ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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Stream Crossing Design:
Building Structures that are Compatible with People, Streams and Wildlife

Projects involving dredge or fill or the placement of structures on or within the banks or bed of surface waters require permitting from the New Hampshire Department of Environmental Services (NHDES) Wetlands Bureau. The Wetlands Bureau operates under RSA 482-A (Fill and Dredge in Wetlands) and the New Hampshire Code of Administrative Rules Env-Wt 100-900. The purpose of Chapter Env-Wt 900 is to "enhance public safety by establishing standards for stream crossings that are designed to lessen the risk of blockages and wash-outs of culverts and bridges, and the associated flooding, which can jeopardize property and human lives upstream and downstream of such crossings." The purpose is also to "preserve and enhance the functions and values of existing streams, support the restoration of impacted streams to their natural state, and improve aquatic organism passage and sediment transport". The goal is therefore to design crossings that are compatible with the hydrology, geomorphology, and the passage of aquatic organisms in the stream.

Deficient Stream Crossings: Public Safety and Environmental Hazards

An undersized culvert increases water velocity and inhibits natural sediment movement through the pipe, resulting in sediment accumulation and ponding upstream, and scour and erosion downstream. Over time, the crossing becomes increasingly vulnerable to overtopping and failure, as well as acting as a barrier to fish and other aquatic organisms.

Deficient stream crossings may cause the following issues:

- Flood hazards that may cause harm to people and property.
- Risk of being blocked with wood and debris.
- Upstream channel widening and ponding.
- Disruption of natural stream function and process.
- Barrier to aquatic connectivity.
- Stream scouring and bank erosion.
- Water quality degradation.

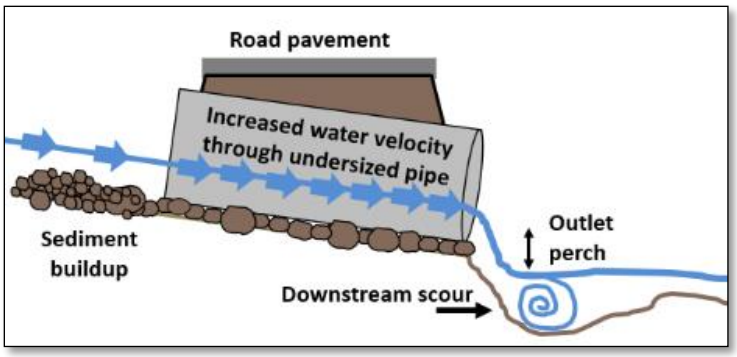

Figure 1 *- Deficient stream crossings. In the stream crossing shown on the left, water velocity (represented by the blue arrows) increases due to the undersized culvert, resulting in sediment buildup at the inlet, and scouring and erosion at the outlet. Over time, the culvert becomes perched (left) and may also contribute to a road washout (right).*

Aquatic Organism Passage

Aquatic organism passage is the ability of native plant and animal species that spend a portion of their life-cycle in water to pass freely through a stream crossing without restrictions. Animals such as amphibians, reptiles and macroinvertebrates require access to specific aquatic habitats to complete phases of their life cycle.

Deficient crossings can be barriers to aquatic organism movement and disrupt aquatic connectivity by:

- Creating a large vertical drop between the crossing and the stream (Figure 2).
- Affecting water levels and velocity, when such as water levels in the crossing are too shallow or velocity that are too fast.
- Creating physical barriers such as screens that block an inlet or outlet.
- Lacking natural substrate in the crossing.

Figure 2 - *This undersized metal pipe has caused severe downstream scour and erosion, causing the outlet to become perched above the stream. The crossing overtops, is vulnerable to failure, and is a barrier to aquatic organism passage.*

What Makes a Good Stream Crossing?

All new stream crossings and modifications of existing stream crossings must be designed to maintain or enhance the geomorphic compatibility and hydraulic capacity of the crossings, as well as adequate aquatic organism passage.

Geomorphic compatibility is the long-term ability of a stream crossing to minimize potential for obstruction by sediment, wood and debris; preserve the natural alignment of the stream; and accommodate the entrenchment ratio, bank full depth and channel slope of the stream. A geomorphically compatible crossing will span both channel banks and be sized to accommodate flows for large storm events.

Hydraulic capacity is a measure of the ability of a stream, channel or conduit to allow water to pass. A structure that cannot accommodate flows from its watershed will frequently overtop. Moreover, flood damages from failed stream crossings can cause harm to people and property.

When stream crossings are geomorphically compatible and have an adequate hydraulic capacity, water depths and velocities in the crossings are similar to those upstream and downstream of the crossings, and water depths are sufficient during low flow. To provide adequate aquatic organism passage, there should be natural sediments throughout the crossing that provides instream habitat for aquatic organisms. These characteristics will allow the crossings to maintain the hydrologic and biological connection between the upstream and downstream reaches.

What is Stream Simulation?

Stream simulation is a method of designing and constructing a stream crossing within the channel that is as similar as possible to the natural channel in both physical structure and function, and takes into account appropriate bed forms and streambed characteristics so that water depths and velocities within the crossing structure at a variety of flows are comparable with those found in the natural channel (Figures 3 and 4).

Figure 3 - *An open-bottom arch with stream simulation design will accommodate flows during flood events, and maintain full aquatic organism passage and water and sediment transport.*

General Design Considerations (Env-Wt 904.01)

NHDES stream crossing rules require that new crossings:

- Will not be a barrier to sediment transport.
- Will not restrict high flows.
- Will maintain existing low flows.
- Not obstruct or disrupt aquatic organism movement.
- Not cause an increase in the frequency of flooding or overtopping of banks.
- Maintain or enhance geomorphic compatibility.
- Preserve or restore watercourse connectivity**.**
- Not cause erosion, aggradation, or scouring upstream or downstream of the crossing.
- Not cause water quality degradation.

For tidal crossings, the rules require that structures be designed to match the velocity, depth, cross-sectional area, and substrate of the natural stream and be sufficient size to not restrict bi-directional tidal flow over the natural tide range above, below, and through the crossing.

Figure 4 – *The twin perched culverts shown on the left were replaced with the fully-spanning stream crossing shown on the right, which provides geomorphic compatibility and adequate hydraulic capacity, as well as allowing aquatic organism passage.*

Additional Resources

The following resources offer more information on stream crossings:

- *New Hampshire Stream Crossing Guidelines.* 2009. University of New Hampshire.
- *Best Management Practices for Routine Roadway Maintenance Activities in New Hampshire.* 2019. New Hampshire Department of Transportation.
- *Wetlands Best Management Practice Techniques for Avoidance and Minimization.* 2019. New England Interstate Water Pollution Control Commission.

For permit application materials, please visit the Wetlands Bureau webpage. You may also contact the NHDES Wetlands Bureau by phone at (603) 271-2147, via email at lrm@des.nh.gov, or by mail at 29 Hazen Drive, P.O. Box 95, Concord, NH 03302-0095.