Fish Passage

Washington Conservation Practice Specification 396

Culvert with no upstream fish passage

Dam with no upstream fish passage

Purpose of Specification Guide
This specification provides guidance for effective planning, design and installation of the Conservation Practice Standard: Fish Passage (396). It is ***critical*** that Conservation Planners work closely with their Area Engineer and Area Biologist in developing the fish passage design to fit the site for the targeted species and age-class. This Specification and Job Sheet is intended to be used with Supporting Practices and their corresponding Specifications and Job Sheets that will provide detailed site-specific information. The guidance may include reference information, examples and other considerations to assist with effective application of the practice to site specific conditions. Gray boxes can be double-clicked to provide drop-down choices in the Job Sheet.

Site specifications for the design, installation, operation and maintenance of the practice shall be prepared for each treatment area in accordance with requirements in the Conservation Practice Standard, Conservation Practice Job Sheet and guidance included in this document and in Supporting Practice documents. The completed Job Sheet with practice specifications shall be reviewed with and provided to the client.

General information:
Fish passage barriers can be *natural* (e.g., waterfalls, beaver dams) or *artificial* (e.g., road culverts, surface water diversions). Native fish have evolved around the presence of natural barriers – they should be left in place. Beaver dams, for example, may block weak-swimming fish at all flows or strong swimmers during only extreme flows, yet they create very diverse habitat for fish and numerous other species of aquatic and terrestrial wildlife.

Artificial barriers, on the other hand, should be completely removed or the stream should be rerouted around them to avoid installing expensive, high-maintenance fishways (fish ladders). However, for some surface-water diversion dams or weirs, a fishway may be the only alternative. A concurrent "passage" problem at these diversion structures is the loss of fish that become entrained in the diverted flow. This problem is best addressed by installing screens, using *Structure for Water Control (587).*

Often, artificial barriers (especially culverts) are associated with unstable stream conditions. When this occurs, the Fish Passage practice should be part of a long-range goal to restore geomorphic stability to the entire stream by combining it with Channel Stabilization (584) and Streambank and Shoreline Protection (580).

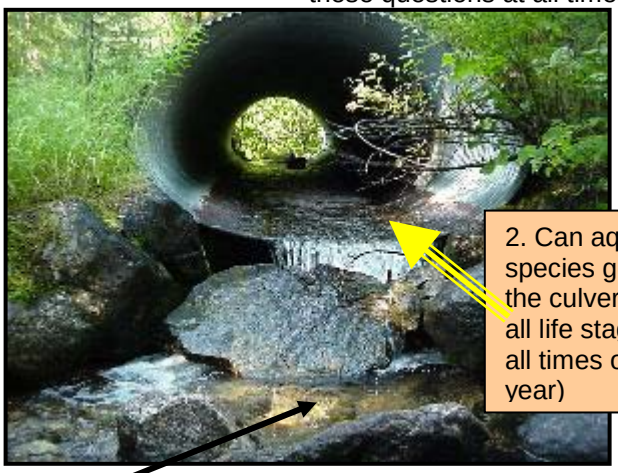
Structures installed under this practice must be designed not only for upstream passage of fish, but also for downstream passage of high flows, bedload, and woody debris. The Washington Department of Fish and Wildlife (WDFW) requires that road crossings maintain their structural integrity during a 100-year flow event.

Fish Passage Criteria

There are **48** native species of anadromous and resident fish that use Washington State streams. Their ability to negotiate instream obstructions varies by species and by size of individual fish within a species. This practice will follow the passage criteria already established by WDFW for the **8** native species of salmon and trout and may be further refined when criteria is set for the state's **15** other migratory species. Also, additional criteria may be required by federal agencies for fish that are protected under the Endangered Species Act.

- **Step 1**: Determine whether the culvert is a barrier or not. This can be done using WDFW Barrier Assessment tool, by contacting your Area Biologist, State Fisheries Biologist or working with the landowner to contact your local WDFW fisheries biologist. The WDFW Assessment of fish barriers can be found at the following website – http://wdfw.wa.gov/hab/engineer/fishbarr.htm It is important to remember that high water temperatures can also be a passage barrier. Barriers may be temporal (only a barrier during low or high flows) and/or vary with life stage (only a barrier to juvenile species). Consider this when assessing the culvert or dam.
  - Identify method used to determine barrier on the 396 Job Sheet

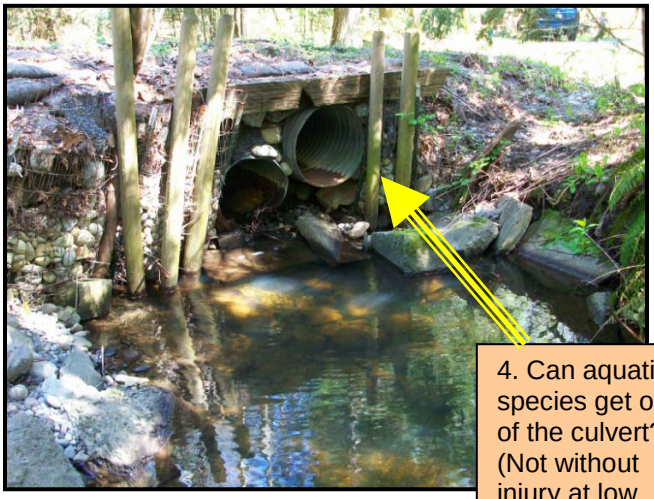
Ask yourself these basic questions when looking at a potential passage barrier. Remember to consider these questions at all times of the year and for all life stages.



2. Can aquatic species get into the culvert? (Not all life stages at all times of the year)

1. Can aquatic species get to the culvert? (Not all life stages at all times of the year)

3. Can aquatic species move through the culvert? (Yes)



4. Can aquatic species get out of the culvert? (Not without injury at low flows)

- **Step 2**: Determine what aquatic species are present in the stream system. This can be done either through the WDFW Priority Habitat and Species (PHS) database or the SalmonScape website can provide information on presence of salmon and trout. WDFW -- SalmonScape Contact your local WDFW fisheries biologist or Area Biologist for further assistance in determining species present.
  - Identify species present on the 396 Job Sheet

- **Step 3**: Contact your Area Engineer during the project planning phase and for help with the design. Your local WDFW fisheries biologist or Area Biologist can also help in the initial design phases.
  - Describe the Existing Culvert or Dam (weir) and potential solutions on the 396 Job Sheet.

Additional Information:

- Culvert design – http://wdfw.wa.gov/hab/engineer/cm/culvert_manual_final.pdf
- WDFW fish screening criteria: - http://wdfw.wa.gov/hab/engineer/habeng.htm
- NMFS fish screening & passage criteria - http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish_Passage_Design.pdf

CULVERTS: Maximum velocities for upstream passage through culverts are based on the *prolonged swimming speed* (medium energy, sustainability in minutes) of the target fish. Passage should be designed for the weakest fish in the system - commonly, salmon fry (<60 mm or 2.2 inches). For these small fish, velocities over 1.1 ft/sec are considered impassable. For adult trout (>150 mm or 6 inches), chum, and pink salmon, velocities must not exceed 4 ft/sec for culverts up to 100 feet long; 3 ft/sec for 100-200 feet and 2 ft/sec, if over 200 feet. For adult chinook, coho, sockeye and steelhead, velocities must not exceed 5, 4, and 3 ft/sec, respectively for the same size culverts mentioned above.

If the culvert has an outfall spill over 9 inches, the passage problem is further compounded, regardless of the velocity in the culvert.

Photo courtesy of Scott Lentz, U.S. Forest Service

Based on these observations, WDFW recommends bridges, but also provides three culvert options:

No-slope Design is used if the stream gradient at the site is less than 3%. The culvert must be at least 1.25 times wider than the average of 3 bankfull width measurements taken upstream and downstream of the site. The culvert is set at zero slope, with at least 20% of the culvert rise embedded in the streambed at the outlet and no more than 40% buried at the inlet.

- Stream Simulation Design is used at sites where the channel slope is between 3% and 7%. Here, the culvert width is 1.2 (average bankfull width) + 2 feet. The culvert is set at streambed slope, with 30-50% of the rise embedded. A bottomless culvert is preferred, but if the culvert does have a bottom, then a mix of boulders, cobbles, and gravel must be placed inside the culvert and arranged in a manner that provides a "roughened channel" to mimic the natural channel immediately upstream and downstream of the culvert. These rock placements are intended to slow down the velocity, while allowing bedload to still pass through at high flows. Rocks should be placed to provide a deeper thalweg in the center of the culvert.

- Hydraulic Design (**NOTE**: This option is used only in the **most extreme** cases and is not something that WDFW permits often). This design is similar to the design used in the FISHXING™ software program of the U.S. Forest Service. This method involves numerous hydrologic calculations based on stream flow during the migration season of the target fish and its swimming ability. This often results in undersized culverts or ones that do not provide adequate passage for fry and fingerlings. WDFW prefers using this option only for barrier culverts that must be left in place and retrofitted with fishways and/or baffles for passage. FishXing software (free) - http://stream.fs.fed.us/fishxing/

Dam (Weir): Talk to the landowner about removal of the dam or weir to provide passage. If that is not an option, then a pool-and-weir design for passage is commonly used. Fish jump, or swim over, each weir using *burst speed* (high energy, sustainability in seconds). Since fish can rest at each pool, fishway length is not critical. Weir height, however, must not exceed 9 inches for adult trout, chum and pink salmon and 12 inches for other adult salmonids. Fishways can be designed to backwater the entire culvert.

Baffles are used in combination to create a roughened channel that slows the velocity throughout the length of the culvert so a fish can swim through without resting – using prolonged swimming speed. Fishways and baffles both require extensive maintenance. Roughened channels and fishways can be used in combination with No-slope culverts.

Maintaining Grade

When designing any instream work, there needs to be some consideration to channel grade and maintaining stability, otherwise the channel bed will erode due to the change in grade after restoration has occurred. Grade stabilization structures, such as instream rock weirs, may be needed to prevent head cuts and maintain channel bed stability. Work closely with your Area Engineer on any design concept.

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