



Culvert Replacement & Removal

SALMONID HABITAT RESTORATION
How-To-Guide for Washington State

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CULVERT REPLACEMENT & REMOVAL

Obstructions can occur on streams where existing culverts have collapsed or are undersized, or where they have yet to be installed. Where a stream is blocked by an obstruction, valuable upstream habitat can be closed to fish. In such cases, a stream crossing—such as a culvert or a bridge—can open the habitat, increasing breeding grounds and working toward restoring healthy populations. By allowing fish to pass up a stream while still providing opportunities for pedestrians and vehicles to cross, a culvert or a bridge helps fish and people to coexist.

This is one in a series of Salmonid Habitat Restoration How-To-Guides for projects in Washington State. It was written to help groups and individuals undertaking similar projects and presumes some knowledge of salmon, habitats and project planning.

Other guides in the series:

- Rearing Pens
- Culvert Replacement
- Nutrient Enhancement
- Live Plants
- Habitat Restoration
- Permitting
- Project Funding
- Streamside Incubation

Building fish-friendly stream crossings requires an understanding of fishery biology, as well as a working knowledge of hydraulic engineering, hydrology and soils/structural engineering. For these reasons, such projects must be done in conjunction with experienced hydrologists and engineers.

There are many factors to take into consideration when planning such a project. This guide is meant to be an overview. It includes a bibliography of existing technical and educational resources to help engineers plan detailed stream crossing projects. The source material is technical, and best left for project designers to interpret.

This guide can be used as a checklist to help you gather the appropriate materials from existing resources, to bring to your attention details that might otherwise be overlooked, and to share the experiences of hydrologists and engineers who have worked on similar projects in the past.

Note that this guide is specific to Washington State. Requirements, laws and details for similar projects in other states may vary.

AN OVERVIEW

On most small streams, crossings are either culverts or bridges designed to provide vehicle or pedestrian access. Poorly designed ones, however, act as obstructions, and can also block the migration of fish up or down streams and change the geomorphic processes by which river channels form and maintain habit over time.

For example, they may block or constrict the passage of sediment and larger pieces of wood moved by river flow, and prevent channel migration, or the lateral movement of a river channel as it adjusts to balance erosion.

Some obstructions are naturally occurring. And not all obstructions or crossings are viable locations for culverts or bridges.

According to the Washington Department of Fish and Wildlife's Design of Road Culverts for Fish Passage, "... great care should be taken to determine whether a culvert is a suitable solution for providing fish passage at the particular site in question. Indeed, environmental circumstances other than fish passage may make it impossible..."

WDFW cites the following by way of example:

"...Wherever a roadway crosses a stream, it creates some level of risk to fish passage, water quality or specific aquatic or riparian habitats. Generally, the risks increase the more the roadway confines and constricts the channel and floodplain. Any and all alternatives should be investigated to minimize the number of sites where a roadway crosses a stream, including designing road alignments to avoid crossings, consolidating crossings and using temporary crossing structures for short-term needs." — Design of Road Culverts for Fish Passage, Washington Department of Fish and Wildlife, 2003.

Even well-designed culverts can affect native fish negatively. For example, culverts built in a spawning area replace natural spawning gravel with a pipe, which must be mitigated by replacing the gravel. Construction also may realign the stream channel, eliminating natural hydrological features that serve as habitat. In addition, culverts can shorten channels and increase current flow, as well as release large amounts of sediment into the stream.

When designing a stream crossing all these factors must be weighed against the potential value of the crossing before deciding whether it is an appropriate project.

Note that the WDFW habitat biologist in the area where your project is located is the final authority for Hydraulic Project Approval. WDFW advises making "contact early on for information on fish passage and other environmental issues that go beyond fish passage."

CULVERT PROJECT REQUIREMENTS

When creating stream crossings, the following steps must be taken:

- Identify a location
- Analyze the site's characteristics
- Design a project plan
- Install the culvert

Identify a location

A stream crossing is worth considering anywhere a road, pathway or similar obstruction blocks fish passage to otherwise useful habitat. However, not all such sites are ultimately appropriate.

One thing to consider is how much upstream habitat is actually closed off to fish by the obstruction. Minor habitat area may not be worth opening when weighed against the cost of construction.

You'll also need to identify the landowner of the property. If the obstruction is on private land, you'll need permission from the landowner not only for the final product but for access to the construction site. If it is on public land, you'll need permission from the appropriate authority, whether it is county, city, state or federal.

Public lands also require additional considerations. Construction work on or around public roads may require permits from the Department of Transportation or similar agencies in addition to standard permits required for stream and wetlands work. For more information, see Salmonid Habitat Restoration Projects in Washington State, How-to Guide: Permitting.

Analyze the site's characteristics

An experienced hydrologist or engineer will study the site to determine what project is appropriate. While the engineering involved is extremely technical, a layman's overview follows.

TYPE OF STREAM CROSSING

Which is appropriate, a culvert or a bridge? Each has its own benefits, and the nature of the road and stream should be taken into consideration. So should cost.

There are also multiple types of each to consider, including bottomless arch, round, box, and ellipse or squashed arch culverts, and span and pre-fabricated bridges.

SIZE OF CROSSING

Recommendations are based on several factors. For bridges, sizing considerations include whether it be used by motorized vehicles or just foot traffic, whether it is a rural road that's rarely used or a busy thoroughfare, and whether heavy industrial vehicles will need to use the crossing.

For culverts, stream flow and downstream considerations will largely dictate size. Stream flow is analyzed by studying the 100-year flood peak and the hydrologic bank flow flood peak. If this data is not available, a hydrologist will have to prepare it.

If a culvert is chosen over a bridge as the best possible crossing, when designing the plan you'll need to consider direct habitat loss, water quality, upstream and downstream ecological connectivity, channel maintenance, construction impacts, and risk of culvert failure.

Finally, survey the site to see what's downstream. If a larger structure, houses, or other objects of value sit downstream from a crossing, in many cases it is appropriate to install a larger-than-needed culvert to protect downstream holdings in high-risk flood scenarios.

Design a project plan

When putting together a project plan, the following steps need to be accounted for.

- *Identify landowners and secure permission.* As noted previously in this document, this may include acquiring permits.
- *Identify necessary materials, and a source to provide them.* This will help in preparing cost estimates, as well. (For more information on funding, see related How-to Guide: Project Funding.)
- *Establish a feasible construction window.* Construction windows vary based on several factors, including the season and the presence of endangered species. Agencies permits may specify these construction windows. Typically, construction on salmon streams in Washington state for similar projects must occur between July 15 and the end of September. Construction windows must also be coordinated with funding and permitting.
- *Ensure accessibility for equipment and materials.* This may be an issue in more rural areas.
- *Provide downstream sediment control.* Acceptable means for this will vary based on the project and materials used. In some cases, hay bales tied together is sufficient to protect large debris from moving downstream. In cases where finer sediment is likely to be released, filter screens or other methods may be employed. Sediment control methods may also be specified in agency permits.
- *Analyze upstream watershed and install cutoff wall if needed.* This is a critical step, and one not easily summarized. Essentially, in some cases a cutoff wall must be installed a certain distance upstream from the culvert at streambed level. Otherwise, a stream may start adjusting to a new depth, or create a new channel, and start eroding—a process called “head-cutting.” On flatter streams this is typically not an issue, but on streams with a graded slope, it's possible to cause more problems by adding a culvert than are being solved. Cutoff walls are installed prior to culvert installation.
- *Ensure project meets permitting requirements.* Such requirements may govern sediment control and construction windows, as already mentioned, as well as the size or nature of the culvert, the amount of drop off the end of the culvert, and more. Make sure inlet and outlet specifications meet state and federal guidelines for fish.
- *Tailor project to the environment.* Make sure the bottom of the culvert closely matches the natural streambed in make-up, materials and grade. The less obtrusive or obvious a manmade stream crossing is, the better it is for the fish that will make use of it.

Install the culvert

As with most riparian and in-stream projects, the process can be summarized simply, as follows:

- Show what you're going to do.
- Do what you said you were going to do.
- Show that you did what you said you would.

As simple as it sounds, this process ensures that plans follow the requirements set forth by permitting agencies and any governments with jurisdiction. It also ensures the actual project or construction follows the plan designed by experienced engineers and/or hydrologists, and is more likely to fall within budgeting estimates. Finally, it helps foster a record of successful project completion which builds an organization or group's reputation, making it easier to get future projects approved, permitted and completed.

OTHER CONSIDERATIONS

Culvert Removal

In some cases the best way to benefit the fish habitat of a particular stream is to remove an existing crossing that has collapsed or become unnecessary, or was poorly built. When removing a culvert, steps must be taken to ensure the following:

- The natural shape of the stream bed and banks are restored
- The shape of the banks matches those up- and downstream of the removed culvert
- Natural streamside vegetation is planted to match native plants and help prevent erosion
- Sediment created by removal is filtered and removed
- Stream bottom is adjusted to match the natural materials and slope

BIBLIOGRAPHY & RESOURCES

The following documents provide technical information, plans and additional resources for designing and constructing stream crossings:

- "*Design of Road Culverts for Fish Passage*," Washington Department of Fish and Wildlife (Aquatic Habitats Guidelines).
<http://wdfw.wa.gov/hab/engineer/cm/>
- "*Planning, Design and Construction of Fish Friendly Stream Crossings*," U.S. Fish and Wildlife Service.
<http://www.fws.gov/midwest/fisheries/streamcrossings/>

- “National Inventory and Assessment Procedure For Identifying Barriers to Aquatic Organism Passage at Road-Stream Crossings,” U.S. Department of Agriculture Forest Service National Technology and Development Program.
<http://www.stream.fs.fed.us/fishxing/publications/PDFs/NIAP.pdf>
- “Fish Passage Through Culverts, an Annotated Bibliography,” Kemset Moore, Michael Furniss, Susan Firor, and Michael Love, Six Rivers National Forest Watershed Interactions Team, Eureka CA.
<http://www.stream.fs.fed.us/fishxing/biblio.pdf>
- “Improving Stream Crossings for Fish Passage: Final Report,” Humboldt State University and NOAA Fisheries, 2004. [http://www.stream.fs.fed.us/fishxing/NMFS%20Final%20Report%20\(No%20Appx%20A\).pdf](http://www.stream.fs.fed.us/fishxing/NMFS%20Final%20Report%20(No%20Appx%20A).pdf)
- “Field Stream Crossing Handbook,” British Columbia Ministry of Forests.
<http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/FishStreamCrossing/FSCGdBk.pdf>
- “Geomorphologic Impacts of Culvert Replacement and Removal: Avoiding Channel Incision,” Janine Castro, Geomorphologist, Oregon Department of Fish and Wildlife 2003.
<http://pacific.fws.gov/jobs/orojitw/document/pdf/guidelines/culvert-guidelines.pdf>
- “Design Considerations for Siting Grade Control Structures: Coastal Hydraulics Engineering Technical Note,” US Army Corps of Engineers 2001. <http://chl.wes.army.mil/library/publications/chetn/pdf/chetn-vii3.pdf>
- “Culvert Criteria for Fish Passage,” Located in the DFG Habitat Manual in PART IX, Appendix A, California Department of Fish and Game. 2003. <http://www.dfg.ca.gov/nafwb/pubs/2003/FishPassage.pdf>

In addition, at the following site you'll find links to various software packages designed specifically to help with the calculations necessary to plan and construct culverts, bridges and other stream crossings:

- <http://www.stream.fs.fed.us/fishxing/pointers.html#software>

The Fish Xing software also has a companion user manual that is an excellent reference independent of the software and available at the same site.

ADDITIONAL INFORMATION

Copies of this document are available through Fish First, and can be found on the Web at www.fishfirst.org. You'll also find a library of how-to guides and fact sheets as well as other resources and information to help with salmon restoration projects.

FOOTNOTES

1. “Design of Road Culverts for Fish Passage,” Washington Department of Fish and Wildlife, 2003.
http://wdfw.wa.gov/hab/engineer/cm/culvert_manual_final.pdf

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