The following material is based principally on ***Culvert Fishway Planning and Design Guidelines***, which provide designers with a basis for planning, design and implementation of fish passage facilities at road crossings and other small waterway structures.

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Hydraulic barriers to fish migration at waterway structures

TS01

Road crossings and other small waterway structures (e.g. culverts, causeways, grade control) may represent barriers to upstream fish migration if hydraulic conditions at the structures are more severe than swim capabilities of fish attempting to pass through. Fish migration barriers will usually occur as a result of major changes to natural waterway conditions at the structure, an d may include the following hydraulic conditions within the culvert barrel / inlet / outlet, on aprons and in channels and other hydraulic zones: high velocity; reduced flow depth; lack of resting place or shelter; excess turbulence; water surface drop.

Provisions for fish passage at road culverts and other waterway structures should address these adverse hydraulic conditions, not only within the culvert barrels, but throughout the full structure length and adjoining waterway sections, to enable fish passage through all hydraulic zones from downstream to upstream at the site.

High velocity

- culvert barrel; inlet / outlet; apron; channel
- steep gradients; uniform channels; constrictions
- velocities in structures higher than natural stream
- culverts / other structure velocities form barriers to upstream fish movement if length between rest points is greater than distance traveled by fish under prolonged or burst / rest swim modes

Shallow water depth

- culvert barrel; inlet / outlet; apron; channel
- steep gradients; wide channels; low tailwater
- flow dispersion in box culverts and on aprons
- shallow water represents a barrier to fish movement when the depth is insufficient to allow fish to swim effectively, particularly larger fish

Lack of resting place or shelter

- culvert barrel; inlet / outlet; apron
- uniform channels; lack of substrate complexity
- more severe in artificial channel than natural
- lack of resting place or shelter form barriers to upstream fish movement if length between rest points is greater than distance traveled by fish under prolonged or burst / rest swim modes

Excess turbulence

- culvert barrel; inlet / outlet; apron; channel
- steep gradients; drops; constrictions / expansions
- localised turbulence due to obstructions / debris
- fish are buffeted in turbulent flow and often lose their orientation in large scale eddies where they are unable to recognise the primary flow direction to allow them to negotiate the structure

Water surface drop

- culvert inlet / outlet; apron; downstream channel
- sudden change in channel / culvert bed
- low flow barriers may be drowned at high flows
- most Australian native fishes have very little capacity to jump and are unable to negotiate small water surface drops

Common occurrence of principal hydraulic barriers to fish migration within particular zones of culverts / waterway structures

Hydraulic barrier type	Zone D: Culvert inlet and upstream channel	Zone C: Culvert barrel	Zone B: Culvert outlet & downstream apron	Zone A: Downstream channel
High velocity	✓	✓	✓	✓
Shallow water depth	✓	✓	✓	
Lack of resting place	✓	✓	✓	
Excess turbulence	✓	✓	✓	✓
Water surface drop	✓		✓	✓

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