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*Agency of Transportation*

**TO:** Chris Bump, District 4 Project Manager

**CC:** Jaron Borg, ANR River Management Engineer

**FROM:** Madeline Glow, Hydraulics Project Engineer

**DATE:** August 25, 2023

**SUBJECT:** Chelsea TH-15 (Doyle Road) over unnamed tributary to First Branch White River  
Site location: C3, 0.2 miles North of Washington Turnpike intersection  
Coordinates: [44.031583, -72.456056](#)

We have completed our hydraulic study for the above referenced site and offer the following for your use. The drainage area and structure size recommended are both large enough that when a survey of the site becomes available, a more detailed model should be developed for this structure.

### **Hydrology**

The following physical characteristics are descriptive of this drainage basin:

Drainage Area	<b>4.76 square miles</b>
Water Bodies and Wetlands (NLCD 2006)	0.15%
Mean Annual Precipitation	44.3 inches

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

Annual Exceedance Probability (AEP)	Flow Rate in Cubic Feet per Second (cfs)
50 %	220
10 %	450
4 %	600 Design Flow – Local Road
2 %	730
1 %	870 Check Flow

### **Channel Morphology**

The channel for this perennial stream is sinuous to straight with an estimated local stream slope of about 1.8%. Field measurements of bankfull width varied from 17 to 21 feet upstream and downstream of the structure.

### **Existing Conditions**

The existing structures are two squashed boiler pipe's approximately 4- and 5-foot diameters, providing a combined waterway opening of 32.2 square feet. 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 complication is known to cause ponding at the inlet, increase stream velocity and scour at the outlet, and may lead to erosion and failure of channel banks.

This structure results in water overtopping the roadway before the 10% AEP.

### **Replacement Recommendations**

In sizing a new structure, we attempt to select structures that meet both the current VTrans hydraulic standards, state environmental standards with regard to span length and opening height, and allow for roadway grade and other site constraints.

The low height from the streambed to the road might limit the replacement options. 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 18 feet and minimum height of 9 feet. The box invert should be buried 2 feet. This will result in a clear height of 7 feet above streambed, providing 126 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 5.6 feet at 4% AEP and 7.2 feet at 1% AEP.
- A bridge or open bottom rigid frame with a minimum rectangular waterway opening of 18 feet wide by 7 feet high, providing 126 square feet of waterway area. This structure results in a headwater depth of 5.6 feet at the 4% AEP and 7.2 feet at the 1% AEP.
- An open bottom pipe arch with a minimum clear span of 21 feet and clear height of 6.9 feet, providing a waterway area of 104 square feet. E-Stone, Type II, may be needed to be used to build the channel through this structure. The bottom of abutment footings should be at least 6 feet below the channel bottom, or to ledge, to prevent undermining. This structure results in a headwater depth of 5.5 feet at 4% AEP and 7.3 feet at 1% AEP.

***Note:** Any similar structure that fits the site conditions could be considered. Any structure with a closed bottom should have bed retention sills and a buried invert. VTrans Hydraulics Manual requires a minimum of 1-foot of freeboard at the design AEP for open bottom structures.*

The structures recommended above have been modeled with a culvert slope of 1.1%. The local stream slope should be verified prior to installation of the new culvert.

Stone Fill, Type II OR E-Stone 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. The 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 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, or to ledge, to serve as undermining prevention.

If a new bridge is installed, the bottom of abutment footings should be at least six feet below the channel bottom, or to ledge, to prevent undermining.

Abutments on piles should be designed to be free standing for a scour depth at least 6 feet below channel bottom. 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.

**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.