State Development Assessment Provisions guideline

State code 18: Constructing or raising waterway barrier works in fish habitats

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Queensland Government

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This publication has been compiled by Fisheries Queensland, Department of Agriculture and Fisheries.

Interpreter statement

The Queensland Government is committed to providing accessible services to Queenslanders from all culturally and linguistically diverse backgrounds. If you need an interpreter to help you understand this document, call 13 25 23 or visit daf.qld.gov.au and search for 'interpreter'.

The Department of Agriculture and Fisheries proudly acknowledges all First Nations peoples (Aboriginal peoples and Torres Strait Islanders) and the Traditional Owners and Custodians of the country on which we live and work. We acknowledge their continuing connection to land, waters and culture and commit to ongoing reconciliation. We pay our respect to their Elders past, present and emerging.

Summary

Free movement of fish along waterways and into other connected wetlands is an essential requirement for many fish species that naturally occur in Queensland. Movement requirements of fish can include adult, juvenile and larval life-history stages. Some fish move between fresh and salt water for access to feeding and breeding habitats, and for refuge. Others traverse large distances in marine, estuarine and riverine environments for protection and dispersal opportunities.

Unimpeded movement of fish within Queensland waterways is vital to sustain healthy fish stocks. In Queensland, the potential impacts of development on the movement of fish are managed through a fisheries development framework. This framework is underpinned by the *Fisheries Act 1994* working in concert with the *Planning Act 2016* and *Environmental Offsets Act 2014.*

The *Planning Act 2016* provides for types and categories of development, and the development assessment and decision-making process. Constructing or raising waterway barrier works is development that is regulated as either assessable or accepted development.

A development approval is required for assessable development. State code 18 of the State Development Assessment Provisions (SDAP) sets out the assessment benchmarks that a development application for operational works that is constructing or raising waterway barrier works is assessed against. Applicants are expected to provide adequate information and respond to the relevant provisions of SDAP.

This guideline helps applicants design more sustainable development that avoids or minimises and mitigates impacts on fish habitat and fish passage. It should be followed when preparing any development application that proposes constructing or raising of waterway barrier works.

Contents

1 Overview

1.1 Introduction

State code 18: Constructing or raising waterway barrier works in fish habitats within the State Development Assessment Provisions (SDAP) ensures development involving constructing or raising of waterway barrier works in fish habitats**:**

1. maintains fish movement and connectivity throughout waterways and within and between fish habitats
2. maintains the health and productivity of fisheries resources and fish habitat
3. maintains the community and fishing sectors' use of the area and access to fisheries resources
4. provides adequate fish passage including a fish way, if necessary
5. avoids impacts or, where the matters of state environmental significance cannot be reasonably avoided, impacts are reasonably minimised and mitigated
6. does not result in a significant residual impact on a matter of state environmental significance unless the significant residual impact is acceptable, and an offset is provided.

Note: The use of stepped spillways cannot comply with this code.

1.2 Purpose

The purpose of this guideline is to assist applicants who are considering development that is constructing or raising waterway barrier works during the following application stages:

- undertaking due diligence and identifying issues with the concept proposal before lodging a development application or investing in the proposal – pre-lodgement advice should also be sought at this time
- preparing a development application and responding in writing to each of the performance outcomes of state code 18.

To prepare a development application, it is necessary to consider whether the proposed impact on fish habitat and fish passage in waterways can be avoided or minimised. It is possible that, by working through this guideline, some applicants may identify ways to avoid impacts to waterways completely, therefore removing this development trigger from their proposal.

If complete avoidance is not achieved, this guideline may also help applicants respond to an information request or a further advice notice that is part of the development assessment process.

This guideline should not be solely relied on for persons who are acting outside their field of competence, expertise or experience. Decisions must be made regarding the extent to which this guidance material is relevant to a particular application and a person suitably qualified and experienced in fish passage biology may be required to assist. Refer to Appendix 1.

The use of this guideline alone does not guarantee compliance with all planning and environmental management requirements for constructing or raising waterway barrier works. This guideline provides advice that is specific to a *Planning Act 2016* development application that is for constructing or raising waterway barrier works. Other development triggers, authorisation requirements and considerations may also apply.

1.3 Using this guideline

This guideline consists of the following:

- section 1 introduces the state code and the purpose of this guideline
- section 2 provides information on the protection and management of waterways, what a waterway is, and what waterway barrier works are
- section 3 provides an overview of the assessment framework
- section 4 provides the standard information that should be submitted with any development application for works involving constructing or raising waterway barrier works
- section 5 provides information to help applicants prepare a response to state code 18 to be submitted with any development application for works involving constructing or raising waterway barrier works
- glossary
- appendices that contain useful information for applicants.

2 Protection and management of waterways

Barriers within waterways can impact on fish movement and access to critical habitat. The requirement to provide adequate fish passage at any new or modified waterway barrier is legislated under the *Fisheries Act 1994* and *Planning Act 2016*. In addition, if works require a development approval from the state and if the development is authorised, conditions may be applied to the design, construction, monitoring and operation of the fish passage provisions of the waterway barrier works.

2.1 What is a waterway?

A waterway is defined in the *Fisheries Act 1994* as including a river, creek, stream, watercourse, drainage feature or inlet of the sea. Waterways are fish habitats and include both permanent, ephemeral and periodically inundated fresh and tidal waters.

Waterways can be natural but can also include those that have been modified in the past. For example, the landscape may have been modified through the construction of drains, floodways or canals. The drainage function of a waterway may be valued by land users; however, other functions or services such as fisheries productivity, habitat and biodiversity are also valued by the community and other industries. For more information on the features of waterways, visit fisheries.qld.gov.au.

The spatial data layer, *Queensland waterways for waterway barrier works,* has been developed to indicate where development within waterways may proceed in accordance with accepted development requirements. It is available on the Queensland Globe and Development Assessment Mapping System (DAMS) mapping applications. This mapping layer must be used in conjunction with the user guide

2.2 Waterways host to protected and threatened species

Some fish found in waterways are legislated as protected or threatened species. Additional specific considerations and requirements are likely to apply if constructing or raising waterway barrier works is proposed where these fish or other protected or threatened organisms are present.

For example, some relevant fish include, but are not limited to:

- Freshwater sawfish (*Pristis pristis*), Mary River cod (*Maccullochella mariensis*), Queensland lungfish (*Neoceratodus forsteri*) and Honey blue-eye (*Pseudomugil mellis*) – listed as threatened species under the *Environment Protection and Biodiversity Conservation Act 1999*
- Mount Elliot crayfish (*Euastacus bindal*), Redfin blue eye (*Scaturiginichthys vermeilipinnis*), Oxleyan pygmy perch (*Nannoperca oxleyana*) and Emerald cling goby (*Stiphodon surrufus*) – protected wildlife under the *Nature Conservation Act 1992*
- Australian lungfish, Bloomfield River cod, river blackfish, fish of the subfamily Sicydiinae (freshwater gobies) and Mary River cod (except within certain impoundments) – regulated as no-take species under the *Fisheries Act 1994*
- Queensland lungfish (*Neoceratodus forsteri*) and Redfin blue eye (*Scaturiginichthys vermeilipinnis*) – listed as threatened species under the International Union for Conservation of Nature's Red List.

2.3 Waterways providing for fish passage is a 'matter of state environmental significance'

Waterways providing for fish passage is a matter of state environmental significance under the *Environmental Offsets Act 2014*. Waterways provide critical fish habitat essential for sustaining healthy fish stocks. Free movement along waterways and into adjoining fish habitats is an essential requirement for fish species in Queensland. Movement occurs at adult, juvenile and larval life stages and can be seasonal in nature, an opportunistic response to favourable environmental conditions, or involuntary in times of flood. Some fish move between fresh and salt water to complete life cycles and access feeding, breeding and refuge habitats. Fish movement may occur over small distances or involve large-scale migrations.

In addition to providing critical fish habitat and pathways for fish movement, waterways have cultural, social, economic and ecological values. Waterways provide a number of ecosystem services, including air quality benefits, carbon capture, nutrient cycling, primary production, environmental flows, water quality improvements and erosion control.

2.4 What is a waterway barrier?

The meaning of waterway barrier works is provided in the schedule dictionary of the *Fisheries Act 1994* and is defined as a dam, weir or other barrier across a waterway if the barrier limits fish stock access and movement along a waterway.

Prior to the regulation of waterway barrier works, many structures such as dams, weirs, floodgates and culverts were built on waterways in Queensland without consideration of fish passage. Other waterways have been filled with soil or other materials, resulting in fragmented fish habitats in some locations. In many cases fish are unable to move into waters upstream or downstream of these barriers. This loss of access to habitat has caused a decline in distribution of native fish populations, including species of commercial, recreational and traditional importance such as barramundi, mullet and Australian bass. In Australia, declines of inland species such as Murray cod, freshwater catfish and silver perch are thought to be largely due to the impacts of barriers to fish movement.

Waterway barriers can be permanent or temporary structures constructed within a waterway that act as, or cause barriers to, fish movement. They can include, but are not limited to:

- **dams and weirs** – designed to impound water, preventing or vastly reducing upstream and downstream fish movement
- **bridge crossings** – abutments, piers or piles and other components within the waterway can reduce the cross-sectional area of the waterway
- **culvert crossings** – generally reduce the cross-sectional area of the waterway through which water can flow, increasing velocities, causing turbulence and creating darkness. The extent of the impact may depend on the size of the culvert and the extent to which the culvert or array of culverts is proposed to span the waterway.
- **bed level crossings** – if not constructed properly, can hinder fish passage on low to medium flows due to head loss differences and increasing velocities
- **causeway crossings** – can hinder fish passage on low to medium flows due to head loss differences and increasing velocities. They incorporate fill or construction materials, that are a

physical barrier to fish passage.

- **tidal or flood gates** – designed to stop the flow of water in a particular direction, only allowing fish passage when the gate is open
- **fences across a waterway –** have the potential to trap, injure and kill fish if not designed with fish passage considerations
- **levee banks across a waterway** – levees built across tributaries connecting floodplain wetlands to larger waterways are waterway barriers. The main reason for the construction of levee banks is to stop flood water or tidal water moving into floodplains or low-lying areas, which are often the site of human habitation or agriculture. In doing so levees cut off access from the main river system to floodplain wetlands, which are used by fish for feeding, breeding and as nursery grounds.
- **silt curtains** – designed to stop the movement of silt and sediment; however, can impede fish passage when fixed across a waterway
- **netting and screens** – installed across waterways to prevent intrusion of predators such as crocodiles and sharks, they may prevent movement of fish depending on mesh size and if lack of maintenance has resulted in a build-up of debris
- **litter booms** – can impede fish movement beneath the floating litter boom where lack of maintenance has resulted in a build-up of debris
- **trash racks** – if fitted to culverts can act as a barrier to fish movement if mesh or grill aperture is inadequate or if lack of maintenance has resulted in a build-up of debris
- **riffle structures** – if constructed across a waterway for infrastructure protection, erosion and sediment control or water quality improvement, they can act as a barrier in low flows
- **revetment wall and abutment works** – have the potential to impede fish passage by narrowing waterways and increasing water velocities
- **rock and grass chutes** – constructed to prevent the progress of head-cut erosion upstream; however, can exacerbate fish passage issues if not designed and located appropriately
- **retrofitting fish ways to existing barriers –** can exacerbate fish passage issues if not designed and located appropriately
- **filling within waterways –** removes habitat available to fish and can fragment upstream and downstream fish habitats by removing the ability for fish to access previously connected fish habitats
- **piping waterways –** piping waterways removes the ability for fish to access pre-existing habitat and/or the habitat condition is impacted and cannot be restored. Fish may not enter the piped system due to darkness, velocities or other reasons, and are likely to be more vulnerable to predation within, entering or exiting a pipe.
- **waterway diversions or meander realignments** – generally proposed to facilitate adjacent development or minimise impacts of other waterway barrier works. Development of such nature can greatly impact fish populations if designed and constructed without fish passage and habitat considerations.

- **maintenance or changes to existing unauthorised waterway barrier works –** structural repairs on existing barriers that are not authorised under legislation for constructing or raising of waterway barrier works prolongs the life of the structure and hence the duration of the impact that it has on fish habitat and fish passage
- **significant changes to existing authorised waterway barriers –** alterations that result in changes to an authorised waterway barrier work have the potential to impact on fish passage and fish habitat, for example, by reducing the cross-sectional area of the waterway, increasing velocities and causing turbulence, reducing the frequency of drown-out of the structure or impacting the operation of a fish way
- **temporary waterway barriers –** constructed for a variety of reasons to facilitate other works; however, may impede important fish movements at a critical stage of their spawning cycles or interrupt other migratory patterns
- **cumulative waterway barriers –** multiple waterway barriers accumulating in series within a waterway can amplify impacts on fish passage within that waterway and the other fish habitats it connects; in some cases, a series of barriers can become an insurmountable obstacle course for fish to pass. For example, if a series of barriers reduces the frequency of upstream and downstream fish passage at individual barriers and/or creates delays for fish to move at each barrier encountered, this can, over time, change or isolate the geographic range of fish populations and their productivity and sustainability.

It should be noted that some structures proposed to be located within waterways do not have to be a barrier to fish passage if they can be designed accordingly. This would avoid the requirement for a development approval for constructing or raising waterway barrier works and the fees associated with the application process. For more information on which structures are not considered to be waterway barriers, visit fisheries.qld.gov.au.

3 Assessment framework

3.1 Development that is constructing or raising waterway barrier works

The *Planning Act 2016* and Planning Regulation 2017 provide for types and categories of development as well as the development assessment and decision-making process. Development that is constructing or raising waterway barrier works is a matter of interest to the state and is either assessable or accepted development.

3.1.1 Accepted development requirements

The accepted development requirements for operational work that is constructing or raising waterway barrier works are prescribed under section 135 of the Fisheries (General) Regulation 2019.

Compliance with all aspects of the requirements can provide authorisation for specified work types as accepted development.

If the proposed work does not comply with all accepted development requirements, the work is not accepted development. Constructing or raising waterway barrier works that is not accepted development is assessable development and requires development approval.

Accepted development requirements for operational work that is the constructing or raising waterway barrier works is available at fisheries.qld.gov.au.

3.1.2 Assessable development

A development approval is required for assessable development, unless the work is accepted development. Assessable development that is constructing or raising waterway barrier works requires a development approval and is assessed against the benchmarks in *State code 18: Constructing or raising waterway barrier works in fish habitats* of the State Development Assessment Provisions (SDAP) prescribed under the Planning Regulation 2017.

Development applications for operational work that is constructing or raising waterway barrier works must be submitted to the State Assessment and Referral Agency (SARA).

It is advisable to determine as early as possible in the development process, whether any proposed construction or raising of waterway barrier works is likely to comply with state code 18 of SDAP.

In cases when the success, extent or form of a broader development proposal is likely to be dependent on an element of assessable development that is constructing or raising waterway barrier works, early consideration of these issues is advised. Each individual waterway barrier work within a proposal should be clearly identified and applied for at the earliest stage possible during an assessment to provide confirmation of what can be achieved at the site. For example, for residential development where waterway barrier works may be intended to manage flood or other inundation levels and the design of the proposal in areas adjacent to the waterway would be dependent on this. In such cases, the waterway barrier works element of the proposal should always be assessed before investing in the other elements of development, for example housing yield, that rely on this outcome. If proposals require constructing or raising of waterway barrier works, this should be investigated at the material change of use or reconfiguration of a lot stage. Pre-lodgement advice through SARA

should be sought at these initial stages and waterway barrier works should be applied for concurrently if they will be proposed as part of the development as a whole.

3.2 Other authorisations

In addition to requiring a development approval or complying with the accepted development requirements, an applicant is required to obtain and comply with other statutory requirements under the *Planning Act 2016* and other legislation. For example:

- development approval for other development under the *Planning Act 2016,* such as to remove, destroy or damage a marine plant or undertake tidal works
- tenure under the *Land Act 1994* may be required for development on state land
- a *Marine Parks Act 2004* permit may be required within a marine park
- a *Fisheries Act 1994 r*esource allocation authority may be required for works completely or partly within a declared fish habitat area.

The above list of examples is not exhaustive, other legislative considerations may apply.

3.3 Pre-lodgement advice

Applicants should request coordinated pre-lodgement advice from SARA prior to lodging the development application. This advice will help applicants understand the development assessment requirements, including technical considerations for the proposed development. The level and detail of advice will depend on the quality and detail of information provided as part of the pre-lodgement request. SARA-coordinated pre-lodgement advice will help identify the required level of detail for a development application.

4 Standard information for all applications

Development applications that involve constructing or raising waterway barrier works are assessed to determine the impacts and effects of the development on fisheries resources, fish habitats and fishing sectors and industries. An application should clearly address each waterway barrier that is proposed and should include statements detailing how the development meets each of the relevant performance outcomes of state code 18. Any statement or assertion made in the application is to be substantiated with relevant supporting information or other evidentiary material.

In addressing the assessment benchmarks of state code 18, the following information is required, proportional to the complexity and/or impact of the application:

1. scaled, referenced and dated plans that show
    - a longitudinal section of the waterway from upstream to downstream showing the existing bed level of the waterway in relation to the proposed waterway barrier works
    - a cross-section of the waterway from bank to bank showing the existing bed and bank levels of the waterway in relation to the proposed waterway barrier works
    - the location of waterways and any tidal land within, and adjacent to, the site including natural bed level, high banks, main channel, low-flow channel and the following where relevant – levels of highest astronomical tide, mean high water spring tide, and low water spring tide
    - registered property boundaries
    - contours of the bed and banks of the waterway at the site and to at least 100 m upstream and downstream of the site
2. details of the proposal for particular waterway barrier works

    2.1 all waterway crossings

    - waterway profile and dimensions at the location of the works including, for example, cross-sectional drawings of the waterway
    - details of associated scour protection materials, design and location in relation to the profile of the waterway and location of the waterway crossing

    2.1.1 bridges

    - bridge type and dimensions
    - location and design of bridge abutments in relation to the natural bed and banks of the waterway
    - whether the waterway profile at the site has been modified by a previous structure
    - number of bridge support piers/piles, location, design and alignment in relation to the direction flow and low-flow channel
    - if the bridge is a replacement structure, details of the removal of any existing structure (e.g. existing piles should be removed or cut below bed level)

2.1.2 culvert crossings

- culvert type and dimensions
- number of culvert cells and proposed positioning across the width of the waterway, and positioning on/below the bed of the waterway (refer to section 1 above for required plans)
- location of the low-flow channel in relation to the culverts
- slope through culvert length compared with natural bed gradient
- height from the obvert of the culverts to the road surface
- velocities and depths through the culverts at a range of flows (refer to performance outcome 5)

2.1.3 bed level crossings

- height of the crossing in relation to the natural bed of the waterway
- cross-sectional drawings showing the profile of the low-flow channel and main channel of the waterway in relation to the proposed structure
- details of the material types and sizes being used to construct the crossing

2.2 details of the proposal for dams, weirs, and associated fish ways

- the limit and area of any waterways that will be impacted at full supply level
- a description of current land use, major roads, townships, waterways and surrounding landmarks – for larger developments, full supply levels should be marked on the plan submitted with the application form
- details of outlet works, gates, etc. including the level below surface water that water will water be drawn off
- maximum depth of dam/weir
- estimated headwater/tailwater differences at various flows that inform the adequacy of the fish passage element
- detailed plans and discussion of the spillway design, including spillway gate if relevant
- details of any dissipaters, baffle blocks, stilling basin, scour protection and aprons at the downstream extent of the barrier
- details of how water will be sourced for the dam and extracted for use (e.g. direct pumping from impounded waters, through downstream releases)
- baseline data relating to historical and seasonal water flows and sediment transport, and deposition processes
- baseline data of the aquatic fish community – for large impoundment structures it is expected that fish sampling should be conducted for at least 2–3 years prior to construction, taking into consideration seasonal fluctuations

3. details of the proposal generally and during construction

- brief overview of the proposed works
- how the development has avoided or minimised impacts to waterways
- composition of bed and bank substrate

- timetable detailing the construction period and the relationship between the construction timetable and seasonal rainfall, flows and fish migration periods
- details of any potential disruption to flows in the waterway during construction (e.g. a statement of the likely impact of construction on fish movement through construction of bunds, dewatering or diversion of flows)

4. discussion of the aquatic ecology and riparian vegetation describing
    - the fish habitat at representative sites upstream and downstream of the waterway barrier work as far as the effect of the barrier will extend – this should include features such as distribution of pool and riffle formations, presence of snags, presence of overhanging vegetation, presence of aquatic macrophytes, sediment type, river profile, presence of sand and gravel bars, and water quality, and indicate the relative proportion of these types of habitats in the system that will be affected
    - the sensitivity of fish habitat at the site, and upstream and downstream of the site, to potential disturbances and changes resulting from the proposed works – this may include the sensitivity of the fish habitats to change or specific habitat requirements for particular species and consideration should be given to water quality, flow regimes, water levels and land use
    - the aquatic ecology of the site, and upstream and downstream of the site – this includes the fish community and any protected or threatened fish species that may be present and historical information such as former distribution, diversities etc. should be included if available
    - for certain proposals including fish ways, fish surveys may be required to better inform the aquatic fish community. Refer to Appendix 2 for guidance) – provide the methodology, including sampling methods, sites, dates and times of sampling, flow conditions and water quality; sampling should be planned for suitable times and not when a waterway is dry; and fish assemblage information should include the distribution, diversity, relative abundance and population descriptors (e.g. size classes / length frequency)
    - fish habitat requirements and usage at the site, and upstream and downstream of the site, including life cycle, seasonal or flow-related variations in those requirements
    - any zones of fish accumulation at the existing structures to help determine the optimum site for a fish way entrance
    - the distribution and species/community type of riparian flora, including the quality, continuity and degree of disturbance to the riparian corridor
    - the location of the works site at a landscape scale – include connected fish habitats such as wetlands. Refer to Appendix 3 for further information on mapping layers that can be used to inform this discussion.

The level of detail submitted in support of a development application is to be tailored and relative to the scale and nature of the development proposal. An applicant should request SARA-coordinated pre-lodgement advice to help identify the required level of detail for a development application.

5 Addressing SDAP state code 18

State code 18 of the State Development Assessment Provisions (SDAP) sets out the assessment benchmarks that a development application for operational work that is constructing or raising waterway barrier works is to be assessed against.

State code 18 is a structured, performance-based code that requires applicants to address performance criteria demonstrating that the development appropriately avoids, minimises and manages impacts to fisheries resources and other fish habitats.

Applicants should provide adequate information and respond to the relevant performance outcomes of SDAP to enable assessment of an application against these assessment benchmarks.

Refer to SDAP for more information on how the state codes are used in development assessments.

5.1 All development – impacts on waterways

5.1.1 Performance outcome 1

Waterways provide critical fish habitat essential for sustaining healthy fish stocks. Free movement along waterways and into adjoining fish habitats is an essential requirement for fish species in Queensland.

The potential for waterway barrier works should be considered early in the following stages of planning so that adverse impacts to waterways can be avoided:

- material change of use
- reconfiguring a lot
- master planning processes
- environmental impact statements
- priority/state development areas.

In some instances, an applicant may already have a material change of use or reconfiguring a lot development approval (e.g. for residential housing and associated storm water management within waterways). This is not an indication that a subsequent application for constructing or raising waterway barrier works will be approved.

Adverse impacts to waterways can occur directly at the site of the impact or in adjacent areas of the waterway. For example, construction of a dam is likely to have far-reaching impacts to the hydrology of the waterway both upstream and downstream of the works.

Other developments may have adverse impacts to cultural, social, economic and ecological values of the waterway or the ecosystem services the waterway provides, (e.g. air quality benefits, carbon capture, nutrient cycling, primary production and erosion control). Impacts of development may also have unintended consequences to the physical characteristics of the waterway, such as alteration of the waterway profile, modification of fish habitat features, alignment of the waterway, bank slumping and erosion of adjacent areas due to poor design or altered flows. Alterations to the physical nature of the waterway can result in changes to the hydrology, composition and distribution of fish and aquatic vegetation within the waterway.

Adverse impacts to waterways can occur when:

- proposed changes impact on the free movement of fish within the waterway
- waterways are impounded
- developments have not been planned appropriately to avoid impacts to waterways
- existing waterway barrier works providing limited fish passage are modified, instead of being replaced or removed.

Adverse impacts to the waterway including, but not limited to, those listed above must be avoided through the design, location, construction and operation of the waterway barrier works.

Performance outcome	Acceptable outcomes
PO1 Waterway barrier works do not result in adverse impacts on waterways.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Demonstrate how the design, construction and maintenance of the development has been planned to not result in adverse impacts to waterways and fish habitats. This includes at relevant planning stages and consideration of the design, location, construction and operation of the waterway barrier works.
- ✓ Demonstrate that the development footprint and construction timeframe are minimised.
- ✓ Demonstrate how the design and construction of the waterway barrier works minimises impacts to the physical habitat features of the waterway and/or proposes restoration where appropriate.
- ✓ Demonstrate how changes to the hydrology of the waterway at the site and both up and downstream are avoided and/or minimised and localised.

Note: Specific responses to the performance outcomes below will further draw out whether the proposed development is likely to result in adverse impacts to waterways. This should be discussed in response to performance outcome 1.

5.1.2 Performance outcome 2

Various development proposals, land uses and activities have the potential to include constructing or raising waterway barrier works that can result in permanent and irreversible loss of fish passage, fish habitat, fisheries resources and fisheries productivity. In addition, development proposals may negatively impact fishing operations.

Thousands of dams, barrages, culverts and other artificial structures have been constructed within Queensland waterways. In many cases fish are unable to successfully move upstream or downstream of these barriers. The cumulative impacts from numerous waterway barrier works within a catchment can impact fisheries resources and result in the loss of fisheries productivity. Impacts from the limitation of fish passage can include local species or population extinctions above barriers and compromise of downstream populations.

Waterway barrier works have the potential to impact fisheries resources through modifications of the natural flow regime and loss or modification of fish habitats. For example, downstream dispersal of eggs and larvae can be hindered or halted in low-velocity weir pools.

Waterways providing for fish passage is a matter of state environmental significance. In accordance with the *Environmental Offsets Act 2014*, development is to avoid impacts to the matter of state environmental significance in the first instance. Avoidance includes measures undertaken to minimise the occurrence of waterway barrier works. There are often other locations, routes or designs that would avoid constructing or raising waterway barrier works and impacting on fish habitats and limiting fish passage, including the following:

- if pipelines are required to cross waterways, they can be horizontally directionally drilled below the bed of the waterway or constructed via aerial crossings
- water storages or water treatment structures can be constructed off-stream – constructing or raising waterway barrier works is to be clearly justified and unavoidable
- undertaking pile driving for bridges from a barge rather than using a temporary construction platform within the waterway
- selecting corridors or routes that avoid meandering sections of waterways that may result in multiple crossings of a single waterway.

If waterway barrier works cannot be avoided, the development should seek to minimise impacts to waterways providing for fish passage. This could include reducing the spatial and temporal extent of impacts to fish passage. If multiple waterway barrier works are proposed, the number of barriers should be limited and each barrier is to be designed, constructed and maintained to avoid and minimise impacts to waterways – a matter of state environmental significance. Alternatives that would minimise impacts to waterways, include the following:

- construct a bridge rather than culverts – this is likely to minimise impacts to waterways by retaining natural substrate and maximising the cross-sectional area of waterway and depth of water column available for fish movement
- design the waterway crossing to simulate the hydrological and physical characteristics of the natural waterway
- ensure culvert cells span 100% of the main channel width of a waterway – this is likely to minimise impacts to hydrological conditions, such as increased velocities compared with culverts that only span a portion of the waterway
- works within the waterway should be undertaken as quickly as possible and be avoided during the wet season – this is likely to minimise impacts to species that are triggered to migrate during elevated flow events.

Performance outcome	Acceptable outcomes
PO2 Development is designed, constructed and maintained to avoid and minimise impacts on matters of state environmental significance.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Include plans and drawings of the development site, identifying all waterways and fish habitats within and adjoining the development site with an overlay of the proposed development. Refer to section 4 in this guideline for a detailed description of the required plans and information to provide with the development application.
- ✓ Demonstrate how the proposed design, location, construction and maintenance of the development will avoid impacts to waterways providing for fish passage to the greatest extent practicable.
- ✓ Provide information demonstrating the number and the size of the waterway barrier works has been minimised (if the works are unavoidable).
- ✓ Provide information demonstrating how the spatial and temporal impacts resulting from the waterway barrier works have been, or will be, minimised (if impacts are unavoidable).
- ✓ Provide information to demonstrate that the overall construction period is minimised and the development is undertaken to avoid elevated flows.
- ✓ Discuss the cumulative impacts from existing disturbances and the proposed disturbance to the aquatic ecosystem (e.g. from other dams/weirs, existing water extraction and upstream barriers). Discuss the ability of the ecosystem to absorb the additional impact/s of the proposed waterway barrier.
- ✓ Provide a maintenance schedule, detailing the timeframe and measures that will be undertaken to ensure that any proposed structures are adequately maintained to minimise any potential disruptions to fish passage. This may include, but is not limited to, clearing of debris following floods and period inspections to ensure scouring has not occurred.

5.1.3 Performance outcome 3

Waterways that provide fish passage are a matter of state environmental significance under the *Environmental Offsets Act 2014*. The 'avoid, minimise, mitigate, offset' hierarchy underpins the state's assessment and decision-making processes for development involving constructing or raising waterway barrier works in waterways providing for fish passage. In the first instance, this framework requires that impacts to waterways providing for fish passage are avoided. If avoidance cannot be achieved, it must be demonstrated that impacts have been minimised and mitigated.

Mitigation actions can reduce the severity of an impact, for example:

- construction of a fish way to provide fish passage for the fish community past the barrier
- incorporation of fish-friendly structures, such as fish hotels within waterways to replace lost fish habitat
- restoration or revegetation of disturbed areas within the waterway bed or banks
- implementation of watering points that are not in the waterway and fencing to prevent stock access to waterways.

In some circumstances mitigation actions can reduce the overall significant residual impact of a proposed development. For example, restoring fish passage by removing unauthorised or obsolete structures.

After all reasonable avoidance and mitigation measures have been taken, if there is a residual impact on waterways providing for fish passage that is found to be acceptable, an offset may be required if the residual impact is, or is likely to be, 'significant'. Guidance for determining if the residual impact on the matter of state environmental significance is significant can be found in the *Significant residual impact guideline* (Department of State Development, Infrastructure and Planning, 2014).

Development involving waterway crossings for vehicular, pedestrian or other access should not result in a significant residual impact on waterways because there are designs available to provide for adequate fish passage.

If development cannot avoid impacts to waterways providing fish passage, the impacts must be acceptable and consistent with ecologically sustainable development. Impacts may be unacceptable when:

- the free passage of fish within waterways is restricted for species that have obligatory movement requirements and that underpin recreational, commercial and traditional fisheries
- a waterway barrier does not provide adequate fish passage for the whole fish community
- tidal or fresh water is impounded for aesthetic purposes
- barriers are likely to cause injury or mortality to fish
- impacts could not be feasibly offset
- fish passage or fish habitat impacts within waterways are known to host threatened fish species
- ecosystem services provided by impacted waterways are highly valuable or difficult to replace, including air quality benefits, carbon capture, nutrient cycling, primary production and erosion control
- development does not comply with the performance outcomes and the purpose statement of this code
- waterways that are a public resource are significantly impacted for a private benefit.

Although impacts from barriers such as dams or weirs may be mitigated to some extent by the provision of adequate fish passage, such as through a fish way, this rarely mitigates all impacts to waterways providing for fish passage, for example:

- a dam or other barrier with a fish way or fish ways will still restrict the location and frequency at which fish can pass the barrier in either direction – depending on the fish way design, this will likely reduce the biomass of fish able to move and the freedom with which it can move
- a dam may result in the permanent modification of fish habitat within the impoundment area
- a barrier may result in the fragmentation of fish habitats between up and downstream areas
- there may be impacts to waterways downstream of a development, for example, permanent modification to the volume, depth, timing, duration, or flow frequency of the waterway
- hydropower plants or pumping infrastructure may result in the injury or mortality of fish that become caught within pumping infrastructure.

Any significant residual impacts must be offset in accordance with the Environmental Offsets framework. If a proponent-driven offset is proposed, the applicant should seek pre-lodgement advice through the State Assessment and Referral Agency to identify any potential development triggers associated with the proposal.

Performance outcome	Acceptable outcomes
PO3 Where development impacts on matters of state environmental significance, development mitigates impacts and provides an offset for any acceptable significant residual impact on matters of state environmental significance. **Statutory note:** For Brisbane core port land, an offset may only be applied to development on land identified as E1 Conservation/Buffer, E2 Open Space or Buffer/Investigation in the Brisbane Port LUP Plan.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Describe the matter(s) of state environmental significance to be impacted. For example, waterways providing for fish passage or legally secured offset areas.
- ✓ Detail and describe all permanent and temporary impacts to waterways that provide for fish passage.
- ✓ Demonstrate that the proposed development mitigates impacts to waterways that provide fish passage to the greatest extent possible and outline proposed mitigation measures to reduce the severity of impacts.
- ✓ If restoration of fish habitat and fish passage within a waterway is proposed, provide a restoration plan that clearly outlines the management actions to be undertaken and the timing of these actions.
- ✓ Identify any significant residual impacts to matter(s) of state environmental significance. Refer to the *Significant residual impact guideline*.
- ✓ Discuss the feasibility of providing an environmental offset for any **significant residual impacts**, if relevant. This information may help to determine if a significant residual impact is likely to be acceptable. Environmental offsets must be delivered in accordance with the *Environmental Offsets Act 2014*, Environmental Offsets Regulation 2014 and *Queensland environmental offsets policy*. Offsets may be delivered financially or through a proponent-driven offset, or a combination of the two.

5.2 All development in general

5.2.1 Performance outcome 4

The movement of fish (fish passage) within and between waterways and other fish habitats is an essential requirement to sustain fisheries resources. Waterways and connected fish habitats are under considerable development pressure. Only waterway barriers that depend on their location within or across a waterway to function will meet this performance outcome. For example, the essential parts of a waterway crossing that will provide a means of getting from one side of a waterway to the other.

However, the functional requirement does not extend to associated or ancillary elements, or design elements that are not compatible with providing adequate fish passage. Further information on what does provide adequate fish passage is provided in performance outcome 5.

Examples of aspects of development that have the potential to demonstrate a functional requirement to be located within waterways include:

- a waterway crossing for road, rail or pedestrian access
- water storage infrastructure
- a boat ramp, pontoon or jetty
- temporary waterway barriers to enable construction works
- a fish way.

The following examples are not acceptable within waterways because they can be located elsewhere and still provide their intended function:

- storm water treatment systems such as detention basins, water sensitive urban design structures, gross pollutant traps or water treatment facilities proposed in a waterway, when they should be treating the water quality outside of the waterway to protect the aquatic ecosystem values
- filling of waterways, for purposes such as:
    - car park areas
    - parks, sports fields or golf courses
    - residential and industrial developments
    - restaurants, hotels or supermarkets
- pond aquaculture and agriculture development
- any access route that is parallel with, and within, a waterway
- sewage effluent treatment works.

Sometimes proposals may involve multiple waterway barriers or modification to an existing waterway barrier. In these instances, information must be provided to clearly demonstrate a functional requirement for each barrier proposed within a waterway. In some instances, existing structures may have a development approval prior to the requirement to consider fish passage requirements. If constructing or raising existing authorised waterway barrier works is required, the fish passage requirement must still be addressed.

In addition to a functional requirement to be located within a waterway, it must be demonstrated that the development cannot be feasibly located outside of the waterway or elsewhere within the waterway to minimise impacts to the waterway. For example:

- small-scale water storage infrastructure could be placed on an overland flow path outside of waterways
- a waterway crossing may not be required if there is a route available that does not require crossing a waterway
- waterway crossings are better placed on naturally straight reaches as opposed to bends – this avoids or minimises turbulence that may affect fish passage and reduces the potential for scour/erosion.

Performance outcome	Acceptable outcomes
PO4 Aspects of development are only permitted within a waterway where there is a functional requirement and the development cannot be feasibly located elsewhere. Ancillary elements are to be located outside of the waterway.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Provide supporting information, including plans and drawings that identify all development components (including construction requirements) within a waterway.
- ✓ Demonstrate that any aspect of development located within a waterway is dependent on being located within the waterway to function.
- ✓ Demonstrate that the development cannot be feasibly located elsewhere.

5.2.2 Performance outcome 5

Fish movement is required for various reasons, including food, shelter, spawning and recruitment. Fish passage is the term used to describe large-scale and small-scale fish movement between alternate habitats. Large-scale movements are popularly known as migrations; however, all fish have a requirement to be able to move freely between and access various habitats. Fish passage is also used to describe the engineering and biological aspects required to provide fish movement past an artificial waterway barrier.

In some instances there may be existing waterway barriers, such as a crossing, present at a site. If constructing or raising existing authorised waterway barrier works is required, the fish passage requirement must still be addressed.

Note: For information on how a waterway crossing can be designed so it is not a barrier to fish passage, visit fisheries.qld.gov.au.

The following types of waterway barriers may be used for crossings (listed in order of preference).

Bridges

If a bridge cannot feasibly be designed so it is not a barrier to fish passage, it is recommended that any proposed bridge should span the waterway wherever possible to minimise impacts. If the placement of pylons within the waterway is unavoidable, use the minimum number possible and avoid impacts to the low-flow channel. There are cost-effective pre-cast bridges available that can minimise impacts on fish movement. These should be investigated as a priority.

Culverts

Waterway crossings that include culverts are a common barrier that can have significant individual and cumulative impacts to fish passage if not designed with fish passage requirements in mind. They are essentially ‘road dams’ and have the potential to disconnect waterways and reduce biodiversity. Historically they have been designed to convey flow without consideration of fish passage and, when designed in this way, the result often restricts fish movement. Many native Australian fish species are very weak swimmers and cannot sustain long periods of swimming against strong velocities. To ensure that culvert crossings provide adequate fish passage, the following approaches can be taken – waterway simulation, or a hydraulically designed culvert crossing.

Waterway simulation culverts

Waterway simulation culverts means that the form and function of the waterway is replicated inside the culvert to mimic the physical and hydrological characteristics of the natural waterway and provide natural fish habitats. Waterway simulation design is often referred to as stream simulation or geomorphic design. Typically, a reference section of the adjacent waterway that captures the range of fish habitats within the waterway (e.g. diversity and size of natural bed and bank material, pools, riffles, runs, etc.) is used to simulate the natural waterway. This reference section is used to design a best-practice waterway simulation culvert that spans the bankfull width of the waterway. The bankfull width is the width of the waterway when the banks are full and before water begins to overtop into adjacent floodplain areas. Ideally, only a single culvert cell is used to achieve the required span. In these instances they may not be a waterway barrier – pre-lodgement advice should be sought in relation to the design as an application may not be required. In other instances a compromised solution may be available, in which culverts simulate the natural waterway to a degree, but reduce the cross-sectional area of the waterway. These are likely to be considered waterway barriers.

Waterway simulation culverts typically have an open bottom or invert buried so it allows the natural waterway bed to be recreated. Typically, large arch culverts or large corrugated pipes are used for stream simulation design. Properly designed waterway simulation culverts that span the bankfull width are likely to have fewer ongoing maintenance costs, such as remediation of scouring, because they cater for the large majority of flows expected at the site – just as the natural waterway would. Culverts are sized wide enough so as to retain the natural line of the bank inside the structure. The bank lines should be contiguous throughout the inlets and outlets of the structure and with those upstream and downstream within the natural waterway. This ensures a low-velocity boundary zone is retained for weak-swimming species of fish.

Note: Waterway simulation design may not be appropriate for all waterway crossings. For example, it is unlikely to be appropriate if long culverts are required, waterways are wide or steep, the waterway bed is unstable or the natural waterway cannot be adequately replicated. For example, a waterway simulation design is likely to be more appropriate for rocky waterways as opposed to waterways with densely vegetated banks that cannot be replicated inside the culvert cell.

Hydraulically designed culverts

Hydraulically designed culverts utilise roughness elements to generate targeted hydraulic conditions for flows where fish are attempting passage. It is therefore critical to understand the hydrology of the waterway, the fish present and the likely periods of fish movement. While fish passage may not be able to be provided through a culvert during the peak of flooding events, the culvert aperture should be sufficient for all other flows and to mitigate impacts to fish passage. Roughening elements such as baffles should be included in the design to reduce velocities and allow fish to rest as they move upstream. Culvert cells should be buried below bed level and contain natural bed material. Providing the velocities within the culvert cells do not exceed that of the natural waterway, sediment deposition within the culvert will be achievable. Natural sediments provide a roughening element, slowing velocities and assisting fish passage during low-flow conditions or for bottom-swimming species such as gudgeon.

Bed level crossings

Bed level crossings are waterway crossings that are designed to be at the bed level of the waterway at its lowest point. They do not include any pipes or culverts and are generally constructed from compacted material such as rocks, gravel, or concrete. Bed level crossings may be suitable in waterways that are characteristically ephemeral and only flow a few times a year. Bed level crossings may be appropriate in areas such as the Channel Country of Queensland, where waterways are typically dry for most of the year and rise and fall quickly when flooded. Most bed level crossing designs should be able to comply with accepted development requirements; however, some may require a development approval if those requirements cannot be met.

Causeways

Crossings that do not incorporate sufficient openings to provide for fish passage and consist largely of fill material such as rock or concrete are likely to be considered a causeway. It is unlikely that causeway designs can meet this performance outcome.

Note: For the purposes of addressing the acceptable outcomes, **drownout** of the structure refers to when the headwater and tailwater levels are equal and covering the structure so that fish passage is unrestricted over the top of the structure. This is not the same as when water begins to overtop the

structure. During times of overtopping, fish passage is likely to be restricted due to a drop in water level over the structure when the headwater level is higher than the tailwater level. The **depth of cover** is the height of fill measured from the obvert of the culvert cell to the road surface/pavement.

If the relevant acceptable outcomes cannot be achieved, it must be demonstrated how the waterway barrier otherwise provides adequate fish passage.

Note: For all other barriers that are not crossings, the acceptable outcomes listed below are not applicable, and it must be demonstrated how adequate fish passage is provided both upstream and downstream past the structure.

Performance outcome
PO5 For the life of the barrier, adequate fish passage must be provided and maintained at all waterway barrier works through: 1. fish way(s) that adequately provide for the movement of fish or 2. the movement of fish is adequately provided for in another way.
Acceptable outcomes
For all crossings: **AO5.1** Hydraulic conditions (depth, velocities and turbulence) from the downstream to the upstream limit of the structure allow for fish passage of all fish attempting to move through the crossing at all flows up to the drownout of the structure. and **AO5.2** For the life of the crossing, the relative levels of: 1. a bed level crossing or a culvert invert 2. bed erosion protection 3. apron scour protection; and 4. the waterway bed are maintained to avoid drops in elevation at their joins. and **AO5.3** The crossing and associated erosion protection structures are installed at no steeper gradient than the waterway bed gradient. and **AO5.4** The crossing and associated erosion protection structures are roughened throughout to approximately simulate natural bed conditions. and **AO5.5** Design and maintenance measures are in place for the life of the crossing to keep crossings clear of blockages through a regular inspection program in order to retain fish passage through the crossing.

Acceptable outcomes cont.
For waterway crossings other than bridges and culverts: **AO5.6** The crossing is built at or below bed level so that the surface of the crossing is no higher than the stream bed at the site. and **AO5.7** The lowest point of the crossing is installed at the level of the lowest point of the natural waterway bed (pre-construction), within the footprint of the proposed crossing. and **AO5.8** There is a height difference between the lowest point of the crossing and the edges of the low-flow section of the crossing so that water is channelled into the low-flow section of the crossing. and **AO5.9** The level of the remainder of the crossing is no higher than the lowest point of the natural waterway bed outside of the low-flow channel.
For bridges: **AO5.10** Bridge support piles are not constructed within the low-flow channel and do not constrict the edges of the low-flow channel, and the number of piles within the waterway are minimised. and **AO5.11** Bridge abutments and bank revetment works do not extend into the waterway beyond the toes of the banks. and **AO5.12** Suitable fish habitats are maintained within the low-flow channel.
For culverts: **AO5.13** Culverts are only installed where the site conditions do not allow for a bridge. and **AO5.14** The combined width of the culvert cell apertures are equal to 100 percent of the main channel width. and **AO5.15** The base of the culvert incorporates a low flow channel consistent with the natural low flow channel and: 1. is buried a minimum of 300 millimetres to allow bed material to deposit and reform the natural bed on top of the culvert base; or 2. the base of the culvert is the waterway bed; or 3. the base of the culvert cell and any scour protection within the waterway is roughened throughout to approximately simulate natural bed conditions. and **AO5.16** The outermost culvert cells incorporate roughening elements such as baffles on their bankside sidewalls. and

Acceptable outcomes cont.
AO5.17 Roughening elements are installed on the upstream wingwalls on both banks to the height of the upstream obvert or the full height of the wingwall. and **AO5.18** Roughening elements provide a contiguous lower velocity zone (no greater than 0.3 metres/second) for at least 100 millimetres width from the wall through the length of the culvert and wingwalls. and **AO5.19** Culvert alignment to the waterway flow minimises water turbulence. and **AO5.20** There is sufficient light at the entrance to and through the culvert so that fish are not discouraged by a sudden darkness. and **AO5.21** The depth of cover above the culvert is as low as structurally possible, except where culverts have an average recurrence interval (ARI) greater than 50 years. and **AO5.22** For culvert crossings designed with a flood immunity ARI greater than 50 years, fish passage is provided up to culvert capacity.
For all other development no acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Submit plans and drawings of the waterway barrier works and any associated structures or works areas. Include detaisl of all design aspects that will provide fish passage. Refer to section 4 in this guideline for the standard information for all applications. Section 4 provides a comprehensive list of the plans and other information that may be required to enable assessment against this state code.
- ✓ Identify the location of the bed and banks of the waterway and any connected fish habitats such as wetlands within, and adjacent to, the development site. Refer to Appendix 3 for further information on mapping layers that can be used to inform this discussion.
- ✓ Detail aquatic vegetation and riparian areas within the development site on plans.
- ✓ If hydraulic modelling will inform how the waterway barrier provides fish passage (e.g. for culverts that are hydraulically designed, provide information demonstrating how the fish passage provisions of the waterway barrier are adequate for both upstream and downstream passage), provide information based on scientific evidence and hydrological modelling. If hydrological and hydraulic modelling is provided, include the following information to inform the data provided:
    - inputs, e.g., spatial and temporal scales, source of data.
    - outputs, e.g., frequency and duration of flood events in relation to the proposed structure.

Fish move frequently within waterways, so if would be useful to include information on:

- how the waterway barrier provides fish passage during frequent flow events that occur multiple times per year (e.g. 2 EY, 3 EY)
- how the waterway barrier provides fish passage during flood events that occur up to a 1 in 5 year (20%) event.

However, this will vary, depending on the development proposed and the nature of the waterways. For example:

- for dams, information is requested up to a 1% annual exceedance probability (1 in 100 year event) – this is to ensure that any fish way proposed can operate under a range of flow conditions and provide safe downstream passage in those events
- some waterways are ephemeral and fish passage may only be provided at limited times; however, in larger flood events there may be additional connectivity, for example in braided waterways. – in these types of waterways, information may be requested up to a 10% or 5% annual exceedance probability (1 in 10 year or 1 in 20 year event).

✓ Provide the expected duration of flows, water depth and water velocities for the above events through the structure in comparison to those within the natural waterway.

✓ Provide context on the information provided, for example whether they are peak velocities of short duration, or whether velocities are the average peak velocities through the structure.

✓ Provide context on the hydrological characteristics of the waterway. For example, some waterways may have ephemeral flows, only flowing for 40% of the year, whilst others may contain water year-round.

✓ Detail the operational range of the fish passage provisions in terms of the fish movement and fish behavioural requirements (based on fish assemblage, biomass and seasonality) and the natural flow regime of the waterway.

5.2.3 Performance outcome 6

Fish passage has been compromised in the past due to lack of knowledge, inappropriate design, inadequate resources and poor maintenance of waterway barrier works and associated fish passage provisions. Often fish passage objectives have focused on the iconic species of commercial or recreational importance; however, it is important that the entire fish assemblage is considered and provided for.

Effective fish passage is the successful transmission of all fish species and individuals attempting to pass the barrier in all flow conditions. The provision of fish passage must consider future and seasonal increases in biomass due to spawning and migration requirements, as well as the ability to accommodate the swimming ability of all species and all life-stages of migrating fish, i.e., larval, juvenile, and adult.

For certain proposals, e.g., fish ways, the fish community may need to be surveyed to determine how the waterway barrier should be designed to provide passage for all members of the fish community. Informative surveys are likely to include the presence/absence of species, abundance and size classes present. A variety of techniques could be employed depending on the water chemistry and

hydrological and physical characteristics of the waterway. As a starting point, reference to some fish survey guidance material can be found in Appendix 2.

Fish passage includes both longitudinal fish movement between upstream and downstream habitats and lateral fish movement between the waterway and adjoining fish habitats. Lateral fish movement into both permanent and temporary systems, such as connected wetlands, is important for the survival of many species, for example to complete essential lifecycle stages. Fragmentation of connectivity into and out of these systems must be mitigated via adequate fish passage.

It is important that the fish passage provisions of the waterway barrier works are designed with consideration of fish movement, behavioural and habitat requirements. This is most successful when a suitably qualified and experienced fish passage biologist is involved during all stages of the development – specifically, the planning and design stages. However, depending on the barrier, a suitably qualified and experienced fish passage biologist may also need to be involved in the construction, operation and monitoring of the development.

Fish movement must be provided for all members of the fish community. However, where a catchment is known to host vulnerable or endangered fish species, this must also be taken into consideration. Examples of these species include, but are not limited to, Freshwater sawfish (*Pristis pristis*), Mary River cod (*Maccullochella mariensis*), Queensland lungfish (*Neoceratodus forsteri*) and Honey blue-eye (*Pseudomugil mellis*).

Performance outcome	Acceptable outcomes
PO6 Waterway barrier works are designed, constructed, operated and maintained to provide lateral and longitudinal fish passage for all members of the fish community.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Identify, map and describe the fish habitats within the waterway and adjacent fish habitats, such as connected wetlands. Refer to Appendix 3 for further information on mapping layers that can be used to inform this discussion.
- ✓ Discuss the flow regimes of the fish habitats and the connectivity between fish habitats.
- ✓ If a fish way is proposed, or otherwise determined, detail the known and expected fish assemblage (include survey methodology) and discuss expected seasonal changes. To demonstrate compliance with this performance outcome, the seasonal and flow-related biomass of the fish community at the location of the proposed waterway barrier works is to be surveyed and addressed in the design of the fish way by a person suitably qualified and experienced in fish passage biology. In addition, any future increases in fish biomass should be quantified and catered for.
    - Detail the presence/absence of species, abundance and size classes of fish present and discuss the fish passage requirements for each.
    - Describe the methodology for any fish surveys that were undertaken.

- ✓ Demonstrate that fish passage will be adequately provided upstream and downstream of the waterway barrier works (longitudinal movement) and between adjacent fish habitats (lateral movement). This discussion must detail how the design addresses the fish behavioural requirements. Assertions made must be based on relevant scientific evidence.

5.2.4 Performance outcome 7

Waterway barrier works, or their components, have the potential to impact the health and productivity of fisheries resources and may cause injury or mortality of fish. For example, undershot weirs or outlet structures that have elevated hydrostatic pressure upstream and low pressure downstream can cause mortality of fish, including larvae or juveniles due to barotrauma. Waterway barriers with stepped spillways have been shown to cause physical injury to adults passing over the crest of the structure. Any proposal that includes stepped spillways will not comply with this state code.

Development that includes waterway barrier works may also include other infrastructure that has the potential to impact on fish safety, including:

- hydropower facilities with turbines or pumps are sometimes proposed as part of a waterway barrier – fish may become entrained, diverted, killed or injured as they are forced through turbines or pumps
- water intake infrastructure within a waterway (e.g. pumping infrastructure)
- gabion baskets that are not below bed level and not backfilled with sediment, or used as a rock chute.

To ensure the safety of fish, best-practice techniques must be employed to ensure all potential pathways of fish movement provide safe fish passage. Modern fish exclusion screens exclude smaller debris, are self-cleaning and do not reduce the amount of water that can be diverted (Boys et al. 2021). Additionally, they have lower velocities in front of the screen, meaning fish do not become sucked into the infrastructure. The approach velocity of a screen is particularly important and must be designed so the weakest swimming fish are able to avoid impingement. Refer to *The practical guide to modern fish-protection screening in Australia* and *Design specifications for fish-protection screens in Australia* for further information and current best-practice designs.

Other structures that have the potential to cause injury to fish include scour protection, intake and outlet structures, spillways, stilling basins, aprons and dissipation structures. Design measures must mitigate impacts to unsafe fish passage, for example, by ensuring that there is adequate tailwater depth within a stilling basin at commence to spill (30% of the head difference). Additionally, the impact velocity of fish being plunged into stilling basins has the potential to cause significant injuries to gills, eyes and internal organs of fish. The design of any dam must aim to minimise these impacts by minimising dam height and through the design of the spillway.

Accumulation of fish occurs downstream of structures where fish passage mechanisms are inefficient at passing the biomass, or structures are not adequately designed. If upstream migrations are continually delayed, fish energy reserves become depleted, compromising fish health or condition. In some instances this can also result in reduced spawning ability, reduced water quality, increased predation, or fish kills.

Some aspects of waterway barrier works may act as a fish trap, cause fish stranding or create conditions that allow excessive predation.

Performance outcome	Acceptable outcomes
PO7 Development is designed and operated so that all components of waterway barrier works and pathways of potential fish movement provide for safe fish passage. Stepped spillways are not acceptable.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ With reference to waterway barrier work plans and designs, identify all potential pathways for fish movement. Consideration should be given to all flow conditions.
- ✓ Discuss risks to safe fish passage and how these risks will be alleviated.

5.2.5 Performance outcome 8

Drownout allows fish passage when the headwater and tailwater levels over the barrier are effectively equal and there is sufficient water depth across the barrier for the fish community and biomass to pass over the structure. The extent to which drownout can provide fish passage depends on the frequency, duration and timing of drownout conditions.

Performance outcome	Acceptable outcomes
PO8 The drownout characteristics of the waterway barrier works are designed and constructed to not result in adverse impacts to fish passage.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Detail and discuss the frequency, duration and timing of drownout of the waterway barrier works in relation to the identified fish passage requirements of the system, taking into consideration adequate fish passage for the fish community and biomass.
- ✓ Detail drownout flow conditions that will provide fish passage (velocities, turbulence, water depth).
- ✓ Detail any delays caused by the barrier in reaching drownout conditions, for example:
  - for culverts and weirs, the delay between the time it takes from when culverts are at capacity (flowing full) until drownout is achieved
  - for fish ways, the upper operational limit until drownout conditions.
- ✓ Include information (modelling etc.) to substantiate any provided information.

5.2.6 Performance outcome 9

The primary purpose of the *Fisheries Act 1994* is to provide for the use, conservation and enhancement of the community's fisheries resources and fish habitats. Any development or works involving constructing or raising waterway barrier works is not to result in adverse impacts to the health, quality, condition or values of **fisheries resources** and fish habitats. Impacts to **fisheries resources** as a result of development have the potential to occur due to:

- changes to biotic and abiotic conditions, such as water and sediment quality
- exposure to substances that are toxic to plants or toxic to, or cumulative within, fish
- changes in habitat structure, such as alteration of the waterway bed and banks
- inadequate incorporation of fish passage elements in the design of waterway barriers resulting in adverse impacts to fish passage, fish migration and access to habitat
- impacts on reproductive success of fish
- depletion of fish energy reserves through alteration or removal of fish habitats and/or food sources
- structures that result in the physically damage, death, trapping or stranding of fish (a fish salvage plan may be required to demonstrate compliance with the performance outcome)
- cold water pollution, such as dam releases from outlets low in the impoundment resulting in impacts to fish productivity
- changes that result in an increase of pest fish and/or other relevant pest species.

Consideration must be given to how the design, construction methodology, materials and timing of the works are designed so they do not result in adverse impacts to fisheries resources.

A fish salvage plan may be required to demonstrate compliance with this performance outcome and may form a condition of any approval. Permits or other authorities may be required under the *Fisheries Act 1994* for the use of regulated fishing apparatus and to possess fisheries resources. Should fish salvage be required, visit fisheries.qld.gov.au for more information.

Performance outcome	Acceptable outcomes
PO9 Development does not result in adverse impacts to fisheries resources.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Discuss any potential impacts to fisheries resources that may result from the proposed development. Particular focus should be given to the following issues:
    - biotic and abiotic conditions, such as water and sediment quality
    - substances that are toxic to plants or toxic to, or cumulative within, fish
    - design of structures
    - impacts on reproductive success
    - effect on fish energy reserves
    - whether fish may be physically damaged, injured, killed, trapped or stranded
    - fish passage and access to habitat generally
    - impacts of pest fish and other relevant pest species.

- ✓ Provide details on how the proposed development has been designed, constructed and/or will be managed to protect fisheries resources from identified potential impacts. This could include, for example, an erosion and sediment control plan and/or use of silt curtains.

5.2.7 Performance outcome 10

Fish habitats and associated fisheries resources are highly susceptible to the adverse impacts and effects resulting from development and land uses. For example, degradation, alteration and loss of fish habitats; and the loss of fish movement or access to fish habitats. A key component of fish passage within waterways is the mosaic of natural fish habitats and the associated complexity providing various flow conditions and shelter.

Unnatural modification of the waterway, for example waterway diversions or realignments should be avoided by appropriate planning of the development around existing waterways.

Waterway barrier works must be designed so the natural processes of erosion and accretion of sediments are retained where possible. For example, culverts that are located on waterway bends remove natural meanders and impact on riparian vegetation. This results in modification to the hydrological characteristics of the waterway by increasing water velocities and reducing bank stability. This in turn can result in the requirement for additional hardening of the banks for scour protection, for example the use of gabion baskets. The extent of erosion control and associated hardening of waterway bed and banks must be demonstrated to be essential.

Performance outcome	Acceptable outcomes
PO10 The design, construction and maintenance of the development does not result in non-essential hardening or unnatural modification of the main channel of the waterway.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Demonstrate that impacts to fish habitats and fish passage have been avoided and natural fish habitats and waterway features have been retained.
- ✓ If any hardening of the waterway is proposed, demonstrate why it is essential for the development, taking into consideration designs that would not require hardening or modifying fish habitats. For example, culverts should be sized appropriately to minimise any scour protection within the waterway.

5.2.8 Performance outcome 11

Natural waterways contain a variety of physical structures that provide habitat complexity and influence fish community composition. Waterway and riparian habitat features may include:

- large woody debris
- rocks
- riffles
- pools
- aquatic macrophytes
- riparian vegetation.

Natural structures such as these provide variable flow conditions, aquatic macrophytes for feeding and areas to seek shelter from predation by birds or larger predatory fish. Natural riparian vegetation along the waterway banks contributes to the natural ecology of the waterway by providing:

- variable flow conditions
- bank stabilisation
- shade
- spawning habitat
- contribution of large woody debris for habitat and shelter
- water quality benefits
- flood mitigation.

When constructing or raising waterway barrier works, they should be designed to retain the habitat complexity of the natural fish habitats.

Performance outcome	Acceptable outcomes
PO11 The development retains natural fish habitat and features such as shade, pools, riffles, rock outcrops and boulders, wherever possible.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Submit supporting material, including plans and discussion, to demonstrate how the development retains natural fish habitats and habitat complexity.

5.2.9 Performance outcome 12

Straightening of waterways results in the direct loss of fish habitat and modification to natural hydrological conditions, which may limit fish passage, for example increased velocities and decreased hydrological complexity. This in turn can decrease habitat complexity and influence community composition. During the early stages of planning, developments must be designed so they are located appropriately to avoid straightening a waterway. This could include, for example:

- planning the layout of development to avoid waterways
- planning linear infrastructure such as roads to avoid encroaching on waterway bends
- locating crossings on naturally straight sections of waterways
- designing developments to avoid the requirement for future maintenance works (e.g. desilting of waterways for flood mitigation).

Performance outcome	Acceptable outcomes
PO12 The design, construction and maintenance of the development does not result in straightening of meandering waterways.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Demonstrate that the design, construction and maintenance of the development avoids straightening natural meanders of the waterway.

5.2.10 Performance outcome 13

Where development proposes significant modification to channels, measures must be implemented to replicate the natural waterway and habitat features of the area to help maintain natural fish populations and community composition. This could include:

- large woody debris
- rocks
- riffles
- pools
- aquatic macrophytes
- riparian vegetation.

Performance outcome	Acceptable outcomes
PO13 Where channels are to be significantly modified, the design and construction of the development replicates natural waterways and habitat features.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ If it has been demonstrated that significant modification to the waterway cannot be avoided and there is a functional requirement for the development to be located within the waterway, discuss the natural habitat features that are incorporated into the development. This could include pools, riffles, shaded and open sections, deep and shallow sections, and different types of substrata.
- ✓ Provide plans showing the elements of the design that include natural waterway features. For example, plan-view, longitudinal and cross-sections of the waterway showing waterway profiles with any proposed pools, vegetation, riffles, etc.
- ✓ Provide a revegetation plan if relevant.

5.2.11 Performance outcome 14

Construction and operation of waterway barrier works has the potential to modify natural flow regimes of waterways. Changes to the hydrological regime can compromise fish passage through existing structures within the same waterway or catchment. A noticeable example of this is the impoundment of waters upstream of a dam or weir or the regulating of downstream water flows compromising the ability of downstream fish ways to operate as intended.

Should the construction or operation of waterway barrier works alter or compromise fish movement over or through existing structures, the fish passage provisions of existing structures must be upgraded to provide adequate fish passage.

Performance outcome	Acceptable outcomes
PO14 Where waterway barrier works will modify water levels or flow characteristics of the waterway, existing up and downstream structures are upgraded to provide adequate fish passage in accordance with the new levels or flow characteristics.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Identify and discuss the extent of the changes to flow regimes and water levels of the waterway.
- ✓ Identify all structures within the waterway or catchment that will be affected by the proposed waterway barrier works and the impact the works will have on their ability to provide fish passage.
- ✓ Clearly outline any activities or measures (including the modification of fish passage provisions on existing structures) that will be undertaken to mitigate impacts to fish passage, fish habitats and fish access to fish habitats. Other performance outcomes of this code are likely to also be applicable to works that will modify fish passage provisions on existing structures.

5.2.12 Performance outcome 15

Fisheries resources, fish habitats and the aquatic ecosystems in which they occur rely on natural flow conditions, characteristics and regimes.

Development that will result in a waterway restriction or blockage, changes to waterway profiles or depths, flow diversions or widening of a waterway has the capacity to modify or reduce tidal or freshwater inundation and extent, or cause water to pond. Reduced water depth can restrict fish passage, and lack of flows due to restrictions or impounded water can reduce dispersal of larvae downstream.

Disturbances or changes to tidal and hydrological regimes can compromise ecological processes and reduce the condition or value of the fish habitats and fisheries resources. In some instances they can cause die back or mortality of these ecosystems or fisheries resources. For example, ponded or stagnant water can become anoxic due to stratification modifying water quality parameters such as temperature and dissolved oxygen.

Performance outcome	Acceptable outcomes
PO15 The development is designed, constructed and maintained to provide water exchange sufficient to maintain or improve water quality and flow conditions on which fisheries resources depend.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Identify if the extent and duration of existing tidal or freshwater inundation and drainage patterns will be restricted or impacted either temporarily or permanently by the proposed work through, but not limited to, the provision of an appropriately scaled drawing or plan identifying:
  - the current extent of tidal inundation, including the level of highest astronomical tide, mean high water springs and mean low water springs
  - the current extent of freshwater inundation at all expected flow intervals
  - the existing profile of the waterway and adjoining riparian zones
  - the resultant extent of tidal inundation, including the level of highest astronomical tide, mean high water springs and mean low water springs
  - the resultant extent of freshwater inundation at all expected flow intervals
  - the proposed profile of the waterway and adjoining riparian zones on completion of the works.
- ✓ Confirm if the duration of tidal inundation or hydrological regime will change as a result of the works and any new infrastructure, and detail and quantify the impacts to fisheries resources.
- ✓ If tidal inundation and drainage patterns will be temporarily restricted, specify the length of time required for the restriction, and detail and quantify the impacts to fisheries resources.
- ✓ Demonstrate how any impacts associated with altered water exchange or flow conditions maintains or improves the health and condition of fisheries resources, ecological functions and fish passage.
- ✓ Clearly outline any activities or measures that will be undertaken to mitigate impacts or remediate the area on completion of the works.

5.2.13 Performance outcome 16

Acid sulfate soils occur naturally over extensive areas of low-lying coastal lands – predominantly areas that are below 5 metres Australian height datum (AHD). Acid sulfate soils exposed to oxygen through works, such as excavation and drainage, results in the production of sulphuric acid and toxic metals. The acid corrodes concrete and steel infrastructure, and together with the metal toxins can kill fish, other aquatic life, native vegetation and crops. It is important that potential acid sulfate soils are managed in accordance with best-practice guidelines to avoid impacts to fisheries resources and fish habitats.

Performance outcome	Acceptable outcomes
PO16 Development likely to cause drainage or disturbance to acid sulfate soils prevents the release of contaminants and impacts on fisheries resources and fish habitats.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Identify if the proposal will expose, disturb or drain acid sulfate soils.
- ✓ Provide an overview of potential acid sulfate soil management and measures to minimise impacts of acid sulfate soils on fisheries resources and fish habitats.
- ✓ Demonstrate that the proposed management is consistent with the current version of the *Queensland acid sulfate soil technical manual*.

5.2.14 Performance outcome 17

The diverse mosaic of fish habitats associated with the bed and banks of waterways and riparian zones provides areas for refuge and feeding, connectivity for fish movement and helps sustain fish stocks.

Constructing or raising waterway barrier works may require the temporary disturbance of a waterway and fish habitats outside of the permanent footprint of the works. Development must prevent these impacts wherever possible.

Performance outcome	Acceptable outcomes
PO17 The development is designed, constructed and maintained to not result in adverse impacts to beds, banks and vegetation adjacent to the permanent development footprint.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Demonstrate how the design of the development prevents adverse impacts to the bed, banks and adjacent vegetation of the waterway.
- ✓ Demonstrate that any temporarily disturbed areas adjacent to the permanent footprint are kept to a minimum.

- ✓ Detail the pre-construction and post-construction measures that will be implemented to prevent erosive processes and maintain bed and bank stability.
- ✓ Demonstrate that the use of any machinery required is outside of the waterway and the size of machinery and extent of impacts to adjacent areas are minimised. The use of load-spreading mats, for example, is likely to minimise compaction of soils and may help to establish any post-construction revegetation.
- ✓ Provide information regarding any future maintenance requirements, including demonstrating how any ongoing maintenance avoids adverse impacts to the beds, banks and vegetation adjacent to the permanent development footprint.

5.2.15 Performance outcome 18

Experience in Australia and overseas has demonstrated that the removal or mitigation of degrading influences and restoration of natural profiles, substrate and conditions are the most cost-effective and biologically successful methods of restoring fish habitats and conditions that provide fish passage.

Upon completion of the works, it is best practice to restore any temporarily disturbed areas adjacent to the permanent works footprint to allow these areas of fish habitat to re-establish. This should include, but is not limited to, the return of natural profiles and sediments to the site to provide the best opportunity for regeneration of the natural hydrology of the waterway and fish habitats.

Performance outcome	Acceptable outcomes
PO18 After completion of works, disturbed areas of the bed and banks of the waterway outside the permanent development footprint are returned to their original profile and stabilised to promote regeneration of natural fish habitats.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Detail any reprofiling, revegetation or other methods proposed within disturbed areas of the bed, banks and immediately adjacent to the waterway. This could include, for example, planting of adjacent overhanging vegetation to provide shelter for fish within the waterway.
- ✓ Detail any proposed monitoring to ensure the successful establishment of fish habitat regeneration within, and adjacent to, the work site. Outline the timeline and quantitative benchmarks that will be used to measure the success of the regeneration. It should also include an ‘alert to action’ component to address any deficiencies identified in the regeneration process. Any proposed monitoring may be conditioned as part of a development approval.

5.2.16 Performance outcome 19

Alteration of the natural substrate can impact natural processes within the waterway, such as erosion and accretion, and impact on the hydrology of the waterway. For example, removal of sediments can result in modification to the natural roughness of the substrate, influencing water velocity, vegetation, and water quality. This can have adverse impacts on fish passage throughout the waterway.

Alteration of the natural substrate of fish habitats can also impact on the reproductive success of native fish. For example, eel-tailed catfish generally construct their nests by pushing gravel and pebbles into circular mounds, while Australian lungfish require low flows and dense aquatic macrophytes to undertake spawning.

It is therefore essential that throughout the development footprint, the natural substrate is maintained wherever possible and that temporarily disturbed areas are returned to their natural condition.

Performance outcome	Acceptable outcomes
PO19 The development is designed and constructed to maintain or restore the natural substrate of the waterway bed.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Demonstrate that the design of the waterway barrier works allows for deposition and retention of natural sediments.
- ✓ Demonstrate that any permanent structures proposed are designed to allow replication of the natural substrate in terms of size and consistency. For example, demonstrate that any scour protection is buried 300 mm below bed level and backfilled with natural bed material.

5.2.17 Performance outcome 20

Development adjacent to, and within, tidal land and waterways has the potential to restrict community access through changes to land use and construction and operation of buildings, structures and infrastructure. The restriction of community access to tidal land and waterways compromises the potential for fair and equitable use of fisheries resources, and may limit community, economic and other benefits.

Performance outcome	Acceptable outcomes
PO20 Development does not adversely impact on community access to tidal land and waterways.	No **acceptable** outcome is prescribed.

Information to be submitted with development application

- ✓ Demonstrate that the community use of, and access to, tidal land and waterways will not be adversely impacted.
- ✓ If any temporary impacts to community access are required, detail the extent of the impacts and management of this issue.

5.2.18 Performance outcome 21

Development within, or adjacent to, tidal fish habitats and waterways has the potential to reduce or restrict community access to fisheries resources in the short or long term. The viability of recreational and traditional fisheries is dependent on the ability for the community to be able to access and catch or harvest fisheries resources. Temporary restrictions to an area may result from construction of temporary structures such as piling platforms or coffer dams, or for workplace health and safety reasons. Long-term impacts to community access arrangements may result from structures in waterways such as culverts, weirs and dams.

In some cases, compensation for impact on fisheries access, operations and/or productivity may be necessary. The *Guideline on fisheries adjustment* provides advice for proponents on relevant fisheries adjustment processes and is available by request from the Department of Agriculture and Fisheries.

Performance outcome	Acceptable outcomes
PO21 Development does not adversely impact on community access to fisheries resources and fish habitats including recreational and Indigenous fishing access.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Discuss existing community access arrangements to fisheries resources, including identification of existing fishing activities and stakeholders.
- ✓ Identify and discuss any elements of the location, design, construction methods or operation of the proposed development that have the potential to adversely impact on community access to fisheries resources and fish habitats with specific reference to recreational and traditional fishing activities.
- ✓ Discuss all aspects of the proposed development that have been incorporated to maintain community access arrangements to fisheries resources and fish habitats.
- ✓ Detail any industry consultation undertaken, including any agreed outcomes. Consider consultation with local fish stocking groups and recreational fishing bodies such as Sunfish Queensland.
- ✓ Detail any fisheries adjustment initiatives that have been, or will be, undertaken to compensate for any adverse impacts to community access arrangements.

5.2.19 Performance outcome 22

Commercial fishing has an important role in providing seafood for purchase and consumption by the general public. Commercial fishing is dependent on access to fish stocks and infrastructure, services and facilities that support these operations. Development has the potential to restrict commercial fishing access to fish stocks and fishing grounds, interrupt or displace fishing activities and sever supply chain linkages.

In some cases, compensation for impact on fisheries access, operations and/or productivity may be necessary. The *Guideline on fisheries adjustment* provides advice for proponents on relevant fisheries adjustment processes and is available by request from the Department of Agriculture and Fisheries.

Performance outcome	Acceptable outcomes
PO22 Development does not adversely impact on commercial fishing access and linkages between a commercial fishery and infrastructure, services and facilities.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Identify existing commercial fishing activities and industries that may be impacted by the development, including consideration of the seasonal and transient nature of commercial fisheries.
- ✓ Discuss existing commercial access arrangements to fisheries resources and quantify any adverse impacts to access arrangements resulting from the proposed development.
- ✓ Identify and discuss any elements of the location, design, construction methods and operation of the proposed development that have the potential to adversely impact on commercial fishing access to fisheries resources and fish habitats.
- ✓ Discuss all aspects of the proposed development that have been incorporated to maintain commercial fishing access arrangements to fisheries resources and fish habitats.
- ✓ Detail any industry consultation undertaken, including any agreed outcomes. This may include the commercial fishing industry and/or peak body such as the Queensland Seafood Industry Association and/or aquaculture industry associations.
- ✓ Detail any fisheries adjustment initiatives that have been, or will be, undertaken to compensate for any adverse impacts to commercial fishing access arrangements.

5.3 Development involving fish ways

The requirement for fish passage was recognised relatively early in Queensland and about 22 fish ways were constructed at significant waterway barriers across the state before the 1970s. These fish ways were based on northern hemisphere designs for salmon and trout, and did not suit the swimming capabilities, requirements or behaviours of Australian fish. In the last few decades, significant work has been done within Australia to determine the swimming and behavioural requirements of native fish and investigate appropriate fish way designs to cater for these. Further information on the various types of fishways can be found at biopassage structures (fishways) on the Department of Environment and Science website.

Fish ways are technical in nature and require design by a suitably qualified and experienced fish passage biologist to ensure that they adequately provide fish passage for the entire fish community, taking into consideration the movement requirements and swimming abilities of fish and the hydrological conditions of the site. Construction should be overseen by a suitably qualified and experienced fish passage biologist and subsequent monitoring is likely to be required to ensure the fish way provides the fish passage designed. These are likely to form conditions of a development approval to ensure that there are no adverse impacts on fish and fish movement. Refer to Appendix 1 for further information on what is considered to be a suitably qualified and experienced fish passage biologist.

For any proposed fish way, a number of management plans must be submitted with the development application to demonstrate the effective operation and maintenance of the fish way and to ensure it provides adequate fish passage. The information provided in these plans will support performance outcomes 23–28 and the detail should be proportional to the type of fish way proposed.

For any lock, lift or other **mechanical fish way** provide:

- ✓ an operational plan

  and

- ✓ a maintenance plan, including contingency measures

  and

- ✓ a monitoring plan

For any **non-mechanical fish way**, such as rock ramp, cone or vertical slot, provide:

- ✓ a maintenance plan, including contingency measures

  and

- ✓ a monitoring plan

The operational plan must include:

- ✓ procedures for any manual operation of the fish way to move fish from one side of the barrier to the other (e.g. fish way infrastructure inspections, pest species sorting and fish release protocols)
- ✓ details of all automated processes to facilitate passage for the trapping, movement and release of fish where relevant
- ✓ demonstration that there are adequate resources to ensure ongoing operation, with consideration of items such as the availability of spare parts that may be susceptible to damage, adequate personnel and timeliness of repairs
- ✓ description and analysis of fish habitat conditions at release sites
- ✓ the frequency of fish movement operations that will minimise delays to fish passage and optimise the condition of fish and their survival upon release
- ✓ demonstration of how fish movement operations will accommodate the ability to vary the frequency of fish movements depending on the results from ongoing monitoring of the numbers and species of fish that moved.

The **maintenance plan** must include:

- ✓ regular maintenance inspections and/or required actions, including frequency of inspections and components inspected
- ✓ entity/personnel responsible for the maintenance
- ✓ demonstration that there are, and will be, sufficient personnel and resources required for the maintenance
- ✓ the timing of, and triggers for, other specific inspections (e.g. following flood events, failures or breakdowns, reports from public or other stakeholders, and as required by an' alert to action')
- ✓ what the specific inspections will include
- ✓ contingency measures
    - an 'alert to action' component that details the actions to be implemented if particular deficiencies are found with the fish way and the timing of the actions
    - an 'alert to action' component that details the actions to be implemented if a flooding event has impacted the fish way and the timing of the actions
    - fish salvage protocols to be implemented in the event of any fish becoming stranded and trapped within fish way infrastructure
    - if actions are required to remediate deficiencies in the fish way, the expected delay to fish passage associated with these actions
    - who will be engaged to remediate issues with the fish way
    - critical fish movement periods for the ongoing productivity of the entire fish community at the specific barrier must be clearly identified

- how fish passage will be provided in the interim – fish passage must be provided if the fish way is non-operational during a critical fish movement period or for a period of more than 14 days when it would usually be expected to be operational.

The **monitoring plan** must include:

- ✓ details of what success means in terms of quantitative performance outcomes for fish way monitoring over the range of conditions in which the fish way is expected to operate
- ✓ details of the frequency, timing and duration of monitoring that investigates the following
    - species composition, size class and abundance of fish immediately upstream and downstream of the barrier and compared with fish entering the fish way
    - whether fish are migrating to and locating the fish way entrance under the full operating range of the fish way
    - whether fish are remaining in the attraction/holding chamber during the attraction phase
    - any stress and damage effects on fish using the fish way or during fish movement operations
    - predation upon and among fish while using the fish way or while being trapped and/or moved
    - environmental conditions within the fish way and at release sites or fish way exit points
    - adequacy of the fish way capacity for the biomass and requirements of fish requiring passage
- ✓ details of the proposed frequency for provision of monitoring reports to the enforcement agency in relation to the proposed monitoring.

5.3.1 Performance outcome 23

For fish ways to mitigate the impacts from waterway barrier works they must be effective for the range of flow conditions and for the fish assemblage expected at the site. Any delays in fish passage must be minimised, for example, by ensuring that fish passage is provided as soon as possible following the commencement of flows into the structure or where relevant through the provision of environmental flows.

Consideration should be given to provision of fish passage during drought and low-flow conditions. Different species and size classes of fish have varying requirements for movement. For example, Australian bass generally tend to move downstream for spawning on suitable flows throughout winter and return upstream during the first number of significant post-winter flows. However, rainbow fish and many other small-bodied species generally move year-round during low flows. Releases through the waterway barrier works and fish way must be sufficient and variable to attract the whole fish community to the fish way entrance and meet behavioural and biological requirements. This issue must be addressed as part of the planning and design of the waterway barrier works.

Resources must be made available to ensure that fish ways will operate for as long as the waterway barrier works are in place.

Performance outcome	Acceptable outcomes
PO23 Having regard to the hydrology of the site and fish movement characteristics, the fish way is capable of operating, and will operate: 1. for as long as the waterway barrier work is in position and 2. whenever there are inflows into the impoundment or waterway, release out of the impoundment and during overtopping events and **3.** when the impoundment is above dead storage level.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Provide evidence that the fish way has been designed by a person that is suitably qualified and experienced in fish passage biology. Refer to Appendix 1 for guidance selecting a fish passage professional.
- ✓ Demonstrate that the fish way construction will be overseen by a person that is suitably qualified and experienced in fish passage biology.
- ✓ Detail the hydrology of the site. This includes, but is not limited to, the frequency, duration and hydrological conditions such as flow, depth and velocity associated with base flow conditions, upstream water releases, cumulative effect of upstream barriers, influences from downstream barriers and/or tailwater conditions/structures.
- ✓ Detail water planning arrangements including, but not limited to, unallocated water to support the operation of the fish way.
- ✓ Detail the fish community at the site and their movement requirements. This includes, but is not limited to, whether the fish community contains species with obligatory movement requirements (e.g. from fresh to salt water for spawning, timing of migrations in relation to seasonal and environmental cues).
- ✓ Detail when the fish way will operate in relation to the proposed waterway barrier works. This includes, but is not limited to, the frequency and duration of operation, water levels and the availability of suitable hydraulic conditions associated with the waterway barrier and fish way.
- ✓ Demonstrate that the fish way operates when there are inflows into the system, releases out of the impoundment and during overtopping events.
- ✓ Demonstrate that the fish way operates when the impoundment level is above dead storage level. Dead storage level is considered to be the level where extraction operations or water releases cease to occur.
- ✓ Detail any expected delays between the commencement of inflows into the structure and the commencement of fish way operation. This should take into consideration historical modelling, the frequency and volume of drawdown, and any operating licenses.
- ✓ Provide an operational plan. Refer to the beginning of section 5.3 for the details to be included.

5.3.2 Performance outcome 24

The design of the development should take into consideration the natural hydrology of the system. For example, many waterways in the channel country have ephemeral flows, so it is essential that any fish way is designed to operate when there are flows in the system as these times may naturally be limited. Similarly, catchments that typically contain a standing level of water would allow fish movement during all times of the year. Any developments should be designed, constructed and maintained to produce hydraulic conditions that mimic the natural hydrology of the catchment and provide for fish passage accordingly. This should take into consideration the seasonality of flows where relevant, velocities, frequencies and depth of the natural waterway.

The size and type of the fish way must be appropriate for the site. Generally, a natural style of fish way such as a rock ramp fish way is preferred rather than a mechanical design if the site conditions allow for it. Another design factor to consider is the ability to attract fish to the fish way entrance and to provide suitable hydraulic conditions throughout the fish way.

Significant investigation into the expected hydraulic conditions of the fish way and likely impacts on the movement of all fish species should be undertaken prior to making an application to ensure the proposed fish way design is the most appropriate for the site conditions and fish community. A fish way must be designed, constructed and maintained to ensure that the hydrology throughout the fish way is suitable for the entire fish community, taking into consideration entry and exit conditions, resting places and suitable turbulence and velocities for the fish community at the site.

Performance outcome	Acceptable outcomes
PO24 The development is designed, constructed and maintained to ensure the hydrology allows for fish movement for the life of the waterway barrier works.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Demonstrate that the expected hydraulic characteristics of the waterway barrier works will allow the fish way and any associated fish passage mechanisms to operate to provide adequate fish passage.
- ✓ Detail the natural hydrology within the catchment. This includes whether waterways typically have a standing level of water or contain flows that are ephemeral.
- ✓ Demonstrate how the fish way is designed, constructed and maintained to maximise the natural hydrology of the system and provide for fish movement. This may include, for example, computational fluid dynamics and other modelling for mechanical fish ways.
- ✓ Demonstrate that the allocation of water resources required for fish passage is adequate and will be made available for the effective operation of the fish way.
- ✓ Detail the operational range of the fish way. If possible, the lower operational range of the fish way should be at least 0.5 metres below the minimum headwater drawdown level* and 0.5 metres below the minimum tailwater level at the site. If this is not achievable, adequate justification must be provided demonstrating why it is not achievable.

  * The minimum headwater drawdown level is considered to be the lowest water level within the impoundment that the impoundment is drawn down to.

- ✓ Discuss the expected timing of fish migrations and how the design and construction of the fish way ensures suitable hydrological conditions that will avoid any delays in fish movement during times of spawning migrations.
- ✓ Demonstrate how delays in fish movement will be minimised immediately following times of flow.
- ✓ Demonstrate that fish are able to exit upstream and downstream fish ways at water level over the full range of headwater and tailwater conditions.
- ✓ Demonstrate that exits are located to avoid fish being washed back over the spillway during overtopping.
- ✓ Demonstrate that there are continuous attraction flows at the fish way entrance under all flow conditions within the fish way's operating range.
- ✓ Demonstrate that, if required, additional means of fish attraction are included in the fish way design.
- ✓ Demonstrate that attraction flow velocities are suitable and variable to attract the whole fish community and expected variations in seasonal biomass.
- ✓ Demonstrate that fish attracted to the spillway or outlet flows are able to access the fish way without having to swim back downstream.
- ✓ Demonstrate that adequate hydraulic conditions and minimum water depth for fish passage is maintained throughout the fish way.
- ✓ Demonstrate that turbulence throughout the fish way is suitable for the whole fish community within the operating range of the fish way.
- ✓ Demonstrate that the exit conditions are adequate for downstream fish passage.
- ✓ For non-mechanical style fish ways, such as rock ramp, bypass, trapezoidal and cone fish ways, demonstrate that appropriate resting areas are available for fish moving through the fish way. If possible, these should be vegetated and/or include suitable refuge comparable to natural waterway conditions.
- ✓ For mechanical style fish ways, such as lock and lift fish ways, demonstrate that the holding chamber is adequate for the expected fish biomass, taking into consideration migration periods and any potential future increases in biomass.
- ✓ Provide a maintenance plan, including contingency measures. Refer to the beginning of section 5.3 for the details to be included.

5.3.3 Performance outcome 25

There are many components of a fish way that have the potential to adversely impact on fish and fish movement if not designed, constructed and maintained appropriately. Fish way design must aim to provide a similar level of fish passage to maintain fish movement in accordance with the natural hydrological conditions of the site and not adversely impact on fish and fish movement. All components and potential pathways of fish movement must be investigated. For example, spillway designs and pumping infrastructure have the potential to injure and kill fish and must be designed to avoid such adverse impacts.

Fish ways must be designed by a suitably qualified and experienced person in fish passage biology to ensure the design is suitable for the hydrological conditions and fish community, and to ensure the hydraulics through the structure do not adversely impact on fish movement. Refer to Appendix 1 for guidelines to select a fish passage professional.

During fish way construction, measures must be implemented to not adversely impact on fish and fish movement. For example, construction works should be scheduled for the dry season, and when fish movement would usually be provided during construction works, fish passage should be provided through another mechanism such as a temporary bypass fish way or staged timing of construction to allow for fish passage.

Ongoing maintenance of fish ways is required to ensure their continued and effective operation. Information to include in a maintenance plan is listed in at the beginning of section 5.3.

Performance outcome	Acceptable outcomes
PO25 Fish ways are designed, constructed and maintained to not adversely impact on fish and fish movement.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Demonstrate how water intakes, outlets, screens and other structures are designed and constructed to prevent entrainment, injury or mortality to fish.
- ✓ Provide evidence that appropriate light levels are maintained at entrances, exits and throughout the fish way to ensure successful use by fish.
- ✓ Demonstrate that the design of the fish way minimises the risk of predation on fish that use the fish way.
- ✓ Demonstrate that the fish way is designed and maintained so that rubbish and debris do not impede fish passage or cause blockages or damage the fish way.
- ✓ Demonstrate that the development incorporates suitable mitigation elements to avoid:
    - direct impact against the base of the spillway or stilling basin
    - excessive velocities or turbulences that are likely to cause injury to internal organs and significant injuries to gills and eyes
    - sudden pressure changes
    - areas where fish are likely to be predated on
    - areas where fish can become stranded
    - detrimental water quality due to factors such as cold-water pollution, hypoxic waters and chemical pollutants.
- ✓ Provide a maintenance plan that includes contingency measures to ensure the continued and effective operation of the fish way. Refer to the beginning of section 5.3 for the details to be included.

5.3.4 Performance outcome 26

To ensure fish ways are effective at providing fish passage, the flow requirements to operate the fish way must be met as a priority. The waterway barrier works and the fish way must provide suitable flows to enable fish to successfully find and enter a fish way without depleting energy reserves. The effectiveness of the fish way in providing fish passage is not to be compromised by the operation of the waterway barrier works. If large volumes of flow are released, this must be done in a way that does not detract from the operation of the fish way. With restricted flows, releases are to be made through the fish way as a priority. The fish way must operate for the range of flows expected at the site.

Performance outcome	Acceptable outcomes
PO26 Fish ways are designed, constructed and operated to direct release water through the fish way as a priority over the outlet works.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Demonstrate that the design of the fish way allows water to be released through the fish way as a priority over the outlet works.
- ✓ Demonstrate that sufficient water releases, including environmental flows, are directed through the fish way as a priority over any outlet works to ensure the effective operation of the fish way.

5.3.5 Performance outcome 27

When designing a fish way, consideration must be given to the available water supply to operate it. This includes natural seasonal flows in addition to existing or proposed water entitlements. A fish way will not be able to operate without thorough investigation into water planning matters.

Consideration of water supply and water quality is integral to ensure that the fish way is designed, constructed and operated so it does not result in adverse impacts to fish or fish passage. Additional information around considerations regarding water quality can be found in performance outcome 30.

Performance outcome	Acceptable outcomes
PO27 Fish ways are designed, constructed and operated to ensure flows and releases of water do not result in adverse impacts to fish or fish passage.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Demonstrate that flows and releases are adequate to support fish way operation. Relevant information should be provided to support this, which may include:
    - outcomes of the relevant water resource plan to support fish passage at the site

- how the resource operations plan facilitates the implementation of the relevant water resource plan (e.g. by ensuring environmental flow objectives are met)
- how the resource operations licence or distribution operations licence supports the operation of the fish way
- how the water supply scheme operations manual, including the operating rules, may affect the operational range of the fish way.

✓ Demonstrate that flows will be provided for the fish way as a priority over all other components of the waterway barrier works to minimise delays in fish passage.

✓ Provide evidence that all flows and releases initiate and terminate adjacent to the fish way or are directed parallel to the fish way entrance.

✓ Demonstrate that all flows are transferred to the fish way as soon as possible during a flow recession.

✓ Demonstrate that there are no flows that would compete with fish way attraction flows or reduce the operation of the fish way.

✓ Provide an operational plan. Refer to the beginning of section 5.3 for the details to be included in an operational plan.

When providing a response, consider that flows and releases include, but are not limited to, spillway overtopping and outlet flows.

5.3.6 Performance outcome 28

Fish ways are customised solutions for fish passage with consideration of the location, height and purpose of the barrier, and the known and expected fish assemblage and their swimming and behavioural requirements. Problems that can arise from not adequately considering the operation of the fish way include inadequate resources for operation or repair and poor maintenance. Although good design is essential, monitoring at commissioning is critical to confirm that the fish way operates as intended. Through this process, issues can be identified and adjustments made to optimise fish way operation. Designs must provide inherent capacity and flexibility to address issues, including future maintenance requirements.

Resources are to be made available for any monitoring or operational costs and to rectify any breakdowns or fish way failures. Large mechanical fish ways have been known to become inoperable due to programming issues or wear and tear on parts. Contingency plans and facilities must be in place to ensure fish passage is provided during any fish way malfunction or breakdown. For example, plan and design for a back-up scenario to provide for fish passage should any fish way become inoperable for a period of more than 14 consecutive days. Delays longer than this can have a significant impact on fisheries resources.

Performance outcome	Acceptable outcomes
PO28 The development is designed, constructed and operated to ensure fish way operational issues are **promptly** rectified for the life of the fish way including: 1. all components are designed to be durable, reliable and adequately protected from damage during high flow and flood events 2. all **components** can be replaced 3. a contingency plan ensures provision of alternate adequate fish passage during the fish way re-instatement process.	No **acceptable** outcome is prescribed.

Information to be submitted with development application

- ✓ Detail any known fish way operational issues using prior knowledge, experience and/or examples of unforeseen incidents that have resulted in fish ways being non-operational.
- ✓ Detail how the design, construction and operation of the fish way avoids the likelihood of those incidences occurring. For example, avoids the use of particular components susceptible to breakdown or mitigates known design issues that may lead to fish way downtime.
- ✓ Demonstrate that the design of the fish way allows for future adjustments in capacity or operation that may be required if identified following wet commissioning.
- ✓ Provide evidence that all components of the fish way can be easily sourced and/or, if known, ensure an additional spare stock of components that may be particularly susceptible to damage to reduce the downtime of a fish way. Downtime of a fish way refers to the period when it is non-operational.
- ✓ Detail the structural integrity and durability of fish way components and demonstrate that they are unlikely to fail or become damaged during high flow events or other environmental conditions such as high winds.
- ✓ Provide a maintenance plan including contingency measures that detail how fish passage is provided in the event that the fish way becomes non-operational, the timeframe associated with implementation and the expected timeframe to rectify any issues. Refer to the beginning of section 5.3 for the information to be included in a maintenance plan.

5.3.7 Performance outcome 29

The success of a fish way cannot be determined until the completion of construction and wet commissioning of the fish way. Monitoring a fish way is likely to form a condition of a development approval to ensure the fish way provides adequate fish passage as proposed in a development application. For this reason, it is essential that the fish way is designed to allow the installation of temporary monitoring equipment that may be required, such as cages, traps or video surveillance equipment at the fish way inlets and outlet.

To determine the range and size classes of species that are present at the site, it is important to monitor both the downstream and upstream sides of the fish way to ensure that fish being attracted to the fish way entrance are successfully passing the fish way. When hazards such as crocodiles or dangerous flow conditions are likely, it may be necessary to devise a safe method of working to ensure that both sides of the fish way can be monitored. This may include, for example, the requirement for boat access or fish friendly access platforms.

Performance outcome	Acceptable outcomes
PO29 The development is designed to allow for installation of monitoring equipment and to allow access for monitoring and maintenance.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Demonstrate that the design of the development allows for the installation of monitoring equipment.
- ✓ Demonstrate that the development allows access for personnel, cars and boats for monitoring, maintenance and operational purposes at the fish way entry and exit. Ensure that these aspects do not compromise the design or operation of the fish way.
- ✓ Ensure that relevant health and safety procedures are in place to allow effective monitoring over the range of headwater and tailwater conditions.
- ✓ Provide a monitoring plan. Refer to the beginning of section 5.3 for the details to be included in the monitoring plan.

5.3.8 Performance outcome 30

Water quality is an important consideration for waterway barrier works and fish way design and operation so that adverse impacts to fish do not occur. For example, water should be sourced from quality surface water commensurate to that of the waterway. Consider the full range of water quality indicators, including chemical indicators, temperature and dissolved oxygen. The goal is to match the water quality of the receiving environment. Outlets creating cold water pollution should be avoided.

Alteration of flow regimes often disrupts environmental cues, which trigger fish migration or movements and can alter habitat conditions. Various forms of water pollution are important to consider in this context, such as cold-water pollution releases from thermally stratified dams or water with low levels of dissolved oxygen.

Performance outcome	Acceptable outcomes
PO30 Fish ways are designed, constructed and operated to source water supply from surface water or equivalent water quality.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Detail the location for all sources of water used in fish way operation, including for any supplementary attraction flows if required.

- ✓ Demonstrate that the characteristics and quality of the surface water being released is similar to that of the receiving environment (e.g. similar pH and chemical composition).
- ✓ Demonstrate that the quality of water used and released is appropriate to maintain aquatic ecosystem values and is consistent with the:
    - Environmental Protection (Water and Wetland Biodiversity) Policy 2019
    - *Australian and New Zealand guidelines for fresh and marine water quality*
    - *Queensland water quality guidelines 2009*.
- ✓ If surface water is not used:
    - demonstrate that the water used for the operation of the fish way, including attraction flows, is suitable for fish passage and will not compromise environmental cues for migration
    - demonstrate that water used and released will not compromise the condition and value of fish habitats or the ability for fish to utilise and access fish habitats
    - demonstrate that the release of deep water that is likely to be low in dissolved oxygen and colder in temperature compared to surface water is avoided within the waterway
    - detail how, when and where all environmental flows will be released. Generally, environmental flows should be through a fish way rather than other outlet structures.

5.3.9 Performance outcome 31

Waterway barrier works such as water supply infrastructure often require additional waterway barrier works downstream to control the level of the tailwater for scour protection and flood mitigation. Tailwater control structures such as a gauging weir, rock bar or waterway crossing must be designed to provide adequate fish passage, including a fish way if necessary.

Performance outcome	Acceptable outcomes
PO31 Tailwater control structures are designed, constructed and maintained to allow for fish passage.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Detail any structures downstream of the fish way that act as a tailwater control structure.
- ✓ Demonstrate that the tailwater control structures are designed to provide for adequate fish passage and will not compromise the ability for fish to access upstream fish habitats, including a fish way where relevant.

5.4 Development involving floodgates

At times, waterways connecting to floodplains have been fitted with floodgates to mitigate the effects of floodwaters and tidal inflows in low-lying areas. These structures can negatively impact fisheries by preventing fish movement along waterways connected to floodplain habitats and by creating conditions with poor water quality. Generally, floodgates consist of a one-way hinged flap gate or vertically lifted gate that prevents the ingress of water to low-lying areas during periods of high water levels (floods or tides). These gates are usually designed to work automatically to minimise the impacts of flooding resulting from floodwaters and/or tides and to include provisions for fish passage.

Existing development that is reliant on floodgates and requires maintenance or upgrade may be appropriate if the management of water allows for adequate fish passage provisions. However, new development that relies on floodgates would generally not be supported due to the significant impacts on waterways and fish habitat.

5.4.1 Performance outcome 32

Floodgates can prevent fish passage by creating high velocities during run-off periods when gates are open and by completely closing. These times are generally associated with periods of high fish movement, so it is essential that floodgates are designed, operated and maintained to provide for fish passage. Many older floodgate structures are poorly maintained and/or left closed for extended periods, preventing fish migrations from occurring. Floodgates should be designed to operate automatically, for example via tidally activated, fish friendly floodgates. Automation of floodgates ensures their continued operation when access is not possible or when it is not safe for people to access the waterway.

Performance outcome	Acceptable outcomes
PO32 The design, construction and operation of a floodgate does not result in adverse impacts on fish, fish passage or fish habitat.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Provide plans and drawings showing a cross-section of the waterway with the proposed floodgate/s, demonstrating that they adequately span the width of the waterway.
- ✓ Provide plans, along with a discussion, detailing how and when the floodgates will operate and how this ensures the provision of adequate fish passage for the range of fish and flood/tidal conditions expected at the site.
- ✓ Demonstrate that the operation of the floodgate will not result in adverse impacts on water quality and detail the measures taken to avoid and mitigate impacts to water quality, including consideration of acid sulfate soils.
- ✓ Demonstrate that the design and operation of the floodgate does not result in adverse impacts on fish habitat, such as limiting the health and productivity of upstream marine plants.
- ✓ Demonstrate that the design and operation of the floodgate provides hydraulic conditions that are suitable for fish passage over an adequate duration of the tidal cycle.
- ✓ Demonstrate that floodgates are designed to be operated automatically in a reliable manner.
- ✓ Provide a maintenance plan, including contingency measures. Refer to the beginning of section 5.3 for the details to be included in the maintenance plan.

5.4.2 Performance outcome 33

Floodgates should span the width of the waterway and be set so that the bottom of the floodgate is at bed level. This will ensure the greatest range of flows and fish passage can be provided through the floodgate when completely open.

Performance outcome	Acceptable outcomes
PO33 Floodgates are designed, constructed and maintained to ensure the invert is at bed level.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Provide a plan showing a cross-section of the waterway and floodgate/s, demonstrating that the invert of the floodgate is at bed level to minimise any delays in fish passage.

5.5 Temporary waterway barrier works

5.5.1 Performance outcome 34

Temporary waterway barriers are constructed for a variety of reasons and have the potential to cause adverse impacts to native fish stocks. Some commonly used temporary waterway barrier works include:

- coffer dams or bunds – for dewatering a section of a waterway to enable works to be carried out
- platforms – to enable bridge piling work to be completed
- temporary waterway crossings for vehicular access – to enable continued traffic while works are undertaken.

Temporary barriers can prevent fish movement and can impact fish habitats, such as drowning of riparian and aquatic vegetation, accelerated erosion of adjacent banks, compaction of natural bed material and the importation of unnatural sediments associated with installation of a barrier.

There are provisions under the accepted development requirements to construct temporary waterway barriers. However, temporary barriers constructed under these provisions are often not planned for appropriately and exceed the timeframes permitted under the accepted development requirements. For example, impacts such as inclement weather and workforce availability should be incorporated into planning and construction timeframes. Extensions under the accepted development requirements are not permitted. It is recommended that any temporary waterway barriers required that may be associated with permanent waterway barrier works are applied for as assessable development and incorporated holistically into the development application. This is likely to save time, money and potential compliance issues in the long-term.

It is important to ensure that the design and timing of any temporary waterway barrier works minimise impacts on fish habitats and fish passage. For example in waterways with ephemeral flows, they should be planned to be in place during the dry season and removed during times of flow so that fish passage is not limited within the waterway.

Performance outcome	Acceptable outcomes
PO34 The temporary waterway barrier works will exist only for a specified temporary period.	No acceptable outcome is prescribed

Information to be submitted with development application

- ✓ Specify the period the temporary waterway barrier works will be in place by providing a timeline detailing construction works.
- ✓ Provide a discussion around the time period required for the works and consideration of any reasonable risk to the works that would extend the works period. This may include, for example, inclement weather, restrictions due to public health and safety, planning and budgetary constraints, and sourcing of materials.
- ✓ Detail the timeframe that temporary waterway barriers will be in place in relation to the range of flow conditions expected at the site.

5.5.2 Performance outcome 35

While the temporary nature of these barriers can reduce their long-term impact on native fish stocks, they may interrupt or restrict fish movement at a critical stage of the spawning cycle or during times of high fish movement. It is therefore important to ensure that the design of the temporary barrier provides for adequate fish movement. This will depend on the species at the site requiring movement and the duration that the barrier is in place.

Performance outcome	Acceptable outcomes
PO35 The temporary waterway barrier works provide for adequate fish movement.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Provide a cross-section of the waterway showing that the temporary barrier is a partial barrier or does not constrict the area or flows of a low-flow channel.
- ✓ Provide a longitudinal section of the temporary waterway barrier in relation to the bed of the waterway upstream and downstream of the works.
- ✓ If the barrier completely blocks a waterway, demonstrate that fish movement is provided for in another way, for example, via a waterway diversion. Plans that are scaled, dated and referenced must be provided for any diversion proposed demonstrating how the waterway diversion will provide for fish passage and how the diversion ties in with the natural waterway upstream and downstream of the works.
- ✓ Provide information demonstrating that the temporary structure is only in place outside of known fish spawning or migration periods and/or that the barrier is opened periodically every five days for at least 48 hours to allow fish movement and water exchange.

5.5.3 Performance outcome 36

Temporary barriers should be in place for the least amount of time as practicable to minimise temporal impacts on fish passage. Upon removal, temporarily disturbed areas must be returned to their natural conditions to ensure that fish habitats are returned to original profiles and stability.

Performance outcome	Acceptable outcomes
PO36 The development is designed, constructed and maintained to ensure temporary barriers are removed and the bed **and** banks are returned to their original profile and stability**.**	No **acceptable** outcome is prescribed.

Information to be submitted with development application

- ✓ Provide a timeline for the development, including construction, operation and removal of temporary waterway barrier works.
- ✓ Provide a plan detailing restoration of temporarily disturbed areas to natural profiles and stability, including the bed and banks of the waterway and adjacent areas.
- ✓ Provide a plan showing proposed revegetation works to restore fish habitats.
- ✓ Demonstrate that full movement for fish will be reinstated following removal of temporary waterway barrier works.

5.5.4 Performance outcome 37

Some fish spend most of their lives in the sea and move upstream to fresh water for breeding. These species are anadromous. Others spend most of their lives in fresh water and require downstream movement to the sea to breed, which is more typical of diadromous species in Queensland. Such species are catadromous and include, but are not limited to, Barramundi (*Lates calcarifer*), Australian bass (*Macquaria novemaculeata*), Longfin eel (*Anguilla reinhardtii*) and Jungle perch (*Kuhlia rupestris*). It is important to ensure that all species, but particularly catadromous species whose life cycle depends on downstream movement, are able to move downstream.

Performance outcome	Acceptable outcomes
PO37 Temporary waterway barrier works are designed, constructed and **maintained** to allow for downstream movement during works, where required by species present.	No **acceptable** outcome is prescribed.

Information to be submitted with development application

- ✓ Detail species likely to be present at the site of the temporary waterway barrier works that require downstream movement during the works.
- ✓ Provide information regarding the provisions of the temporary waterway barrier that allow those species to move downstream, including design, construction and maintenance measures.

5.5.5 Performance outcome 38

Aquatic macrophytes play an important role in providing areas for feeding, breeding and refuge for native Australian fish. For example, the Australian lungfish lays its eggs in submerged vegetation. Altered flow regimes and temporary works may impact aquatic macrophytes and the life cycle of native Australian fish. It is important to ensure that the condition and value of aquatic macrophytes and other fish habitats is maintained or improved.

Performance outcome	Acceptable outcomes
PO38 The condition and value of aquatic macrophytes and other fish habitats is maintained.	No acceptable outcome is prescribed.

Information to be submitted with development application

- ✓ Provide photos of the area prior to the commencement of works showing the condition and value of aquatic macrophytes and fish habitats.
- ✓ Provide a discussion of the natural types and condition of aquatic macrophytes at the location of the works.
- ✓ Demonstrate how the condition and value of aquatic macrophytes will be maintained or improved.
- ✓ Propose a monitoring program that will identify the success or otherwise of the regeneration and/or restoration of fish habitats and include an alert/action component to ensure that any deficiencies in the regeneration are rectified in a timely manner.

Glossary

Declared fish habitat area see the *Fisheries Act 1994*
Note: Declared fish habitat area means an area that is declared under the *Fisheries Act 1994* to be a fish habitat area.
Note: Section 120 of the *Fisheries Act 1994* deals with declaration of fish habitat areas.

Ecologically sustainable development see section 3 of the *Fisheries Act 1994*
Note: Section 3 (5) Ecologically sustainable development means using, conserving and enhancing the community's fisheries resources and fish habitats so that—

(a) the ecological processes on which life depends are maintained; and
(b) the total quality of life, both now and in the future, can be improved.

Environmental offset see section 7 of the *Environmental Offsets Act 2014*
Note: Section (7)(2) An Environmental offset is an activity undertaken to counterbalance a significant residual impact of a prescribed activity on a prescribed environmental matter.

Fish see section 5 of the *Fisheries Act 1994*
Note: Fish:

1. Fish means an animal (whether living or dead) of a species that throughout its life cycle usually lives:
   (a) in water (whether freshwater or saltwater); or
   (b) in or on foreshores; or
   (c) in or on land under water.
2. Fish includes:
   (a) prawns, crayfish, rock lobsters, crabs and other crustaceans; and
   (b) scallops, oysters, pearl oysters and other molluscs; and
   (c) sponges, annelid worms, bêche-de-mer and other holothurians; and
   (d) trochus and green snails
3. However, fish does not include:
   (a) crocodiles, or
   (b) protected animals under the *Nature Conservation Act 1992* for which a wildlife authority or a protected area authority under that Act is required to take, keep, use, move or deal with the animal; or
   (c) pests under the *Medicines and Poisons Act 2019*; or
   (d) animals prescribed by regulation not to be fish
4. Fish also includes:
   (a) the spat, spawn and eggs of fish; and
   (b) any part of fish or spat, spawn or eggs of fish; and
   (c) treated fish, including treated spat, spawn and eggs of fish; and
   (d) coral, coral limestone, shell grit or star sand; and
   (e) freshwater or saltwater products declared under a regulation to be fish.
5. A regulation under subsection (4)(e) may declare a product to be fish only—
   (a) for a particular provision of this Act; or
   (b) if the product is used for a particular purpose.
6. Subsection (5) does not limit the *Statutory Instruments Act 1992,* section 24 or 25.

Fish habitat see the *Fisheries Act 1994*
Note: Fish habitat includes land, waters and plants associated with the life cycle of fish, and includes land and waters not presently occupied by fisheries resources.

Fish way see the *Fisheries Act 1994*
Note: Fish way means a fish ladder or another structure or device by which fish can pass through, by or over waterway barrier works.

Fisheries resources see the *Fisheries Act 1994*
Note: Fisheries resources includes fish and marine plants.

Fishery see section 7 of the *Fisheries Act 1994*
Note: Fishery includes activities by way of fishing, for example, activities specified by reference to all or any of the following—

1. a species of fish;
2. a type of fish by reference to sex, size or age or another characteristic;
3. an area;
4. a way of fishing;
5. a type of boat;
6. a class of person;
7. the purpose of an activity;
8. the effect of the activity on a fish habitat, whether or not the activity involves fishing;
9. anything else prescribed by a regulation.

Fishing see the *Fisheries Act 1994*
Note: Fishing includes—

(a) searching for, or taking, fish; and
(b) attempting to search for, or take, fish; and
(c) engaging in other activities that can reasonably be expected to result in the locating, or taking, of fish; and
(d) landing fish (from a boat or in another way), bringing fish ashore or transhipping fish.

Foreshore see the *Fisheries Act 1994*
Note: Foreshore means parts of the banks, beds, reefs, shoals, shore and other land between high water and low water.

Highest astronomical tide means the highest level of the tides that can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions.

Land includes foreshores and tidal and non-tidal land.

Legally secured offset area see section 29 of the *Environmental Offsets Act 2014*
Note:

1. An area of land is a legally secured offset area if:
   (a) the area is—
      (i) an environmental offset protection area; or
      (ii) an area declared as an area of high nature conservation value under the *Vegetation Management Act 1999*, section 19F; or
      (iii) another area prescribed under a regulation; and
   (b) under this Act or another Act, the area is subject to a delivery or management plan or agreement (however described in this Act or the other Act) to achieve a conservation outcome for a prescribed environmental matter.
2. Also, an area is a legally secured offset area if, after an offset condition is imposed on an authority—
   (a) The area is dedicated, or declared by regulation, as mentioned in the *Nature Conservation Act 1992,* section 29(1), 43D or 46; and
   (b) The area is subject to a delivery or management plan or agreement (however described in the *Nature Conservation Act 1992*) to achieve a conservation outcome for a prescribed environmental matter.
3. Also, an area is a legally secured offset area if—
   (a) Before the commencement of this Act, a condition imposed on an authority under another Act (including a condition imposed under the State Development Act) required the establishment of the area; and
   (b) The area is of a type prescribed under a regulation as legally secured for the purposes of the other Act.

Marine plant see section 8 of the *Fisheries Act 1994*
Note:

1. Marine plant includes the following:
   (a) a plant (a tidal plant) that usually grows on, or adjacent to, tidal land, whether it is living, dead, standing or fallen;
   (b) material of a tidal plant, or other plant material on tidal land;
   (c) a plant, or material of a plant, prescribed by regulation to be a marine plant.
2. A marine plant does not include a plant that is—
   (a) prohibited or restricted matter under the *Biosecurity Act 2014*; or
   Notes—
      1. See the *Biosecurity Act 2014,* schedule 1 or schedule 2.
      2. See also the note to the *Biosecurity Act 2014,* schedules 1 and 2.
   (b) controlled biosecurity matter or regulated biosecurity matter under the *Biosecurity Act 2014.*

Matters of state environmental significance see schedule 2 of the Environmental Offsets Regulation 2014
Note: Matters of state environmental significance are prescribed environmental matters under the Environmental Offsets Regulation 2014 that require an offset when a prescribed activity will have a significant residual impact on the matter. A matter of state environmental significance is any of the following matters:

1. regional ecosystems under the *Vegetation Management Act 1999* that:
   a. are endangered regional ecosystems
   b. are of concern regional ecosystems
   c. intersect with a wetland shown on the vegetation management wetlands map
   d. contain areas of essential habitat shown on the essential habitat map for an animal that is endangered wildlife or vulnerable wildlife or a plant that is endangered wildlife or vulnerable wildlife
   e. are located within the defined distances stated in the Environmental Offsets Policy 2014 from the defining banks of a relevant watercourse or drainage feature as shown on the vegetation management watercourse and drainage feature map; or
   f. are areas of land determined to be required for ecosystem functioning (‘connectivity areas’); or
2. wetlands in a wetland protection area or wetlands of high ecological significance shown on the map of referable wetlands under the Environmental Protection Regulation 2019
3. wetlands and watercourses in high ecological value waters as defined in schedule 2 of the Environmental Protection (Water and Wetland Biodiversity) Policy 2019
4. designated precincts in strategic environmental areas under the Regional Planning Interests Regulation 2014
5. threatened wildlife under the *Nature Conservation Act 1992* and special least concern animals under the Nature Conservation (Wildlife) Regulation 2006
6. protected areas under the *Nature Conservation Act 1992,* excluding coordinated conservation areas
7. highly protected zones of state marine parks under the *Marine Parks Act 2004*
8. declared fish habitat areas under the *Fisheries Act 1994*
9. waterways that provide for fish passage under the *Fisheries Act 1994* if the construction, installation or modification of waterway barrier works carried will limit the passage of fish along the waterway
10. marine plants under the *Fisheries Act 1994*; or
11. legally secured offset areas.

Offset means environmental offset under the *Environmental Offsets Act 2014*
Note: Environmental offset means an activity undertaken to counterbalance a significant residual impact of a prescribed activity on a prescribed environmental matter, delivered in accordance with the Environmental offsets framework. The prescribed environmental matters assessed under the State Development Assessment Provisions are matters of state environmental significance.

Prescribed environmental matters see the *Environmental Offsets Act 2014*
Note: A prescribed environmental matter is any species, ecosystem or other similar matter protected under Queensland legislation for which an offset may be provided. A prescribed environmental matter may be a matter of national, state or local environmental significance, however, assessment criteria in the State Development Assessment Provisions only relate to matters of state environmental significance. Each of the prescribed environmental matters are listed under the Environmental Offsets Regulation 2014.

Restoration involves actions to return a site to an agreed pre-existing condition. Implies a final objective to return all aspects of the previous system.

Significant residual impact see the *Environmental Offsets Act 2014*
Note: Significant residual impact is an impact, whether direct or indirect, of a prescribed activity on all or part of a prescribed environmental matter that:

1. remains, or will or is likely to remain, (whether temporarily or permanently) despite on-site mitigation measures for the prescribed activity
2. is, or will or is likely to be, significant.

Guidance for determining if a prescribed activity will have a significant residual impact on a matter of state environmental significance is provided in the Significant Residual Impact Guideline, Department of State Development, Infrastructure and Planning, 2014.

Tidal land see the *Fisheries Act 1994*
Note: Tidal land includes reefs, shoals and other land permanently or periodically submerged by waters subject to tidal influence.

Waterway see the *Fisheries Act 1994*
Note: Waterway includes a river, creek, stream, watercourse, drainage feature or inlet of the sea. For further guidance see fact sheet Maintaining Fish Passage in Queensland: What is a waterway?, Department of Agriculture, Fisheries and Forestry, 2014.

Waterway barrier works see the *Fisheries Act 1994*
Note: Waterway barrier works means a dam, weir or other barrier across a waterway if the barrier limits fish stock access and movement along a waterway. For further guidance see the factsheets Maintaining Fish Passage in Queensland: What is a waterway barrier work?, Department of Agriculture, Fisheries and Forestry, 2014 and Maintaining Fish Passage in Queensland: What is not a waterway barrier work?, Department of Agriculture, Fisheries and Forestry, 2014.

Wetland see Queensland Wetlands Program wetland definition
Note: Wetlands are areas of permanent or periodic/intermittent inundation, with water that is static or flowing fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 metres. To be a wetland the area must have one or more of the following attributes:

- at least periodically the land supports plants or animals that are adapted to and dependent on living in wet conditions for at least part of their life cycle, or
- the substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers, or
- the substratum is not soil and is saturated with water, or covered by water at some time.

The wetland definition used on WetlandInfo is based on the Ramsar Convention (1971) and is consistent with the definition used in the Strategy for conservation and management of Queensland's wetlands. Visit https://wetlandinfo.des.qld.gov.au

References

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Environmental Protection (Water and Wetland Biodiversity) Policy 2019 https://www.legislation.qld.gov.au/view/pdf/inforce/current/sl-2019-0156.

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Appendix 1: Criteria and capabilities of a suitably qualified and experienced fish passage professional

Specialised knowledge is required to understand the biology and behaviour of native fish and how structures can be designed or modified to provide effective fish passage. Engaging a fish passage professional to design fish passage elements of waterway barriers is more likely to result in suitable fish passage outcomes.

A fish passage professional can help accurately identify and map waterways and connected fish habitats associated with the proposal and achieve a design that meets the relevant performance outcomes for a development application involving constructing or raising waterway barrier works.

There are certain key capabilities and experience that should be considered in selecting a fish passage professional, including:

- knowledge of the aquatic biology and ecology of Queensland's native fish species, including fish behaviour, swimming ability, life cycles, and movement patterns

  and

- personal experience in the design, construction, operation, monitoring and maintenance of waterway barrier works of the type and scale being applied for – this includes rectification of designs as an outcome of monitoring.

For fish ways, a fish passage professional must be able to demonstrate how the proposed fish way design has been successfully built and commissioned to provide adequate fish passage elsewhere under similar conditions to the proposal. For example, considering size of the waterway barrier or barriers, flow capacity, fish community species composition and biomass.

It is important to note that not all fish way professionals have the experience to design all types of fish ways. Any fish way professional should demonstrate the relevant experience in the type of fish way being applied for in the development application.

Alternatively, if the fish way proposed is a new concept or design that has not yet been undertaken by the professional, a fish passage professional must be able to provide:

- evidence of how in-depth hydrological modelling / trials / scaled fluid dynamics of such concepts will work in providing fish passage
  and
- examples showing similar successful designs that have been built and commissioned to deliver expected outcomes.

Appendix 2: Fish survey guidance material

Many factors must be considered when fish surveys are undertaken. This includes, but is not limited to:

- a desktop search of species with the potential to be present within the area
- permits or approvals required to undertake sampling (e.g. a general fisheries permit under the *Fisheries Act 1994* to use regulated fishing apparatus or possess regulated fish)
- selecting an appropriate study area in relation to the proposal
- determining the timing of the fish surveys, taking into consideration time of day, period of rainfall prior to the event and seasonal or migratory patterns
- sampling replication
- sampling type – active versus passive
- gear selection (e.g. electrofishing, fyke nets, box traps) – this will be influenced by
    - the size of the species expected
    - physical parameters such as depth and habitat structure
    - boat or other accessibility
    - fish behaviour
    - water quality parameters such as turbidity, salinity
- record keeping – qualitative information (e.g. habitat complexity and condition) and quantitative information (e.g. species and size classes present)

The person or entity undertaking the surveys should be experienced in:

- the identification of native Queensland fish relevant to the region in addition to pest fish
- the use of sampling gear and methods.

Additional habitat and water quality surveys should be undertaken concurrently. These are likely to inform the presence, absence and community composition of the fish surveys.

The following documents can be used for reference:

- *Monitoring and sampling manual: Environmental protection (water) policy,* Department of Environment and Science, 2018.
- *Survey guidelines for Australia's threatened fish: Guidelines for detecting fish listed as threatened under the* Environment Protection and Biodiversity Conservation Act 1999*,* Department of Sustainability, Environment, Water, Population and Communities, 2011.

Appendix 3: Information that can assist in identifying fish habitats and connectivity between fish habitats

There are a number of spatial data layers that will assist in identifying fish habitats when planning and preparing a development application. These are outlined below, along with basic recommendations for how they are used in this context.

The following mapping layers, used in conjunction with the user guide, provide guidance on the likely location of waterways:

- Queensland waterways for waterway barrier works mapping available on the Development Assessment Mapping System (DAMS) or Queensland Globe.
- Additionally, Queensland waterways for waterway barrier works (tidal) mapping available on DAMs and Queensland Globe, provides guidance on areas likely to be considered tidal waterways.

The following mapping layer is an updated version of one of the input data sets used to create the Queensland waterways for waterway barrier works mapping:

- Watercourse mapping available on Queensland Globe (Layers>inland waters>Watercourse) displays watercourse lines that are a way or course through which water flows from time to time. These areas may constitute waterways and provide fish habitat. This layer is updated to provide a more accurate on-ground representation of paths where water flows.

The following mapping layers can be used in conjunction with aerial imagery to help identify areas that are fish habitats and areas that fish are likely to move between fish habitats:

- Queensland wetlands mapping available on Queensland Globe, shows the extensive wetland systems that occur throughout Queensland. Marine, estuarine, riverine, lacustrine and palustrine wetlands are likely to be fish habitat.
- Highest astronomical tide, available on Queensland Globe, represents an approximation of the land–tidal water interface at the highest water level that can be predicted to occur under any combination of astronomical conditions. At the available scale and currency of the spatial layer this can be used to get an idea of where this may be on a given site.

Although some of the above spatial data is available in DAMs, it is recommended that applicants undertake this review in Queensland Globe as all the above layers are available and can be more readily compared. The spatial layers can be downloaded from QSpatial for incorporation into plan-making software.

It is recommended that when the information that is available in these spatial data layers is applicable to a development proposal, the development application should show how this information has been considered in determining the extent of waterways and fish habitats that may be relevant to the proposal. It is important to understand that the scale and accuracy of this spatial data is unlikely to be ideal for interpretation at property level, as required for a development application. Nonetheless, this spatial data should be used to provide context to the scale of waterways and fish habitats near the development site.

Supporting information must clearly show the location of waterways and the various fish habitats in relation to the development proposal.