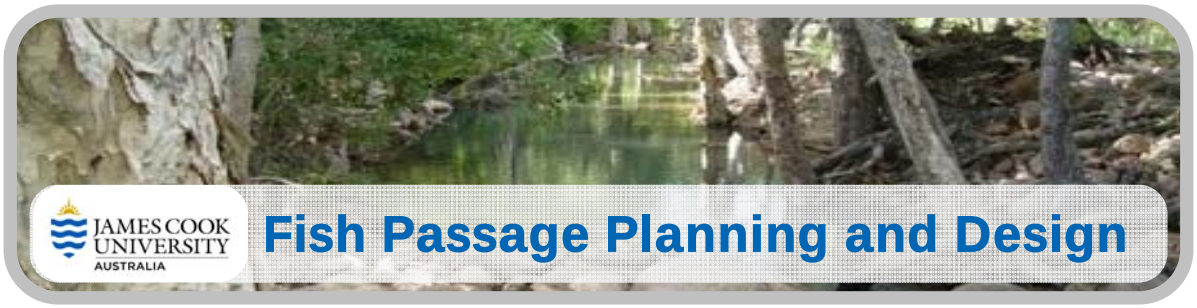

Culvert Fishway Planning and Design Guidelines

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PREFACE

These *Culvert Fishway Planning and Design Guidelines*, which have been supported by the Queensland Department of Transport and Main Roads, are an important step toward improving aquatic fauna connectivity at road culverts and other waterway structures in Queensland and Australian streams. Migration of fish and other aquatic fauna is often obstructed at these structures by adverse hydraulic conditions such as high velocities, water surface drops and shallow water depth. Recent emphasis in ecosystem management and sustainable design solutions for road and waterway infrastructure has created much interest in planning and design for migration of aquatic, terrestrial and arboreal fauna. Provisions for fish passage are now being made through mitigation designs to overcome migration barriers in many new road and waterway projects and through remediation of migration barriers at existing drainage infrastructure.

As natural resource managers, environmental scientists and design engineers increase their interest in aquatic fauna connectivity and take account of fish passage requirements at road crossings and other waterway structures, they face the challenge of how best to incorporate fish passage provisions with other multipurpose design requirements relating to transport, drainage function, amenity and environmental values. Important questions posed by design practitioners and managers in these projects often include:

- how to integrate fish passage planning and design within other project activities
- which mitigation measures are appropriate to provide for fish passage in particular situations
- and how these measures are performing over time

These *Guidelines* address aquatic fauna connectivity aspirations and requirements for road and waterway projects, and present a framework for incorporating fish passage provisions within planning and design protocols for these projects. Solutions to fish migration barrier problems at road crossings and other waterway structures are examined using an ecohydraulics approach (founded on hydraulic laboratory testing, prototype facilities and field installations). Anticipated fish movement behaviour for the site and the hydraulic characteristics of the waterway structure and fish passage devices are considered in an integrated manner, and other multipurpose requirements are accounted for in design of the facility. Design solutions are conceptualised for Australian conditions, which are different in many respects to northern hemisphere conditions where many conventional culvert fishway practices have been developed.

The approach taken in the *Guidelines* is applicable to mitigation design, to address potential fish migration barrier impacts in new projects; and to remediation design, where fish passage provisions are made through retrofit of existing structures. A range of measures are outlined. Whilst bridges or arches are often recognised as the best solutions for aquatic fauna connectivity at road crossings, culverts equipped with appropriate fish passage devices can also offer many benefits. Depending on aquatic habitat and fish movement corridor values and other site characteristics, use of culvert fishways may preclude the need to adopt over-conservative and unnecessarily expensive designs using bridges. The suitability of culvert fishway facilities in meeting fish passage and other multipurpose design requirements can be demonstrated for numerous waterway types and structure configurations, and particularly for retrofit facilities.

The *Guidelines* recognise the need for ongoing design development and evaluation of fish passage facilities for road crossings and other waterway structures and for innovative solutions to address aquatic fauna connectivity barriers. The *Guidelines* do however caution against overly speculative attempts that may be unsubstantiated and potentially counterproductive. Unless grounded on sound theory and the practical application of hydraulic and ecological principles, these innovative approaches will not provide robust solutions to fish passage requirements.

At this point in the environmental "journey" towards sustainable infrastructure design and provisions for aquatic fauna connectivity at road crossings and other waterway structures, very few dead ends and blind gullies have so far been encountered, and enthusiasm for success has not been dulled by the burden of failure. Culvert fishway "technology" for Australian waterways is still in an embryonic stage, and it is hoped that these *Culvert Fishway Planning and Design Guidelines* will enthuse and greatly assist road designers, waterway managers, environmental officers and scientists in identifying and meeting the needs for aquatic fauna connectivity, and in providing successful mitigation measures to address fish passage for road and waterway projects.

DISCLAIMER

These *Guidelines* are intended for use in linear infrastructure projects (e.g. roads, railways), and waterway and drainage projects involving road and other small waterway structures in Queensland and other parts of Australia. This encompasses projects undertaken by or for the Queensland Department of Transport and Main Roads (DTMR), and by other transport agencies, local authorities, government agencies, consultants and contractors. The *Guidelines* may be used as a guide to fish passage planning and design for waterway structures other than road crossings. Whilst they have been developed primarily for road-waterway crossings in coastal Queensland, the material will also be mostly relevant to other structures and for other regions in Australia.

The *Guidelines* are not intended to be a code, design standard or regulation for fish passage provisions in road or waterway projects undertaken by transport agencies or other organisations. Users should make their own site-specific evaluation, testing and design arrangements, and should obtain their own specialist advice and input. Use of the *Guidelines* requires professional interpretation and judgement, and appropriate design procedures and assessment must be applied to suit the particular circumstances under consideration. The adoption of these *Guidelines* will not necessarily guarantee compliance with any statutory obligations, or meet legislative or policy provisions for Queensland Department of Transport and Main Roads, local authorities or other agencies. There may be situations where the *Guidelines* are not applicable or where other regulations take precedence, and users should make their own assessment of these requirements.

The *Guidelines* have been prepared from existing technical material; from research and development studies involving field prototype, hydraulic laboratory modelling, and case study projects; and from conceptual design input by the author. The environmental assessment techniques and the fish passage technology outlined are in an early stage of development, and should be applied with due consideration to their suitability. Although the author and sponsoring organisation have endeavoured to verify that the methods and recommendations contained are appropriate to road-waterway crossings in Queensland, the material presented cannot fully represent conditions that may be encountered for any particular project.

The document does not contain a comprehensive statement of legal obligations, including the legal obligations applying to concerned parties, and users should seek legal advice on these matters if needed before acting upon the recommendations. The document does not provide detailed costing advice and users should obtain relevant professional advice on project costs.

While every effort has been made to ensure the accuracy and completeness of information presented in these *Guidelines*, James Cook University and Queensland Department of Transport and Main Roads accept no liability or responsibility for the user, any other person or entity who suffers any loss or damage caused, directly or indirectly, by their adoption and by use of the methods and recommendations of the *Guidelines*. This shall include, but not be limited to, any interruption of service, loss of business (including any anticipatory profits) or consequential damages; requirements for fish passage and aquatic habitat enhancement of the stream; transport and drainage functions of the road crossing; or avoidance of environmental harm or nuisance.

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These *Guidelines* and the associated case study project design and prototype monitoring reports are the outcome of research and development work undertaken by James Cook University (JCU) with funding support by Queensland Department of Transport and Main Road (DTMR). The culvert fishway R & D work includes substantial in-kind contribution of expertise and research facilities by JCU School of Engineering and Physical Sciences. Third party cash and in-kind funding support for prototype fishway development and associated case study projects has also been provided by other agencies and organisations.

The author is grateful for the contributions of road project design consultants, agency specialists and industry personnel who have provided guidance and collaborated on a number of aspects of the project. This includes Mark Pettigrew and design personnel from Maunsell Australia, Tim Marsden of Queensland Department of Primary Industries and Fisheries, and Peter Hill and officers from James Cook University Facilities Management Office. Many other practitioners, managers and community personnel have shown great enthusiasm for the work, and their interest and engagement on the topic have provided impetus and helped in giving a robust product.

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Dr Alan Webb from the Australian Centre for Tropical Freshwater Research has provided unfailing support in the monitoring and evaluation of the prototype fishways on University Creek, having undertaken fish community surveys in the creek upstream and downstream of the fishway sites for many years, in conjunction with fish movement observations in and around the various prototype facilities. My brother John Kapitzke, who had a long and distinguished career in road and drainage design for Department of Main Roads, assisted with fishway monitoring in University Creek, and provided an intellectual sounding board on many questions on culvert hydraulics. John has been a great supporter and ally in this work.

I acknowledge the support and encouragement of Queensland Department of Transport and Main Roads staff in undertaking this project, and in adopting and promoting the project findings. Divisional managers in Townsville were instrumental in supporting the business case for the R & D program, and project managers have been actively engaged in design and management applications of the assessment methodologies and fish passage techniques. I would like to especially acknowledge DTMR environmental officers Jay Quadrio – for his support and championing of the fish passage work over many years, and Michael Yates – who has been instrumental in finalising the project on behalf of DTMR and in facilitating publication.

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