

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

Table 18.2.2: Operational work

Performance outcomes	Acceptable outcomes	Response
All development		
PO1 There is a demonstrated need for the development and alternatives (locations and designs) which do not involve constructing or raising waterway barrier works are not viable.	No acceptable outcome is prescribed.	No alternative irrigation storage development option is available at this site.
PO2 Development has a functional requirement to be located within a waterway. Ancillary elements of development occur outside the waterway.  Note: Bed and banks of the waterway and any associated wetlands and riparian areas within the development site should be accurately identified on plans provided with the application, together with the location of highest astronomical tide, mean high water spring and mean low water spring tide heights if the waterway is tidal.	No acceptable outcome is prescribed.	The dam will capture overland flow and must necessarily be located within the drainage feature. Ancillary structures, (spillways and fish-way), will be located outside the drainage feature.
PO3 The number and extent of waterway barrier works and the spatial and temporal extent of their impacts on waterways providing for fish passage are minimised.	No acceptable outcome is prescribed.	Additional irrigation storages are planned for the future; however they will be located on other drainage features distant from this site.

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<p>PO4 For the life of the barrier, adequate fish passage must be provided and maintained at all waterway barrier works through:</p> <p>fish way(s) that adequately provide for the movement of fish; or</p> <p>the movement of fish is adequately provided for in another way.</p>	<p>For all crossings:</p> <p>AO4.1 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.</p> <p>AND</p>	<p>The fish-way, as designed, will allow fish passage during over-flow events, i.e. during the wet season, which is when fish migration is most likely to occur.</p>
	<p>AO4.2 For the life of the crossing, the relative levels of:</p> <p>a bed level crossing or a culvert invert</p> <p>bed erosion protection apron scour protection; and</p> <p>the stream bed are maintained to avoid drops in elevation at their joins.</p> <p>AND</p>	N/A
	<p>AO4.3 The crossing and associated erosion protection structures are installed at no steeper gradient than the <b>waterway</b> bed gradient.</p> <p>AND</p>	N/A
	<p>AO4.4 The crossing and associated erosion protection structures are roughened throughout to approximately simulate natural bed conditions.</p> <p>AND</p>	N/A
	<p>AO4.5 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.</p> <p>AND</p>	N/A

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	For waterway crossings other than bridges and culverts:  AO4.6 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	N/A
	AO4.7 The lowest point of the crossing is installed at the level of the lowest point of the natural stream bed (pre-construction), within the footprint of the proposed crossing. AND	N/A
	AO4.8 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	N/A
	AO4.9 The level of the remainder of the crossing is no higher than the lowest point of the natural stream bed outside of the low flow channel. AND	N/A
	For bridges:  AO4.10 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 in-stream are minimised. AND	N/A
	AO4.11 Bridge abutments and bank revetment works do not extend into the <b>waterway</b> beyond the toes of the banks. AND	N/A

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	AO4.12 Suitable fish habitats are maintained within the low-flow channel. AND	N/A
	For culverts:  AO4.13 Culverts are only installed where the site conditions do not allow for a bridge. AND	N/A
	AO4.14 The combined width of the culvert cell apertures are equal to 100 percent of the <b>main channel</b> width. AND	N/A
	AO4.15 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 stream bed; or (3) the base of the culvert cell and any instream scour protection is roughened throughout to approximately simulate natural bed conditions. AND	N/A
	AO4.16 The outermost culvert cells incorporate roughening elements such as baffles on their bankside sidewalls. AND	N/A
	AO4.17 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	N/A

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	AO4.18 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	N/A
	AO4.19 Culvert alignment to the stream flow minimises water turbulence. AND	N/A
	AO4.20 There is sufficient light at the entrance to and through the culvert so that <b>fish</b> are not discouraged by a sudden darkness. AND	N/A
	AO4.21 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	N/A
	AO4.22 For culvert crossings designed with a flood immunity ARI greater than 50 years, <b>fish</b> passage is provided up to culvert capacity.  For all other development no acceptable outcome is prescribed.	N/A
<p>(4) PO5 <b>Waterway</b> barrier works are designed, constructed, operated and maintained to provide lateral and longitudinal <b>fish</b> passage for all members of the fish community, regardless of size, species, life-stage or swimming ability, and accommodating future and seasonal increases in fish biomass.</p> <p>(5)</p> <p>(6) Note: In order to demonstrate compliance with this performance outcome, the seasonal and flow related biomass of the fish</p>	No acceptable outcome is prescribed.	<p>Australasian Fish Passage Services have assessed the design of the fishway and have deemed the design suitable to provide effective fish passage for all species likely to be present in this up-stream aquatic system.</p> <p>Mr. Tim Marsden of Australasian Fish Passage Services is adequately qualified and experienced to assess the adequacy of the fishway design.</p>

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<p>community at the location of the proposed waterway barrier works will need 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.</p> <p>(7)</p> <p>(8) Longitudinal fish passage refers to the movement into both permanent and temporary offstream systems, including wetlands, lagoons, floodplain etc. Fragmentation of connectivity into and out of these systems must be mitigated via adequate fish passage.</p> <p>(9)</p>		<p>The design of the channel has ensured that there are no barriers within the channel, enabling adequate longitudinal passage. There is no floodplain at the site so lateral passage is not required.</p>
<p>PO6 Development is designed and operated so that all components of <b>waterway</b> barrier works (for example scour protection, intake and outlet structures, spillway, stilling basin, apron and dissipation structures) and all pathways of potential fish movement provide safe <b>fish</b> passage.</p> <p>Stepped spillways (including sheet pile weirs) are not acceptable.</p> <p>Note: Stepped spillway (including sheet pile weirs) have been associated with high mortalities and injuries to fish.</p> <p>Assessment of this performance outcome will include consideration of adequate tailwater depth at the toe of the spillway (for example: stilling basin) at commencement to spill (for example: 30 percent of the head difference).</p>	No acceptable outcome is prescribed.	<p>The fishway inlet, channel and stream outlet are simple gravity structures that afford unrestricted fish passage whenever there is flow in the system. These structures will require only minimal maintenance to ensure continuing successful operation.</p> <p>The fishway inlet is 2 m wide with a flow depth of 0.3 m</p> <p>The fishway channel has a base-width of 1.8 m, side batters of 2:1 and mean gradient of 5 %.</p> <p>Resting pools with dimensions of approx. 3 m W x 4 m L x 0.6 m D are located at 20 m intervals along the fishway channel.</p>

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<p>PO7 The drownout characteristics of the waterway barrier works and the frequency, timing and duration of drownout conditions will provide adequate fish passage for the fish community and biomass moving past the barrier.</p> <p>Note: Determining adequacy of fish passage will involve consideration of passage achieved during drownout and during other hydraulic conditions and the relative frequencies of these conditions among other things.</p>	No acceptable outcome is prescribed.	The fishway design maintains conditions that are suitable for all the fish species and life stages that are likely to be encountered at the site as the channel forms the entire stream.
<p>PO8 Development does not increase the risk of mortality, disease or injury, or compromise the health, productivity, marketability or suitability for human consumption of fisheries resources, having regard to (but not limited to):</p> <ul style="list-style-type: none"> <li>biotic and abiotic conditions, such as water and sediment quality</li> <li>substances that are toxic to plants or toxic to or cumulative within fish</li> <li>design of structures</li> <li>impacts on reproductive success</li> <li>effect on fish energy reserves</li> <li>whether fish may be physically damaged, injured, killed, trapped or stranded</li> <li>fish passage and access to habitat generally; and</li> </ul>	No acceptable outcome is prescribed.	<p>The fishway channel mimics the natural stream channel and will present no more of a challenge to fish health than ordinarily encountered in the natural environment.</p> <p>Given the location of this development, it is unlikely that any significant fisheries resources will establish to effect human health. The contributing catchment is devoid of any development, so water and sediment quality is expected to be very high. Sediment load will be minimal.</p>

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<p>the impacts of pest fish and other relevant pest species.</p> <p>Note: A fish salvage plan may be required to demonstrate compliance with the performance outcome and may form a condition of any approval.</p> <p>Permits or other authorities may be required under the <i>Fisheries Act 1994</i> for the use of regulated fishing apparatus and to possess fisheries resources.</p>		
<p>PO9 Development:</p> <p>avoids non-essential hardening or unnatural modification of the main channel of the waterway</p> <p>retains natural fish habitat and features such as rock outcrops and boulders, wherever possible</p> <p>avoids channelisation (i.e. straightening) of meandering <b>waterways</b> or where channels need to be significantly modified, simulates natural watercourses and habitat features (for example, by including meanders, pools, riffles, shaded and open sections, deep and shallow sections and different types of substrata); and</p> <p>avoids construction during times of elevated flows.</p>	No acceptable outcome is prescribed.	The design of the fishway inlet and channel incorporate natural features and materials that are very similar to the gully down-stream of the proposed dam embankment. Excavation of the channel and “rough” excavation of the resting pools will replicate the natural system.



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PO10 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.	There are no existing barrier works in the drainage feature down-stream of the proposed dam. There is a very small stock-water dam up-stream of the proposed embankment, which will be inundated by the proposed development.
PO11 Sufficient water exchange and flow is maintained and provided to sustain and where necessary restore, water quality and the health and condition of fisheries resources, ecological functions and fish passage.	No acceptable outcome is prescribed.	The fish-way, as designed, will allow fish passage during over-flow events, i.e. during the wet season, which is when fish migration is most likely to occur
PO12 Development likely to cause drainage or disturbance to acid sulfate soils, prevents the release of contaminants and impacts on fisheries resources and fish habitats.  Note: Management of acid sulfate soil is consistent with the current Queensland acid sulfate soil technical manual: Soil Management Guidelines V4.0, Department of Science, Information Technology, Innovation and the Arts, 2014.	No acceptable outcome is prescribed.	No acid-sulphate soils occur in the vicinity.
PO13 Construction avoids direct and indirect disturbance, or where avoidance is not possible, minimises direct and indirect disturbance to beds, banks and vegetation adjacent to the permanent development footprint.	No acceptable outcome is prescribed.	The development will result in removal of native vegetation, by impoundment, up to the level of the dam's normal full supply level, which is controlled by the elevation of the fishway inlet. Native vegetation will also be cleared to allow construction of the spillways and fishway channel. There is no intention to remove native vegetation from areas adjacent to the development.
PO14 After completion of in-stream 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 <b>fish</b>	No acceptable outcome is prescribed.	There will be no disturbance of the bed and banks of the drainage feature outside of the development area. There are no existing natural fish habitats.

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<p><b>habitats.</b></p> <p>Note: Monitoring of the success of fish habitat regeneration, within and adjacent to the work site, is likely to be conditioned as part of any development approval.</p>		
<p>PO15 The natural substrate of the <b>waterway</b> bed is retained or reconstructed so that the post-construction substrate is comparable to the natural substrate; for example in terms of size and consistency.</p>	No acceptable outcome is prescribed.	No change to the natural substrate of the bed of the drainage feature is anticipated.
<p>PO16 Development does not adversely impact on community access to tidal land and waterways.</p>	No acceptable outcome is prescribed.	N/A
<p>PO17 Development does not adversely impact on community access to fisheries resources and fish habitats including recreational and indigenous fishing access.</p> <p>Note: 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.</p>	No acceptable outcome is prescribed.	N/A
<p>PO18 Development does not adversely impact on commercial fishing access and linkages between a commercial fishery and infrastructure, services and facilities.</p> <p>Note: In some cases, compensation for impact on fisheries access, operations and/or productivity may be necessary. The Guideline on fisheries adjustment provides advice for</p>	No acceptable outcome is prescribed.	N/A

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proponents on relevant fisheries adjustment processes and is available by request from the Department of Agriculture and Fisheries.		
Development involving fish ways		
PO19 Having regard to the hydrology of the site and fish movement characteristics, the fish way is capable of operating, and will operate: for as long as the waterway barrier work is in position; and whenever there are inflows into the impoundment or waterway, release out of the impoundment and during overtopping events; and when the impoundment is above dead storage level.	AO19.1 For the life of the waterway barrier works, the lower operational range of the fish way is at least: 0.5 metres below minimum headwater drawdown level; and 0.5 metres below minimum tail water level at the site.	The fish-way, as designed, will allow fish passage during over-flow events, i.e. during the wet season, which is the only time in this arid-tropical environment when fish migration is likely to occur
PO20 For the life of the waterway barrier works, the hydrology of the development allows for adequate fish movement.	AO20.1 The lower operational range of the fish way is at least: 0.5 metres below minimum headwater drawdown level; and 0.5 metres below minimum tail water level at the site.	As above
PO21 Fish way maximises fish movement by providing:  continuous attraction flows at the fish way entrance under all flow conditions within the fish way's operating range  additional means of fish attraction are included in the fish way design if appropriate  attraction flow velocities are sufficient and variable to attract the whole fish community, and expected future and seasonal biomass  adequate holding chamber capacity for the	No acceptable outcome is prescribed.	As above. No further comment is warranted due to the perceived lack of extended natural flow duration and expected low fish population.

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<p>expected fish biomass in any lock, lift, trap and transfer type fish ways</p> <p>adequate exit conditions for downstream fish passage; and</p> <p>for future adjustments in capacity or operation that may be needed once in place.</p>		
<p>PO22 Fish ways are designed so that:</p> <p>water intakes, outlets, screens and other structures do not cause entrainment, injury or mortality to fish</p> <p>appropriate light levels are maintained at entrances, exits and throughout the fish way to ensure successful use by fish</p> <p>fish attracted to the spillway or outlet flows are able to access the fish way without having to swim back downstream</p> <p>fish are able to exit upstream and downstream fish ways at a water levels over the full range of tailwater and headwater levels</p> <p>exits are located to avoid fish being washed back over the spillway during overtopping</p> <p>adequate hydraulic conditions and minimum water depth for fish passage is maintained</p>	No acceptable outcome is prescribed.	<p>The design of the fishway inlet, channel, and outlet incorporate natural features and materials that are very similar to the gully down-stream of the proposed dam embankment. Excavation of the channel and “rough” excavation of the resting pools will replicate the natural system. Adequate fish passage, both up-stream and down-stream will be afforded to fish species at either end of the spillway over-flow hydrograph.</p> <p>Excavation of the fishway channel into natural rocky terrain will result in a rough surface that, along with deeper resting pools, will afford as much or more refuge from predators than in the existing natural system.</p> <p>Unlike urban catchments, rubbish and debris are not likely to be an issue in this natural, relatively pristine, environment.</p> <p>The fishway is designed to operate whenever there is flow over the spillway. It is anticipated that the dam will fill relatively quickly during storm events or the wet-season monsoon, so there will be minimal delay from commencement of flow to dam spilling and the fishway operating</p>

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<p>throughout the fish way</p> <p>predation on fish using the fish way is avoided</p> <p>rubbish and debris do not impede fish passage or cause blockages or damage the fish way</p> <p>delays in fish movement are avoided when fish are undertaking upstream spawning migrations; and</p> <p>delays in fish movement are avoided immediately after times when there have been flows in the system but no fish passage in the rising hydrograph.</p>		<p>Prior to operation of the spillway/s and after cessation of spillway flows, fish will have exclusive access and egress, as the only flow in the system will be via the fishway.</p> <p>As flow in this system will only occur for a few days in the wet season, with no extraction from the dam, it is not anticipated that there will be long periods of inflow into the dam with no outflows from the dam. As such, the fishway will operate once the dam reaches FSL, which will be only a minor delay from the commencement of inflows. Extending the range below this level is not justified in these circumstances.</p>
PO23 All water releases are directed through the <b>fish way</b> as a priority over the outlet works.	No acceptable outcome is prescribed.	The inlet level of the fishway is 250 mm below the level of the primary spillway. Thus, the fishway will provide fish passage for the entire duration of the hydrograph, particularly tail-water flows when flow over the spillway ceases.
<p>PO24 All flows and releases initiate and terminate adjacent to the fish way or are directed parallel to the fish way entrance and all flows are transferred to the fish way as soon as possible during a flow recession.</p> <p>Note: Flows and releases include but are not limited to spillway overtopping and outlet flows. Such flows must not compete with fish way attraction flows or reduce the operation of a fish way.</p>	No acceptable outcome is prescribed.	As above

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<p>PO25 Mechanisms are in place to ensure that operational issues in <b>fish ways</b> are promptly rectified for the life of the <b>fish way including but not limited to:</b>  all components are designed to be durable, reliable and adequately protected from damage during high flow and flood events  all components can be replaced; and  a contingency plan ensures provision of alternate adequate fish passage during the fish way re-instatement process.</p> <p>Note: Fish way downtime greater than 14 consecutive calendar days is likely to have a significant impact to fisheries resources.</p>	No acceptable outcome is prescribed.	<p>The fishway comprises concrete and durable, natural materials that are unlikely to be damaged during the course of a significant spillway flow event.</p> <p>As the catchment of the dam is less than 500 ha, fishway operation is expected to be episodic, with duration of days rather than weeks. Therefore ample opportunity will be available to rectify any damage or carry-out maintenance between operation events.</p>
<p>PO26 Development provides for:</p> <p>installation of monitoring equipment (such as traps and lifting equipment); and access for monitoring, maintenance and operational purposes.</p>	No acceptable outcome is prescribed.	Suitable access will be provided to sections of the fishway to allow trapping of fish, if any, for monitoring purposes. It is not considered that fish populations will be sufficient to warrant a formal monitoring program. A suitable level of monitoring may be by simple visual assessment of the fishway in operation.
PO27 Water supply for the fish ways and attraction flows are sourced from surface quality water or equivalent water quality.	No acceptable outcome is prescribed.	Water supply from natural catchment and dam storage will be of very good quality.
PO28 Tailwater control structures such as a gauging weir, rock bar or stream crossings are fitted with a <b>fish way</b> or designed to provide <b>fish</b> passage.	No acceptable outcome is prescribed.	No downstream control structures exist nor are any planned.
Development involving floodgates		
<p>PO29 Floodgates are designed and operated:</p> <p>to provide hydraulic conditions adequate for fish passage over an adequate duration of the tidal cycle; and as tidally activated,</p>	No acceptable outcome is prescribed.	The dam design does not include flood-gates nor any other spillway control structure.

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automatic floodgates.		
PO30 The invert of the floodgate is at bed level.	No acceptable outcome is prescribed.	N/A
PO31 The operation of the floodgate will not result in adverse impacts on water quality that may harm <b>fish</b> or <b>fish habitat</b> .	No acceptable outcome is prescribed.	N/A
Temporary waterway barrier works		
PO32 The temporary <b>waterway barrier works</b> will exist only for a specified temporary period and provide for adequate <b>fish</b> movement.	AO32.1 The temporary waterway barrier work: is a partial barrier, or does not constrict the area or flows of a low flow channel.	The proposed dam will be a permanent structure.
	AND one of the following acceptable outcomes apply:  AO32.2 The temporary structure is only in place outside of known fish spawning or migration periods. OR	N/A
	AO32.3 The barrier is opened periodically every five days for at least 48 hours to allow <b>fish</b> movement and water exchange. OR	N/A