Drainage Management
Whatcom Conservation District

BMP Factsheet #11

CULVERT MAINTENANCE & REPLACEMENT

Introduction

Road crossing culverts are common on all types of watercourses and are critical infrastructure for field and farm access. But if undersized or poorly installed, culverts can be a problem because they impede or block fish passage to important habitat. Culverts that impede fish passage have been identified as one of the most limiting factors to healthy stocks of migrating salmon and other fish species. In comparison, well constructed bridges are superior to culverts in allowing drainage and fish passage. Consider replacing culverts with bridges (see BMP *Factsheet #12 Bridge Maintenance and Replacement*).

Drainage Improvement Districts (DIDs) may include and permit culvert maintenance and replacement as part of their Drainage Maintenance Plan (DMP) if Best Management Practices (BMPs) listed in this *Factsheet* are adopted.

Culvert Replacement and Fish Passage

When replacing or installing a culvert in natural watercourses or modified natural watercourses, the design will largely be based on criteria necessary to ensure fish passage and avoid impacts to fish habitat. There are five common conditions at culverts that create barriers to migrating fish:

- Excess drop at the culvert outlet
- High velocity within the culvert
- Inadequate depth within the culvert
- Turbulence within the culvert
- Debris and sediment accumulation at the culvert inlet or internally

Salmon jumping at culvert.

The Washington Department of Fish & Wildlife (WDFW) has published extensive information on culvert design and installation. This guidance should be used when replacing an existing culvert or installing a new culvert. It is recommended that installations on constructed watercourses also use WDFW criteria because it ensures that new culverts are properly sized and will not impede drainage. See *Factsheet #4 Agency Contact Requirements*. Additional fish passage criteria can be found at http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/fish_passage_design.pdf.

Culvert Maintenance BMPs

Every watercourse structure will require periodic maintenance. Culverts often become plugged or their capacity reduced because of debris or vegetative material. Headwalls may need occasional maintenance to prevent erosion and collapse. In conducting maintenance activities consider:

1. Timing Limitations: When water is present, culvert maintenance shall only occur from August 1 to September 30 when flows are low.
2. Debris or vegetative material can be removed by hand without timing limitations to prevent the need for larger repairs.
3. Maintenance work on culverts in modified natural watercourses are subject to *Agency Contact Requirements*, see Permitting *Factsheet #4*.
4. Headwall repair should take place during the dry season when the work can be completed out of the water.
5. If water is present when removing large quantities of debris, vegetation or accumulated sediments, additional measures must be taken to minimize impacts to aquatic life and water quality. See *BMP Factsheet #16 Water Quality Protection Measures* for more details.

Culvert Replacement or Installation

Three design options have been approved by WDFW:

- The No-Slope Design Option results in reasonably sized culverts without requiring much in the way of calculations. The No-Slope option is almost always the best choice for lowland agricultural watercourses.
- The Hydraulic Design Option is based on velocity, depth and maximum turbulence requirements for a target fish species and age class.
- The Stream Simulation Design Option involves constructing an artificial stream channel inside the culvert, thereby providing passage for any fish that may be migrating through the reach.

Undersized culvert with unstable road crossing

Culvert Location

Even the best designed culvert has the potential to become a fish passage barrier, drainage barrier or maintenance headache. Look at your farm or Drainage Improvement District from a big-picture perspective and find ways to have as few culverts as possible. Location considerations include:

- Make the culvert as short as possible without deviating from the direction of the upstream and downstream channel course by more than 30 degrees.
- Choose an area with minimal and consistent stream gradient, not areas where the gradient is steep or transitioning.

No-Slope Design Option

Successful fish passage can be expected if the culvert is sufficiently large and is installed flat, allowing the natural movement of bedload to form a stable bed inside the culvert. Bedload is the sediments making up the watercourse bottom such as gravel and soils. Design criteria for a No-Slope culvert are:

- Width equal to or greater than the average channel bed width at the elevation the culvert meets the streambed. Make the culvert the same width as the channel to maximize both water flow and fish passage.
- A flat gradient. (No slope)
- The downstream invert is countersunk below the channel bed by a minimum of 20 percent of the culvert diameter or rise.
- The upstream invert is countersunk below the channel bed by a maximum of 40 percent of the culvert diameter or rise.
- The possibility of upstream headcut has been taken into account.
- There is adequate flood capacity.

Combining the requirements of countersinking the outlet and the culvert width for a circular culvert, the diameter must be at least 1.25 times the channel bed width. The information typically needed for a No-Slope Design Option culvert includes:

- The average natural channel-bed width.
- The natural channel slope.
- The elevation of the natural channel bed at the culvert outlet.
- The evaluation of potential headcut impacts upstream of the culvert.

Channel-bed Width

Use the average of at least three typical widths in free flowing and unconstrained areas upstream and downstream of the culvert location. For the purpose of culvert design, the channel-bed width is defined as the width of the bankfull channel. The bankfull channel is defined as the stage when water just begins to overflow into the active floodplain. Many incised streams or modified watercourses are no longer connected to the floodplain. In these situations the channel bed width may also be determined from the Active Channel Width and Ordinary High Water Mark (OHWM). The OHWM can usually be identified by physical scarring along the bank

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or shore, or by other distinctive signs such as the lower line of perennial vegetation. This scarring is the mark along the bank where the action of water is so common as to leave a natural line impressed on the bank. That line may be indicated by erosion, shelving, change in soil characteristics, destruction of terrestrial vegetation, presence of litter or debris, or other distinctive physical characteristics.

Culvert Replacement

Channel Slope

The calculation for average channel slope is based on water-surface elevations and a distance along the channel that is at least 40 channel widths long, or 400 feet.

Once these determinations are made, a culvert design can be finalized. In fish bearing watercourses it has become common place to fill the bottom 20% of the culvert with "fish gravel" to both stabilize the bed material and enhance a little fish habitat. It may be advisable to hire professional help to ensure an appropriate design and long lasting installation.

Concrete

If any concrete, cast-in-place concrete, or grouting works are to be undertaken, a high potential exists for concrete and/or concrete leachate to enter a watercourse. Concrete, concrete leachate, grout and other uncured concrete substances (e.g. concrete bags for headwall construction) are deleterious and highly toxic to fish and other aquatic organisms.

To perform any concrete-related works, all water must be completely isolated prior to the commencement of any instream works. In addition, measures must be taken to prevent the incidence of concrete from entering a watercourse, ravine or storm sewer system for a minimum of 72 hours after the works have been completed. This is to ensure that the concrete has fully cured.

Culvert Replacement BMPs

1. Timing Limitations: When water is present in the channel, culvert work below the waterline shall occur between August 1 and September 30.
2. The damaged culvert and associated fill shall be removed from the watercourse and deposited upland so that it cannot re-enter the watercourse.
3. The culvert shall be placed on a flat gradient with the bottom of the culvert placed below the level of the streambed a minimum of 20 percent of the culvert diameter for a round culvert, and 20 percent of the culvert's rise for an elliptical culvert. The 20 percent placement below the streambed shall be measured at the culvert outlet. (see above for more details).
4. The culvert shall be constructed to pass the 100-year peak flow with considertation of the debris likely to be encountered.
5. The culvert shall be maintained free of debris to ensure unimpeded drainage and fish passage.
6. Fill associated with the culvert installation and approach material shall be structurally stable and shall be composed of material that, if eroded into the watercourse, shall not be detrimental to fish life.
7. Fill associated with the culvert installation and approach material shall be protected from erosion to the 100-year peak flow.
8. If an existing culvert is replaced by a bridge structure, then the existing culvert and associated fill shall be completely removed from the watercourse and the new bridge shall be subject to the bridge provisions discussed in *Factsheet #12 Bridge Maintenance and Replacement*.
9. When water is present in the channel, fish must be removed from the impacted area prior to any work. *Factsheet #15 Fish Protection* provides more detailed information.
10. When water is present in the channel, measures must be implemented to ensure that contaminated water does not leave the work site. *Factsheet #16 Water Quality Protection Measures* provides more detailed information.
11. Leave riparian vegetation along the banks of the watercourse.
12. All disturbed areas must be re-graded and stabilized by seeding or re-vegetating the riparian area upon completion. This helps to prevent surface erosion and/or sedimentation of the watercourse.

Figure 1