

# Stream Crossings

## Common Issues

Bridge and culvert design can have a significant impact on river health. If designed and constructed incorrectly, crossing infrastructure can cause problems such as erosion, loss of habitat, changes to channel form, flooding, and maintenance headaches. If the river is considered at the outset, the crossing infrastructure can be more resilient over its lifespan and not impact river health.

## Questions to Consider

- Is the opening of the crossing sized sufficiently for the range of expected stream flows?
- Does the size of the opening consider sediment, large wood, and debris in addition to water?
- Are there side channel flows that should also be considered as part of the crossing layout?
- Can an open bottom crossing be considered to allow passage of aquatic species such as fish and macroinvertebrates?
- For large openings or multiple pipe layouts, can low flow be factored into design to maintain critical flow depth for passage of aquatic species?
- Are beavers present in the area?

## Principles of River Health

### Culverts and Bridges May Restrict Flow and Transport

Undersized crossings can often lead to upstream flooding, alter sediment transport, increase flow velocity in the crossing, cause challenges with woody material moving in the stream, restrict passage of fish and other aquatic organisms, and often severely limit a river's ability to access the floodplain. They also create safety hazards during floods or post-fire debris flows, because large debris can build up upstream and block the flow of water.

### Crossings Lock a Stream in Place

Bridges and culverts act as fixed points in a river corridor. Because they anchor the river at a specific location, they interrupt the natural ability of the channel to migrate, braid, avulse, or shift across its floodplain. While crossings are necessary for transportation and water delivery, they impose structural constraints that can cause imbalances in river processes. The river's energy builds up at that fixed point, often causing accelerated erosion, channel widening, or headcutting. A fixed point tends to accumulate excess sediment and wood, changing the channel's direction unexpectedly when the crossing becomes flanked or blocked. When a river is prevented from meandering naturally, this leads to increased erosion where vegetation growth cannot keep pace with altered flow patterns.



*A railroad bridge causes unnatural river dynamics, leading to an odd angle and erosion problems  
Photo by Roddy Beall, Zenobia Consultants*

## Infrastructure Can Create Wildlife Barriers

Bridges and culverts can create unique threats if they block the movement of fish and other aquatic species. Fish, amphibians, insects, other animals need to move throughout the river corridor, and crossings infrastructure can fragment that movement. When habitat is fragmented, it can hurt individuals and it can also reduce genetic flow to a point that harms the whole population.

## Recommended Practices or Actions

Landowners and managers can undertake a variety of actions to reduce the impacts of stream crossings on aquatic species, sediment transport, and natural stream processes. Several recommendations are discussed below, including minimizing the total number of crossings, using widespan bridges where feasible, designing crossings to accommodate low- and high-flow conditions, incorporating aquatic organism passage, planning for beaver coexistence, and modifying or removing undersized culverts to improve water and sediment continuity.

### Reduce the Total Number of Crossings

Minimizing the number of stream crossings throughout the region can reduce the overall impact on aquatic species and stream health. Consolidating crossings and using existing crossings will reduce the number of crossings; however, crossings might need to be upgraded to ensure they can accommodate the expected volume and type of traffic. Proper placement of crossings on a landscape scale can help avoid disturbances to hydrologic connectivity and critical habitat areas. For example, it is recommended to place culverts at least 500 meters upstream or downstream of any identified fish spawning beds.

### Use Widespan Bridges Where Possible

The best crossing option for river function is a widespan bridge that allows water, sediment, wood, debris, and recreational boaters to pass through during even the highest flow conditions. While they may be an expensive option, the longevity and minimal maintenance required for these structures, in addition to their low impacts on river health, make these an excellent choice where feasible.

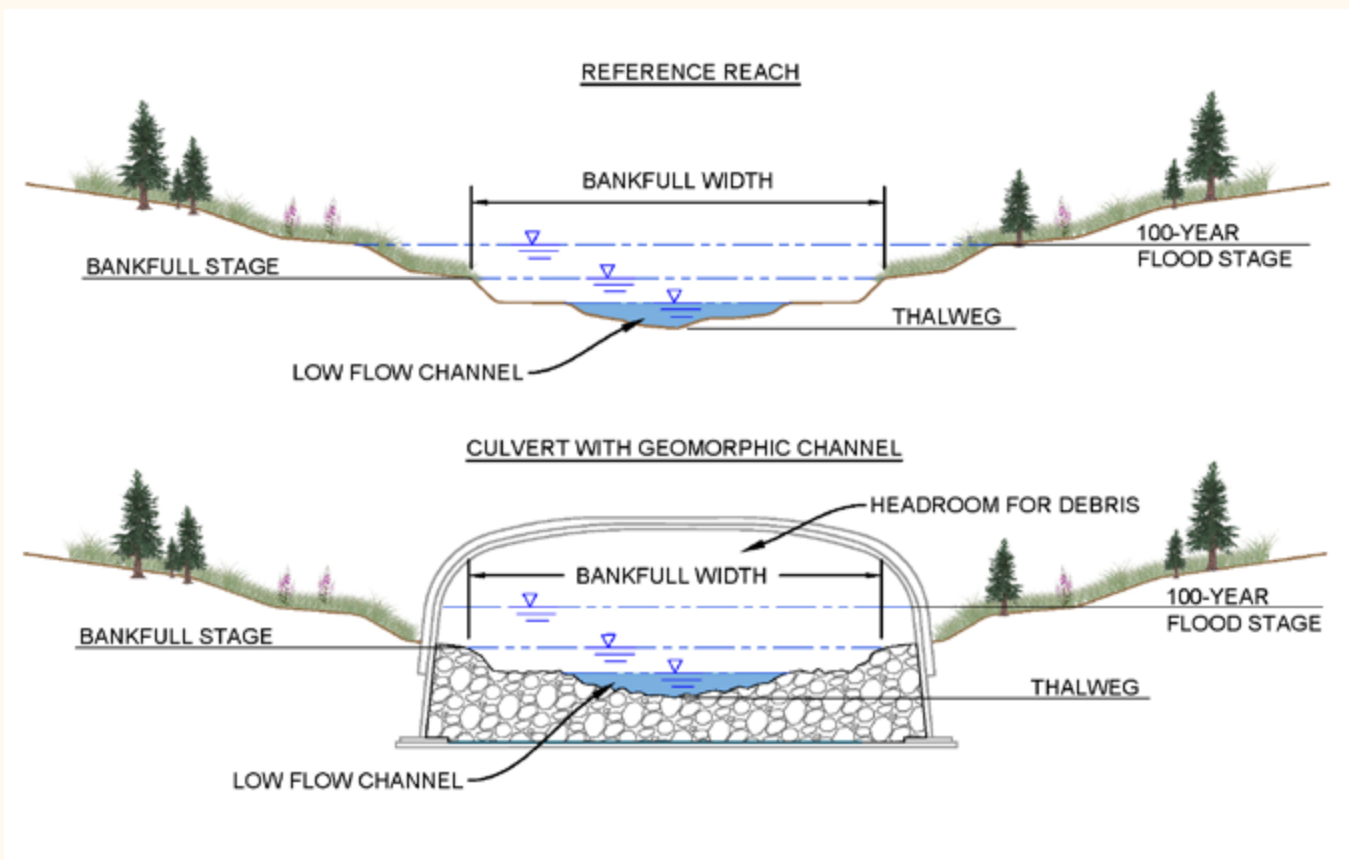


*A widespan crossing doesn't have pillars to obstruct the stream | Photo by Roddy Beall, Zenobia Consultants*

## Design Widespan Crossings and Multiple Barrel Installations for Low-Flow Conditions

The deepest part of the stream channel, or thalweg, is critical during low-flow conditions in order for fish and other aquatic species to move up and downstream. With widespan crossings (large bridges without central support pillars), it is important to consider how low flows will move along the streambed under the crossing. It may be necessary to intentionally create a low-flow pathway that will maintain water depth year-round, instead of spreading the water across a flat concrete channel or large riprap.

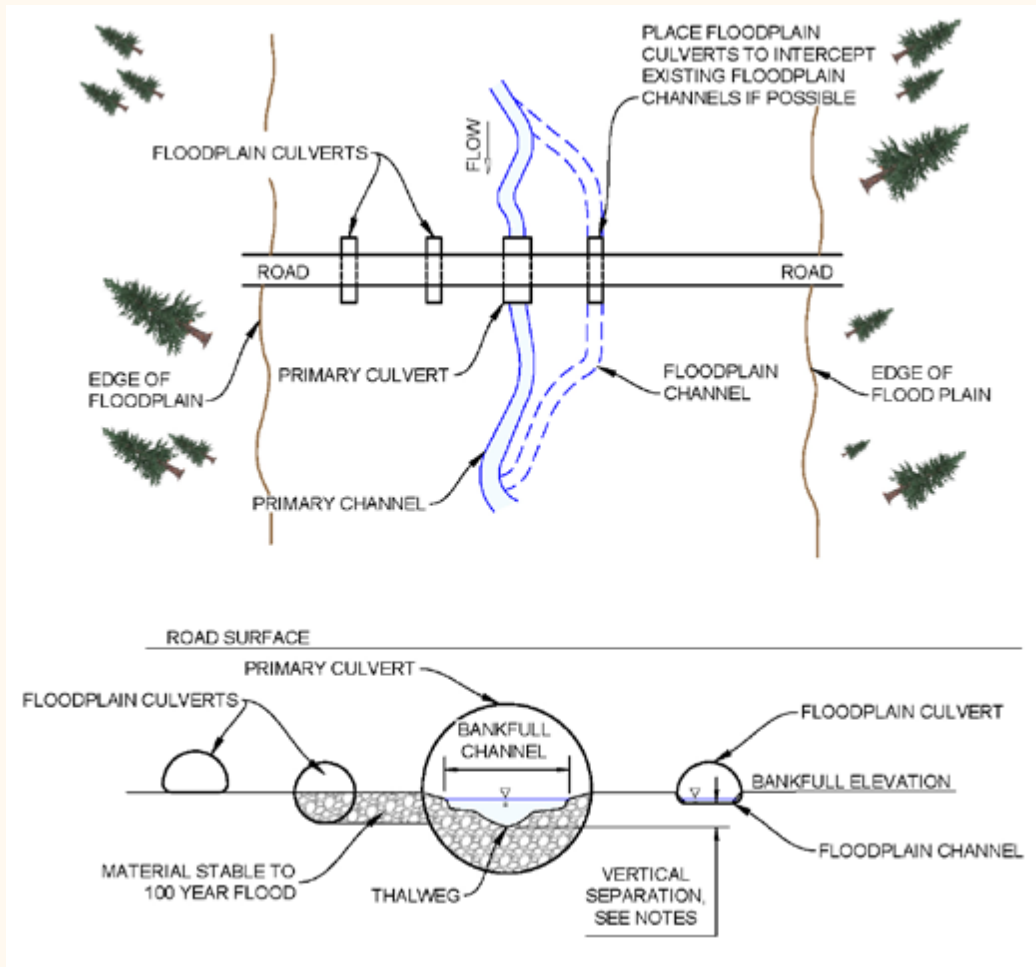
In the case of multiple barrel culvert pipe installations (crossings with several individual pipes or “barrels” installed side-by-side), the barrels should align with the flow and gradient of the river upstream and downstream of the installation. It is important to make sure that one culvert is lower than the others to maintain depth of flow in the thalweg.



*Widespan culverts with natural streambed material and low flow channel are preferred to preserve natural stream processes. When one or more culverts are necessary, culvert and channel elevations can be considered for the same purposes. | Diagram by U.S. Fish and Wildlife Service*

## Install Flood Flow Culverts

Stream crossing designs should consider high flow events such as large storm events and spring snowmelt. An important addition to a stream crossing could be one or more flood flow culverts, which could be located away from the channel location, and may not flow during all storm events. Flood flow culverts can be placed at elevated locations within the floodplain that allow flood flows to equalize across the floodplain and avoid concentration of flow at the primary channel. Flood flow culverts are especially important where side channels are present or where the potential for formation of side channels or stream movement exists.



*This figure is a plan view of a road crossing of a stream channel and its floodplain. The primary channel (solid blue) has a primary culvert, and a floodplain channel (dashed blue) has a floodplain culvert. Additional floodplain culverts are situated within the floodplain, outside of the channels. | Diagram by U.S. Fish and Wildlife Service*

## Keep Culverts Open with Beaver Coexistence Strategies

As discussed in the beaver coexistence section, living with beavers is an ongoing process that requires some proactive measures. Culverts can be protected by building fences, by building a porous starter dam upstream of a culvert, or by creating a steeper stream gradient at the inlet to the culvert that is not conducive to beaver dam construction. Beavers provide many benefits to a property, but culverts and ditches must be protected.

## Design Culverts with Aquatic Species in Mind

As discussed in the Fisheries section, some fish species, such as trout, are good jumpers, while species like sculpin, suckers, and dace are not. Culverts should be designed to allow for upstream and downstream passage of the fish species present within the particular stretch of stream. Culverts with undersized pipes, or where the downstream end of the pipe is elevated above the stream water surface (“perched”) are particularly problematic. Additionally, steep culverts can create a passage barrier by increasing the water velocity flowing through the pipe to a point where fish cannot swim upstream through it. Culverts can be replaced with a design that matches stream bottom conditions through a “bottomless” arch-culverts design or a bridge that eliminates culverts altogether.



*This “bottomless” pipe arch culvert maintains natural stream bottom conditions | Photo by Trout Unlimited*

## Remove or Modify Undersized Culverts for Water and Sediment

Culverts should be designed to allow sediment to pass through them; this can most efficiently be done by matching design flow velocities within the culvert with expected stream velocities upstream of the culvert location. Adequately sized culverts and the number of culverts placed should also consider low flow conditions to maintain year-round stream connection and at least a 100-year flood event. As a rule of thumb, culverts should accommodate flow in the bank full condition plus two feet on either side.

## Benefits of Implementing Recommended Practices

- Improved crossings are a long-term solution and don't often have to be replaced or maintained
- Improved infrastructure improves property value
- Reduced maintenance time
- Reduced flooding

## Reference and Resource Materials

The [Routt County Unified Development Code](#) has Waterbody Crossings standards in section 3.31.G, which is found on page 151.

The [Resilient Crossings Handbook](#) is a guidance document for private landowners considering replacing or updating their crossings. It was developed by a partnership between the Fourmile Watershed Coalition, the Coal Creek Canyon Watershed Partnership, the Coalition for the Poudre River Watershed, and the Saint Vrain Creek Coalition as a resource for property owners in response to the 2013 floods on the Colorado Front Range.

The US Fish and Wildlife Service (USFWS) provides a great resource for culvert installation that keeps in mind low flow design, passage of sediment and woody material, and mitigation of stream flow processes including floodplain preservation [Culvert Design Guidelines for Ecological Function](#).

The Federal Highway Administration has developed a [technical design resource](#) for helping to consider aquatic species passage for culvert installation projects.