MONTANA CONSERVATION PRACTICE SPECIFICATION
NATURAL RESOURCES CONSERVATION SERVICE

FISH PASSAGE (NO.)

CODE 396

SCOPE: Fish passage or fishway designs should account for the fish species and life stages expected to use the facility. Generally the structure should be designed to allow passage of the weakest or youngest fish expected to use it (OFW 2001).

The swimming speed of the limiting fish species life state is critical to designing a passage structure. (See TABLE 1)

- Cruising speed can be maintained for hours and is used during migration.
- Sustained speed can be maintained for minutes and is used for passage through difficult areas.
- Darting speed can be maintained for less than 10 seconds and is generally used for feeding and escape from predators.

TABLE 1. Swimming Speeds of Adult and Juvenile Salmonids

SPECIES–ADULT	CRUISING SPEED	SUSTAINED SPEED	DARTING SPEED
Whitefish	**< 2 fps**	**2–5 fps**	**5–9 fps**
Grayling	**≤ 3**	**3–7**	**7–14**
Adult trout	**≤ 2**	**2–6**	**6–14**
SPECIES–JUVENILE SPEED	**CRUISING SPEED**	**SUSTAINED SPEED**	**DARTING**
Brook trout, 3–5 in.	**≤ 2**		
Grayling, 2–4 in.		**1.5–2**	

WATER VELOCITIES:

FISHWAY TYPE*	RECOMMENDED MAXIMUM VELOCITY	
	Adult Trout	Juvenile Trout
Culverts up to 100 feet long	4.0 fps	2.0 fps
Culverts greater than 100 feet	2.0 fps	2.0 fps

* Other fishway types: Consult with area or state biologist to obtain design criteria for specialized fish passage structures, including pool and weir fishways, Denil fishways, vertical slot fishways, and rock step-pool fish ladders.

Generally, design velocities in passage structures should be kept below the darting speed for the weakest fish species or life stage expected to use the facility. In fishways where darting speeds are required between resting pools, a maximum darting time of 7.5 seconds is recommended.

MINIMUM WATER DEPTH:

Trout and kokanee need at least 8 inches of water in a culvert for passage.

Maximum vertical jump height at culvert entrance and jump pool:

- Juvenile Trout–Maximum jump height is 6 inches.
- Adult Trout–Maximum jump height is 1 foot.

The depth of the jump pool is 1.5 times the height of the jump or a minimum of 2 feet—use the larger of the two numbers.

MAINTENANCE OF FISH PASSAGE STRUCTURES:

All structures must be inspected regularly and cleaned of debris accumulations, which will interfere with fish movement.

CULVERT DESIGN CONSIDERATIONS:

Culverts are the most common road crossing device and are the most likely to be barriers to fish migration.

1. Natural barriers upstream or downstream of the crossing may eliminate the need for fish passage considerations. Consult with a fisheries biologist to determine both the need for fish passage facilities and the species/life stage of the migratory fish present. Also determine when the fish migrate and their swimming capabilities. Whenever possible, maintain the streambed characteristics through the passage facility. Priorities for fish passage design, in decreasing order of preference, are:
   - Culvert removal—realign the road to avoid crossing the stream
   - Bridge—remove existing culvert, restore the stream section, and span the stream with a bridge
   - Low water crossing—if the stream channel and slope configuration is suitable, a low water crossing is preferable to a culvert for seasonal transportation requirements
   - Streambed simulation strategy—use a bottomless arch or embedded culvert design
   - Non-embedded culvert—use a hydraulic design to match the hydraulic performance of the culvert with the swimming abilities of the fish species of concern—limited to low slopes for fish passage
   - Baffled culvert or fishway (i.e., Denil fish ladder, etc.) for steeper slopes.
2. There are a number of problems associated with culverts and fish passage:
   - Water velocity in the culvert is too great for fish entrance and passage
   - Water depth in the culvert is too shallow
   - There are no resting pools at the culvert entrance and exit
   - The jump into the culvert is too high and/or the jump pool is too shallow
   - Debris accumulation at the culvert inlet
   - Turbulence within the culvert.
3. Resting pools are required when the swimming distance is greater than 50 feet through the culvert.
4. Control scouring at the culvert outlet—this may require a series of low-head dams below the structure.

CULVERT DESIGN CONSIDERATIONS CONTINUED:

5. Culvert types, in order of preference for fish passage are:
   - Structural plate arch set in concrete footings—leaves the streambed unchanged
   - Pipe-arch culvert—can be buried to incorporate streambed materials throughout the culvert
   - Standard corrugated-round culvert
     - ☐ keep gradient at or near 0 percent;
     - ☐ use baffles only as a last resort if high water velocities are unavoidable;
     - ☐ design to assure fish passage during all but the highest (greatest 5%) flows.
6. Confine work to periods when little fish activity occurs.
7. Trash racks and livestock fences should not be used near the culvert inlet.
8. Timely clearing of debris from the culvert is critical.
9. Culverts should only be installed in a de-watered site with a sediment control and flow routing plan, which meets all applicable permitting requirements.

TABLE 2. Spawning Season and Fry Emergence Dates for Selected Species

SPECIES	SPAWNING DATES*	FRY EMERGENCE DATES*
Rainbow Trout	**April–July**	
Brown Trout	**Oct.–Dec.**	**Late Winter–Spring**
Brook Trout	**Sept.–Oct.**	**Feb.–April**
Cutthroat Trout	**Spring–Early Summer**	**Summer**
Bull Trout	**Sept.–Nov.**	**April–May**
Lake Trout	**Oct.–Nov.**	**April**
Kokanee	**Aug.–Nov.**	**April–May**
Arctic Grayling	**March–June**	
Mountain Whitefish	**Oct.–Nov.**	
Sauger	**April–May**	
Walleye	**Spring**	

- **Dates vary with water temperature.**

FISH SCREENS:

Whenever there is a chance of fish being entrained into irrigation ditches, the diversion points will be screened to prevent entrainment of the appropriate fish species and life stages expected to enter the ditch. Refer to the following publication for fish screen design criteria: *Designing Fish Screens for Fish Protection at Water Diversions* by Bryan Nordlund, P.E., National Marine Fisheries Service. Area engineers have this publication which can be downloaded from:
http://www.nwr.noaa.gov/1hyrdop/hydroweb/docs/usfws_97.htm