Using spoiler baffles to improve fish passage

New Zealand Fish Passage Advisory Group

What are spoiler baffles and why should they be used?

Spoiler baffles can be installed in culverts or on instream structures to reduce the water velocity and/or increase the water depth, improving fish passage. They are one of the remediation techniques recommended in the **New Zealand Fish Passage Guidelines** for improving fish passage in existing culvert barriers.

Spoiler baffles consist of rectangular blocks set in a staggered configuration that slow and disperse the flow of water near the bed. They provide deeper water and resting zones behind the blocks and a low-velocity path through the culvert, making it easier for fish to move upstream or downstream through or over a structure.

A range of baffle designs are available, but spoiler baffle designs are the solution recommended by the New Zealand Fish Passage Guidelines for enhancing fish passage in culverts with diameters ≥1.2 m

When can they be used?

This factsheet focuses on installing spoiler baffles in the base of existing circular and box culverts (**Figure 1**), which is their main recommended use. However, they are also sometimes installed on the face of smooth concrete aprons, fish ramps and weirs. They should not be required in new culverts that have been installed in accordance with the design principles set out in the New Zealand Fish Passage Guidelines.

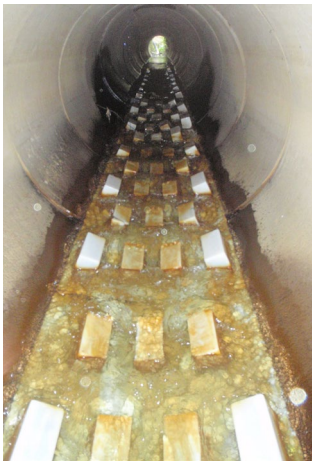

Figure 1. Spoiler baffle sheets installed inside a circular culvert. *Photo: Paul Franklin (NIWA)*

Spoiler baffles are promoted for use in culverts with diameters ≥1.2 m, as retrofitting baffles in culverts smaller than this will often be impractical or would likely reduce the culvert's conveyance capacity. Spoiler baffles may also be less effective in corrugated pipes where the baffle sheets cannot be securely sealed to the floor. Therefore, other remediation options may be more suitable in smaller culverts and corrugated culverts.

Although the installation of baffles in culverts has major benefits for fish, baffles will also decrease culvert capacity, increase roughness and may increase the risk of blockage by debris. Therefore, as with any other remediation technique, their use should be carefully considered, and monitoring and maintenance, including the removal of any accumulation of debris after high flows, will be important over the long term.

Recommended specifications

The baffle size should be adjusted to suit the target fish species, culvert size and range of flows over which the fish must pass.

For culvert slopes up to 2% (1.15° or 1:50), it is currently recommended that rectangular baffles (0.25 m long × 0.12 m wide × 0.12 m high) are installed in a staggered configuration with 0.2 m spaces between the rows and 0.12 m spaces between blocks within the rows (**Figure 2**).

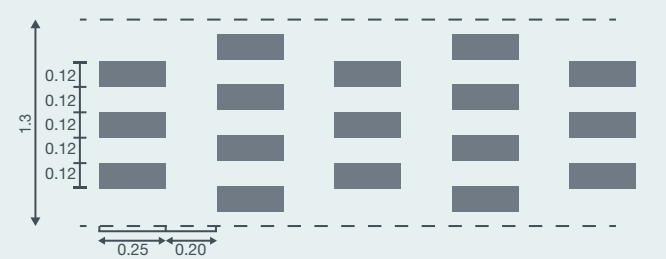

Figure 2. Plan view of the recommended spoiler baffle arrangement within a 1.3-m-diameter culvert. Source: New Zealand Fish Passage Guidelines.

This spacing will help ensure that small fish such as īnanga (*Galaxias maculatus*) are able to use the resting areas created between the rows of baffles, while still providing sufficient room for large galaxiids, such as adult kōaro (*G. brevipinnis*) and banded kōkopu (*G. fasciatus*), and other adult native fishes to pass through.

For culvert slopes >2%, it may be necessary to adapt the size and shape of spoiler baffles to ensure suitable conditions are available for fish passage. For example, research has indicated that smaller baffles (0.12 m × 0.12 m × 0.12 m) with the same configuration and spacing as outlined above may be more effective at reducing water velocities in culvert barrels with slopes of 3% (1.72°) (Stevenson et al. 2008). For different structure situations where guidance is not yet available, information within Stevenson et al. (2008) and from 3D computational fluid dynamics (CFD) modelling could be used as a starting point to guide the size and configuration of baffles to improve fish passage. However, outcome monitoring will be required with any novel configurations as their effectiveness has yet to be evaluated.

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As a general rule of thumb, the baffles should cover approximately one-third of the circular culvert's internal circumference. **Table 1** provides a guide to the number of baffles required for circular culverts of different sizes.

Table 1. Guide to the number of baffles required for different circular culvert diameters. Source: New Zealand Fish Passage Guidelines.

Culvert diameter (m)	No. baffles in alternating rows
1.2	5 & 6
1.5	6 & 7
1.8	7 & 8
2.1	9 & 10
2.4	10 & 11

Where to source spoiler baffles

Baffles can be installed as individual blocks or fitted as moulded sheets.

Individual blocks can be made manually or bought from hardware companies if the dimensions are correct.

Pre-moulded, UV-stabilised polyethylene sheets of spoiler baffles can be purchased from **Rotational Plastics**. There are currently three spoiler baffle sheets for sale, but only one of these (2440 mm × 940 mm × 125 mm) meets the design that has been tested and is known to improve fish passage through culverts with a slope of up to 2%. If other spoiler baffle sheets are purchased, outcome monitoring will be required to ensure they improve fish passage.

How to install spoiler baffles

Before installing spoiler baffles, please check with your local regional council if any approvals are required.

Individual blocks may be relatively cheap to construct but time consuming to install, especially in larger culverts. It is recommended that the blocks are bolted in place where possible, but they can also be glued or cemented onto the culvert base, with the most suitable method depending on the long-term stream and culvert conditions, any approvals required to undertake the works, and which method will result in the most effective and long-term attachment.

Moulded sheets will be quicker to install. It is important that they are fixed to the base of the culvert securely to avoid water flowing under them, which may cause them to lift and fail. Moulded baffle sheets can be attached to the base of concrete, plastic or metal culverts using a variety of fixing types, such as anchor screws or wedge anchors. Fixings required will depend on the culvert material, structural integrity, anticipated hydraulic and bedload forces (especially in steep rocky streams), and thickness of the culvert you are installing them into. It will be important to determine the hydraulic impact and impact forces anticipated from bedload or debris at the culvert to ensure the attachment design will work and this will warn if the forces are likely to exceed the strength of baffle sheet material. A suitably experienced engineer or appropriately qualified practitioner should determine the appropriate fixings on a case by case basis.

Multiple fixings are required on both the ends and sides of each baffle sheet. The sheets should be overlapped for installation (50 mm), with the upstream baffle sheet lying over the downstream baffle sheet. The first row of baffles should be attached flush to the end of the pipe at the culvert inlet and it is recommended that the first row of baffles should have the lesser number of baffles (as per **Figure 2** above). Baffles should be fixed to the culvert aprons (if there are any) as well as within the culvert pipe. Water will likely need to be diverted during installation, and other safety precautions will need to be taken whilst working in a confined space. As an example, the moulded baffle sheets have been attached using 10-12mm dynabolts when installing into typical long concrete culvert, with at least 4-6 fixings on the leading edge, when adhesion is a concern.

References and additional resources

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Further information

For general fish passage information, guidance and case studies, visit **www.doc.govt.nz/fishpassage** or contact the **New Zealand Fish Passage Advisory Group** or your local council or Department of Conservation office.