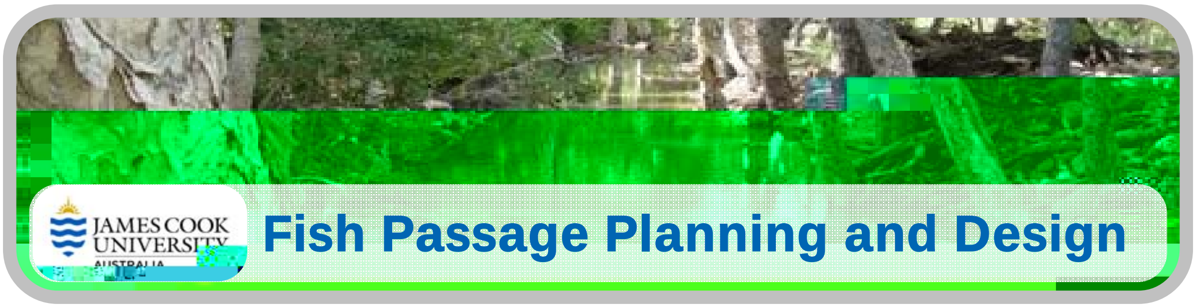

Culvert Fishway Planning and Design Guidelines

Part A – About These Guidelines

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April 2010 – VER2.0

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2 FISH MIGRATION BARRIERS AND PROVISIONS FOR FISH PASSAGE

Barriers to fish migration at road crossings and other waterway structures can severely deplete fish populations and alter fish species diversity within a catchment by obstructing migration to critical spawning or growth habitats. Many opportunities are available for practitioners and managers to develop innovative solutions and multipurpose designs for fishway facilities at culverts and other structures in order to provide for fish passage, hydraulic capacity, transport function, operation and amenity values.

Freshwater fish provide significant commercial, design. This has brought about extensive problems for fish passage, where the objectives are to achieve low velocities, clear fish pathways, and diverse streambed habitat.

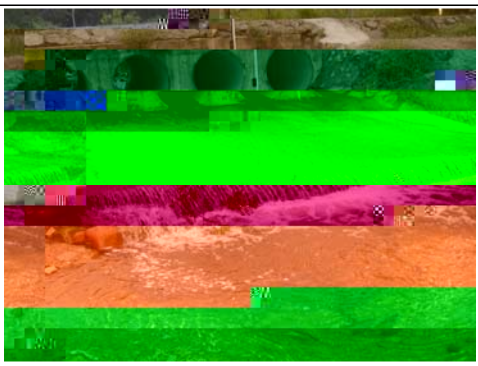
Water velocities in culverts and artificial channel sections are usually much higher and more uniform than those in natural channels, where stream meandering, pools and riffles, boulders and other substrate and in-channel form provide diverse patterns of slow or fast velocities suited to fish. Water surface drops at culvert outlets and at grade control structures in constructed waterways are also commonly more severe than in natural channel riffles (Box A1.2). For conditions other than deep slow moving water through the culvert barrel, plain culverts are rarely suited to fish swimming and passage capabilities, particularly for small fish.

Solutions to the ubiquitous problem of fish migration barriers at road crossings have not been firmly established for Australian streams and fish species. Culvert fishway technology from northern hemisphere environments is not directly transferable to local conditions because of vastly different stream hydrology (e.g. fish passage design discharge) and fish movement characteristics (e.g. swimming ability), as well as different culvert structures (e.g. concrete box and pipe culverts compared with corrugated steel pipes).

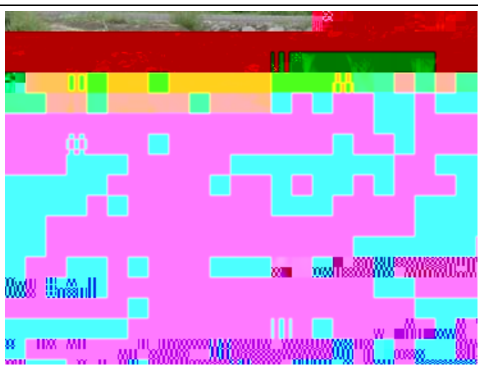
Very few examples exist in Australia where appropriate provisions for fish passage have been made, either as remediation of existing fish migration barriers or as mitigation of barrier effects at new crossings. Many of the techniques considered lead to expensive designs involving large waterway cross sections in order to achieve low velocities for fish, whilst others are speculative and unproven, commonly failing to meet multipurpose requirements relating to fish passage, drainage, transport, amenity and cost. For many waterways, including some with significant aquatic habitat and fish movement corridor values, conservative design approaches using bridges or arches in lieu of culverts will be unnecessarily expensive and may not be warranted. Furthermore, speculative attempts such as placing rocks as ad hoc roughening elements within the culvert barrels, are often unsubstantiated, and are potentially counter productive.

These issues are addressed in these *Guidelines*, which propose an ecohydraulics design approach that assesses fish passage along with other multipurpose design requirements for the site. A range of solutions are outlined, including incorporation of fish passage facilities into culverts and other waterway structures in order to achieve aquatic fauna connectivity.

Box A1.2: Fish migration barrier and remediation at culvert outlet apron – Solander Road culvert crossing of University Creek in Townsville *(Source: Ross Kapitzke)*



Fish migration barrier prior to construction – Fish accumulating downstream of water surface drop at culvert outlet apron (13/01/04)



Fishway after construction – Raised tailwater level at culvert outlet due to rock ramp fishway allowing fish passage onto outlet apron (10/04/06)

Box A1.3: Prototype fishways on University Creek in Townsville *(Source: Ross Kapitzke)*

University Creek is the largest and least altered tributary entering the lower reaches of Ross River in Townsville, and represents a significant corridor for terrestrial and aquatic fauna connecting Ross River with Mount Stuart and adjoining mountain ranges.

The creek provides natural spawning and growth habitat during wet season conditions for up to 13 native fish species, including Plotosid Catfish, Purple Spotted Gudgeon and Rainbowfish.

University Creek is a substantial natural asset on the JCU campus, providing an excellent field laboratory for research and teaching, including physical and biological monitoring of fish passage.

University Creek on JCU campus: Intermittent pool habitat for fish in upstream reaches (25/03/06)

The Discovery Drive prototype offset baffle fishway was developed in 2002 and first substantial testing undertaken in 2004.

The main hydraulic barriers to be overcome at the crossing are high velocities in the culvert barrel, shallow water depths at low flows, regular culvert cross section and lack of resting place.

The fishway components installed at the site include the offset baffle fishway for box culverts within the culvert barrel.

Monitoring facilities at the site include access ladders, platforms, gauge boards, flow control boards, fishway fences and cage.

Prototype Fishway #1: Discovery Drive offset baffle fishway for box culverts (-/01/04)

Douglas Arterial Project prototype rock ramp fishway was developed in 2004, with the first testing undertaken in 2005.

The main hydraulic barriers to be overcome as mitigation of the effects of channelisation are high velocities, shallow water depths,

Box A1.4: Hydraulic laboratory test facilities and fishway models at JCU *(Source: Ross Kapitzke)*

- scale models of the box culvert and pipe culvert prototype fishways on University Creek are established in the hydraulics test flume
- various alternative fishway components at 1:5 scale (box) and 1:3.3 scale (pipe) are tested in the culvert model
- laws of similitude are applied to transfer values between model and prototype, with results applicable to prototypes of various size.
- velocity profiles are measured with a miniature propeller meter for various water depths and discharges, and flow patterns are observed using die tracers and other visualisation techniques

5 USING THESE GUIDELINES FOR FISH PASSAGE PLANNING AND DESIGN

options and their suitability for the site are examined in terms of fishway hydraulics, attraction flows, effectiveness and expected performance characteristics of the fishway, and the layout and configuration of the adopted fishway facility is discussed. Site scale design for fish passage is illustrated through the University Creek Solander Road and Bruce Highway Corduroy Creek to Tully case study projects.

Part F – Baffle Fishways for Box Culverts presents baffle fishway design options for box culverts, and describes culvert and fishway configuration and hydraulics. Configurations, design principles and criteria for the offset baffle fishway and the corner “EL” baffle fishway for box culverts are outlined. Baffle fishways for box culverts are illustrated through the University Creek Discovery Drive and Bruce Highway Corduroy Creek to Tully case study projects.

Part G – Baffle Fishways for Pipe Culverts presents baffle fishway design options for pipe culverts, and describes culvert and fishway configuration and hydraulics. Configurations, design principles and criteria for the offset baffle fishway and the corner “Quad” baffle fishway for pipe culverts are outlined. Baffle fishways for pipe culverts are illustrated through the University Creek Solander Road case study project.

Part H – Rock Ramp Fishways for Open Channels describes fishway configuration, hydraulics and fish passage characteristics, and outlines design principles and criteria and construction aspects for rock ramp fishway design. Rock ramp and rock ramp cascade fishways are illustrated through the University Creek Douglas Arterial Road and Solander Road case study projects.

Part I – Design Drawings for Fishway Projects provides example designs for fishway projects undertaken through the University Creek prototype fishways at Discovery Drive, Solander Road and Douglas Arterial Road, and the Bruce Highway Corduroy Creek to Tully case study project.

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