The estimated replacement costs and associated benefits to the roads at the bridge were input using the property structure type of Roads and Bridges. The Hazard Type is Riverine Flood because the flooding is associated with flood and erosion damages from Great Brook. The Mitigation Action Type is Drainage Improvement as the bridge replacement will reduce the existing constriction, reducing flood water surface elevations and velocities. The standard 50-year project useful life was used that applies to bridge replacement projects. Brook Road overtops with flood waters during moderate to large flood events requiring road closures. In several cases the road embankment has washed out. The bridge was built in 1920 (i.e., 101-year analysis duration).

The economic cost of a detour is considered a benefit. The detour around the Brook Road bridge crossing is 0.4 miles and one minute longer than the direct route according to Google Maps. The number of estimated one-way traffic detour trips were provided by VTtrans as 769 AADT in 2019 as reported in the Transportation Data Management System.

Historical Damages Before Mitigation were collected for storms that had available damage data (Table 1). Flood recurrence interval data were provided in the Updated Flood History, Great Brook Watershed, Plainfield, Vermont in 2015 (attached). The road closure time for flood events was reported by the Town Road Foreman. Damage repair values were provided by the Town Clerk for 2015, a FEMA Damage Survey Report for 1984, and a FEMA project worksheet for 2011.

Table 1 Summary of Historical Damages Before Mitigation

Date of Flood	Estimated Recurrence Interval	Bridge Repair	
	Years	Days closed	Cost
1984	2		\$16,650 (FEMA PW)
May, 2011	200	21	\$53,867.13 (FEMA PW)
7/19/2015	10	7	\$7,840 (Town Record)

Expected Damages After Mitigation were determined based on hydraulic model results and project design parameters. Hydraulic modeling shows the proposed bridge will safely pass the 100-year storm with freeboard and velocities lower than the designed scour protection. No damage is expected to the structure for the 100-year storm and no road closure will be needed. Following the 100-year storm it is expected that the town road crew will inspect the bridge and may need to spend a few hours clearing debris, with an estimated cost of \$500. The 500-year storm will just crest the road surface and is expected to need a 1-day road closure followed by the road crew clearing debris from the road surface, with an estimated cost for labor and equipment of \$1,000. The road surface and downstream bridge face are designed to resist flood velocities, so no erosion damage will need to be repaired following the 500-year storm.

The benefits of the bridge replacement on the surrounding properties were input into the BCA. Hydraulic modeling results indicate that three homes have reduced hazard levels due to the bridge replacement. Each of the three benefiting homes have been entered as a separate structure that benefits from the drainage improvement of the Brook Road Bridge replacement. All costs of the bridge replacement have been included in the BCA under the Road and Bridge section with the bridge specific cost and benefit information. No physical changes are proposed at the homes. They are included as benefits only and have no costs associated with the homes.

For the three residential homes Mitigation Action Type of Drainage Improvement was chosen for the Riverine Flood Hazard Type, referring to the drainage improvement project of the Bridge Replacement. The property structure type of Residential Building was selected. The project useful life of 50-years corresponding to the bridge project useful life was used. The adjacent grade was surveyed in 2020 as part of the bridge design project and the height to the first floor was measured to calculate the Lowest Floor Elevation. Existing and proposed water surface elevations were identified at each building using the HEC-RAS hydraulic model output. Building information including number of stories, building size, and presence of basements are from Town lister cards. The FEMA standard replacement value of \$100 per square foot was used.

The BCA resulted in a positive Benefit Cost Ratio of +1.83 (Table 2).

Table 2 BCA Results

Variable	Value
Total Mitigation Project Benefits	\$2,282,023
Engineer's Opinion of Probable Construction Cost	\$1,242,496.88
Annual Maintenance Costs for inspection and minor repairs (\$500/year)	\$34,149.01
Total Costs	\$1,249,400
Benefit Cost Ratio	+1.83

Estimate BROOK RD BRIDGE

Estimated Cost:\$1,183,330.36

Contingency: 5.00%

Estimated Total: \$1,242,496.88

REMOVAL AND REPLACEMENT OF BRIDGE NO. 21 ON THE EXISTING ALIGNMENT

Base Date: 02/26/21

Spec Year: 18

Unit System: E

Work Type: BRIDGE CONSTRUCTION

Highway Type: LOCAL

Urban/Rural Type: RURAL

Season: CONSTRUCTION (APRIL 15th - OCTOBER 15th)

County: PLAINFIELD

Latitude of Midpoint: 441631

Longitude of Midpoint: 722524

District: SE

Federal Project Number: N/A

State Project Number:

Estimate Type: CONTRACT PLANS

Prepared by J.D. KEENER on 02/26/21

Checked by S.E. BURBANK on 02/26/21

Approved by S.E. BURBANK on 02/26/21