VERMONT

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Agency of Transportation

TO: Christopher Bump, District 4 Project Manager
Margy Becker, Town of Sharon

CC: Scott Jensen, A.N.R. River Management Engineer

FROM: Cassidy Cote, Hydraulics Engineer

DATE: December 11, 2018

SUBJECT: Sharon TH-11, Quimby Mountain Road, over unnamed tributary to High Pole Branch
Site location 0.5 miles east of VT-14
GPS coordinates: N 43.773626°, W 72.440385°

We have completed our hydraulic study for the above referenced site, and offer the following for your use:

Hydrology

The following physical characteristics are descriptive of this drainage basin:

Drainage Area	0.32 square miles
Land Cover	Tyler Mountain, forested with some residential area
Avg. Drainage Basin Slope	13 %
Water Bodies and Wetlands (NLCD 2006)	0 %

Using the USGS hydrologic method, the following design flow rates were selected:

Annual Exceedance Probability (AEP)	Flow Rate in Cubic Feet per Second (cfs)	
43 %	20	
10 %	40	
4 %	54	Design Flow – Local Road
2 %	67	
1 %	82	Check Flow

Channel Morphology

The channel for this perennial stream is straight with a local channel slope of 9.0%. The upstream channel is laterally confined by the roadway. Approximately 100 feet upstream of the crossing, the channel runs through a corrugated metal pipe arch beneath Morrill Hill Road. This structure has a clear span of 2.5 feet and a clear height of 1.5 feet, providing a waterway opening of 2.9 square feet. Field measurements of bankfull width varied from 5 to 6 feet at a bankfull depth of 2 to 3.5 feet upstream and downstream of the structure. Confluence of this brook with High Pole Branch is 40 feet downstream of the crossing. This reach of High Pole Branch has a bankfull width of 18 to 22 feet and a local stream slope of 5.7%.

These hydraulic conditions indicate that the culvert in question may be affected by water backing up from the High Pole Branch during flood flows on that river. Due to the difference in drainage area size, this brook will be at flood stage much earlier than the High Pole Branch. However, when the High Pole Branch is at flood stage, it may overtop the roadway regardless of the size of structure placed here. Further analysis would be required to determine the extent of this possibility as this memo strictly addresses replacement options considering runoff volumes and environmental standards. Headwater depths may therefore be greater than reported if water backs up from this river.

Existing Conditions

The existing structure is a concrete box with flared wingwalls. The structure has a clear span of 3 feet and a clear height of 3 feet, providing a waterway opening of 9 square feet. There is erosion behind the channel right inlet wingwall due to the poor alignment of this structure with the channel. Both wingwalls are showing signs of scour and advanced deterioration. At the outlet, the structure significantly undercuts the roadway. Any replacement structure should be lengthened and should consider realignment to better match the grade and layout of the channel.

Our calculations, field observations and measurements indicate the existing structure does not meet current standards of the VTrans Hydraulic Manual nor does the existing structure meet state stream equilibrium standards for bankfull width (span length). The existing structure constricts the channel width, resulting in an increased potential for debris blockage. This structure results in a headwater depth of approximately 3.7 feet at 4% AEP with water overtopping the roadway prior to the 2% AEP.

Replacement Recommendations

In sizing a new structure, we attempt to select structures that meet both the current VTrans hydraulic standards, state environmental standards regarding span length and opening height, and allow for roadway grade and other site constraints. These recommendations have been made without backwater of the High Pole Branch.

The low height from the streambed to the road may limit the replacement options to a box structure, as the roadway could have to be raised substantially for the pipe arch recommended below. This option is not recommended as an increase in roadway elevation could create a dam, thereby increasing the extent of flooding upstream. Pipe manufacturers can provide specific recommendations regarding minimum and maximum fill heights and required pipe thickness.

Based on the above considerations and the information available, we recommend any of the following structures as a replacement at this site:

- A concrete box with an inside opening span of 6 feet and minimum height of 5 feet. The box invert should be buried 2 feet. This will result in a clear height of 3 feet above streambed, providing 18 square feet of waterway area. Bed retention sills should be added in the bottom of the structure. Sills should be 12 inches high at the edges of the box and 6 inches high in the center, creating a V-shape across the full width of the box. Sills should be spaced no more than 8 feet apart throughout the structure with one sill placed at both the inlet and the outlet. The structure should be filled level to the streambed with E-stone, Type II, allowing flow to be kept above the surface, providing the conditions necessary for aquatic organism passage. This structure results in a headwater depth of 2.4 feet at 4% AEP and 3.1 feet at 1% AEP.

- A pipe arch with a minimum clear span of 76 inches and height of 57.1 inches. The invert should be buried 24 inches. This will result in a clear height of 33.1 inches above streambed, providing 12.8 square feet of waterway area. Bed retention sills need to be added and filled as described for the box above. This structure results in a headwater depth of 2.6 feet at 4% AEP and 3.7 feet at 1% AEP.

Note: *Any similar structure that fits the site conditions could be considered. Please contact the VTrans Hydraulics Section with alternatives that have significantly different inlet geometry so headwater depths may be calculated. Any structure with a closed bottom should have bed retention sills and a buried invert as described above.*

Headwater depths reported above are with respect to the existing structure slope. If a culvert grade exceeding 7.5% is selected for replacement of this structure, please contact the VTrans Hydraulics Section with a proposed profile so headwater depths and outlet velocities may be calculated. If a structure grade in excess of 7.5% is selected, E-stone, Type III may be necessary to reduce erosion and prevent a scour hole.

Stone Fill, Type II should be used to protect any disturbed channel banks or roadway slopes at the structure's inlet and outlet, up to a height of at least one-foot above the top of the opening. Stone fill should not constrict the channel or structure opening.

Prior to any action toward the implementation of any recommendations received from VTrans, stream type and structure size must be confirmed, and may be modified, by the VT ANR River Management Engineer to ensure compliance with state environmental standards for stream crossing structures. Regulatory authorities including the US Army Corps of Engineers may have additional concerns or requirements regarding this structure.

General Comments

It is always desirable for a new structure to have flared wingwalls, matched into the channel banks at the inlet and outlet, to smoothly transition flow and protect the structure and roadway approaches from erosion. It is also recommended that full height concrete headwalls be constructed at the inlet and outlet. Any closed bottom structure should also be equipped with cutoff walls, extending to a depth equal to the culvert rise, up to 4 feet below the streambed, or to ledge, to serve as undermining prevention. Any new structure should be properly aligned with the channel, span the natural channel width, and be constructed on a grade that matches the channel.

The structures recommended above have been sized with respect to hydraulic and environmental standards and do not consider debris blockage or limitations on constructability. **It may be desirable to upsize the opening height to facilitate installation of E-stone, Type II within the structure.** To minimize maintenance, it is also recommended that the structure height be adequate for passage of debris.

Please note that while a site visit was made, these recommendations were made without the benefit of a survey and are based on limited information. The final decision regarding replacement of this structure must comply with state regulatory standards, and should take into consideration matching natural channel conditions, roadway grade, environmental concerns, safety, and other requirements.

Please contact us if you have any questions or if we may be of further assistance.