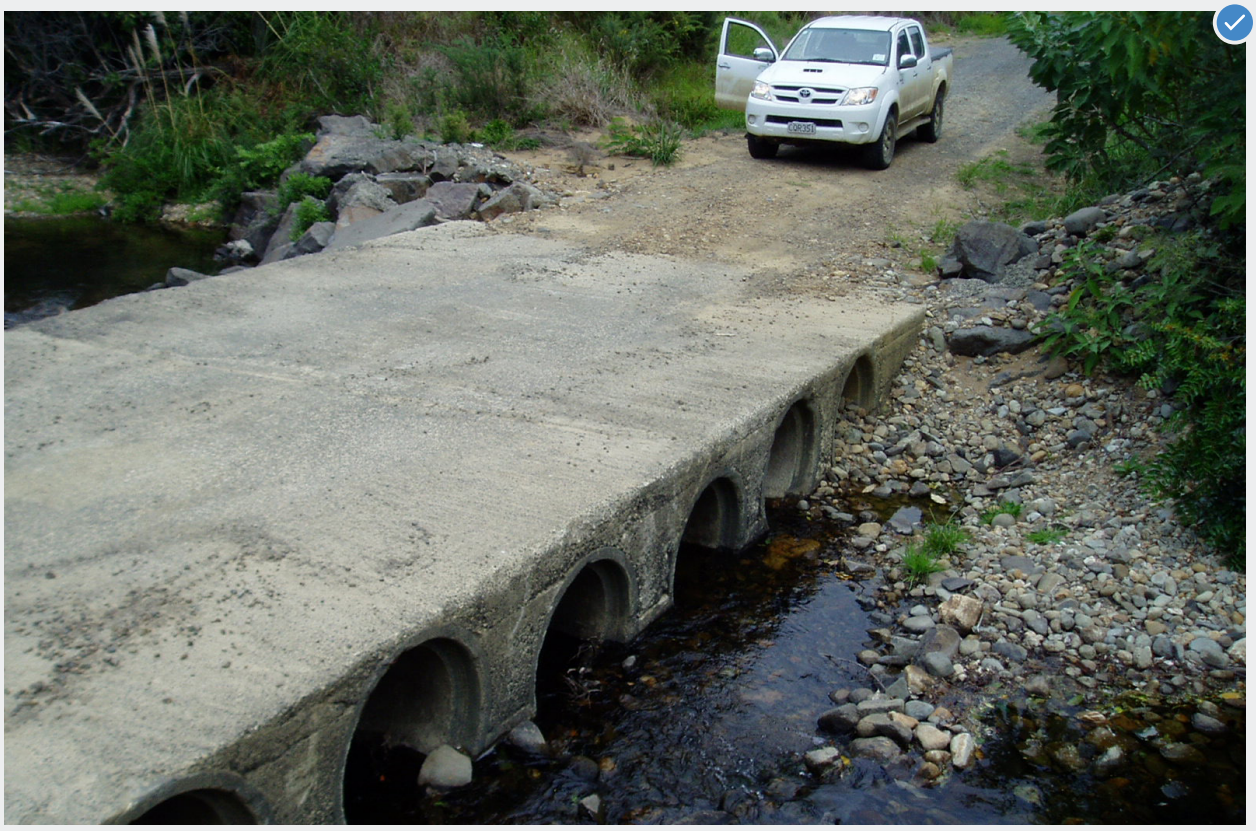
Forest Practice Guide

Non-Regulatory

Crossings
3.1 Battery Culvert River Crossings

Battery *culverts* are a series of pipe or box *culverts* installed alongside each other to form a low profile crossing. The *river's* base flow passes through the *culverts*, but during flood events, water flows over the top of the crossing. This allows for the dry passage of vehicles in base flow conditions but may result in the road occasionally being closed to vehicles for short periods during flood flow. Battery *culverts* need careful planning and installation to prevent failure.



Fit for purpose battery *culvert*.

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A Where and when to use

1. Where fording the bed of a *river* would generate fine *sediment*.
2. Where there will be more than 20 axle crossings per day.
3. Where the installation of a single *culvert* to carry the full design flood flow is impractical.
4. Where a bridge is too expensive or has other design challenges.

B Where not to use

1. In *river* reaches that are susceptible to high rates of bed load movement, as this can result in blocked *culvert* pipes.
2. In high gradient, high energy *rivers* or *river* beds that are mobile and unconsolidated.
3. In reaches of *rivers* with large mobile boulders of a similar size to the *culvert* pipe diameters as these boulders can become lodged inside the *culvert* pipes, resulting in blockages.

C 4. Design

1. To reduce scour of the approaches, locate the crossing on a straight section of *river*, if possible.
2. Ensure the approaches are perpendicular to the *river*, so that water does not get directed to either end of the structure.
3. Ensure carriageway height is above base to moderate flows, to limit crossing closure.
4. Ensure approaches have suitable gradient and transitions so that vehicles are not grounded, especially low loader transporters.
5. Design to resist hydraulic pressure and erosion effects during flood flow conditions or debris flows. This may require reinforced aprons or deeply set rip rap on the outflow of the crossing.
6. Design to resist damage or blockage from woody debris. This may require the design of flared or chamfered *culvert* inlets or *slash* deflectors.
7. Ensure upstream and downstream passage of fish is maintained except where approved by a relevant fisheries manager (e.g. to protect populations of upland native galaxids from predation by introduced fish species such as trout).
8. Avoid locations that alter the natural course and gradient of the *river* channel or create erosion of the banks and bed of the *river*.
9. Determine the correct type and size of *culvert* pipes for the structure. Calculate the flood design and use engineering formulae to determine the required *culvert* size (refer to Schedule 2 of the NES-PF for design flood flow calculators and or https://stream-explorer.niwa.co.nz). In higher risk situations, consult with a forest engineer, hydrologist or other specialist to help with design and construction if necessary. Given the costs and risks involved, it is recommended that flood design calculations are peer reviewed.
    a. Reinforced concrete pipes have very good hydraulic characteristics as they are smooth and have a high load bearing capacity – but they may create a barrier to fish passage.
    b. Use existing structures, where present, as a tool to gauge the *culvert* pipe size against that derived from the flow calculations.
    c. Ensure the contributing *catchment* area and average annual flow are considered.

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D Construction

Ensure the installation specifications and procedures are followed.

1. Construct in suitable weather and with low base water flow.
2. Check for any fish spawning timing constraints under the NES-PF.
3. Limit earthwork disturbance to the immediate construction site, which will include an area upstream and downstream of the crossing.
4. Minimise the need for machinery to operate in flowing water.
5. Wet or curing concrete must not be in contact with flowing water. Cement is a contaminant and is toxic to invertebrates and fish. When pouring concrete, the water channel will need to be temporarily diverted.
6. Elevated *sediment* discharge levels will occur during construction, but must not occur for more than eight consecutive hours.
7. Divert water flow around the construction site to assist in the foundation work, reduce the risk of contaminants entering water, and minimise discharge of *sediment*.
8. Excavate the crossing bed, as required, to the correct depth and grade.
9. Ensure one of the *culverts* is at least 100 mm below *river* bed level and located to carry low or base flow. This will allow for fish passage.
10. Take care not to damage the *culverts* during installation. Concrete pipes are heavy, hard to place into position and need heavy equipment to transport, load, unload, and position them.
11. Bed *culverts* so they lie flat and are supported on a firm or concrete base.
12. Ensure *culvert* pipes lie at or below the natural *stream* gradient, otherwise they may create plunge pool erosion in the bed of the watercourse at the outfall of the *culverts*.
13. *Stabilise* the banks upstream of the structure inlet, if necessary, to prevent bank erosion.
14. Protect the inlet and outlet of the structure. Armour outlets with concrete aprons, rip rap, *reno mattress*, or other energy dissipating structures. Inlets are best protected by having deflectors that force most woody debris up and over the structure.
15. Limit *sedimentation* entering the crossing from the approaches by:
    a. Diverting road surface water off the approaches, as close as practicable to the structure, and ideally within 10 m. To limit *sediment* entry into the *river* use stormwater and *sediment* control measures such as *berms*, *cut-outs*, *water table* drains and *culverts*, *flumes* and *sediment* traps. Build these above the annual flood flow level.
    b. Avoiding long steep road approaches as these are ongoing sources of *sediment*.
    c. Using clean gravel on approaches where the existing road surface could create a *sedimentation* problem.
16. Check regularly during and on completion of construction. If the work does not meet the design plan and standards then initiate corrective actions.

E Maintenance

1. Prepare a routine maintenance plan including heavy rainfall response measures.
2. Check new structures after a flood flow. Initially they can require regular maintenance especially to the headwall, *batters* and outlet. Fix any issues promptly.

F Other methods

1. Fords, drift decks or bridges are alternate structures (note NES-PF truck movement limitation for fords).

National Environmental Standards for Plantation Forestry

Particular relevant provisions for crossings are Regulations 38 – 49.

Refer also to the Department of Conservation **Fish Passage Guidelines**: https://www.doc.govt.nz/nature/habitats/freshwater/fish-passage-management/nz-fish-passage-guidelines/

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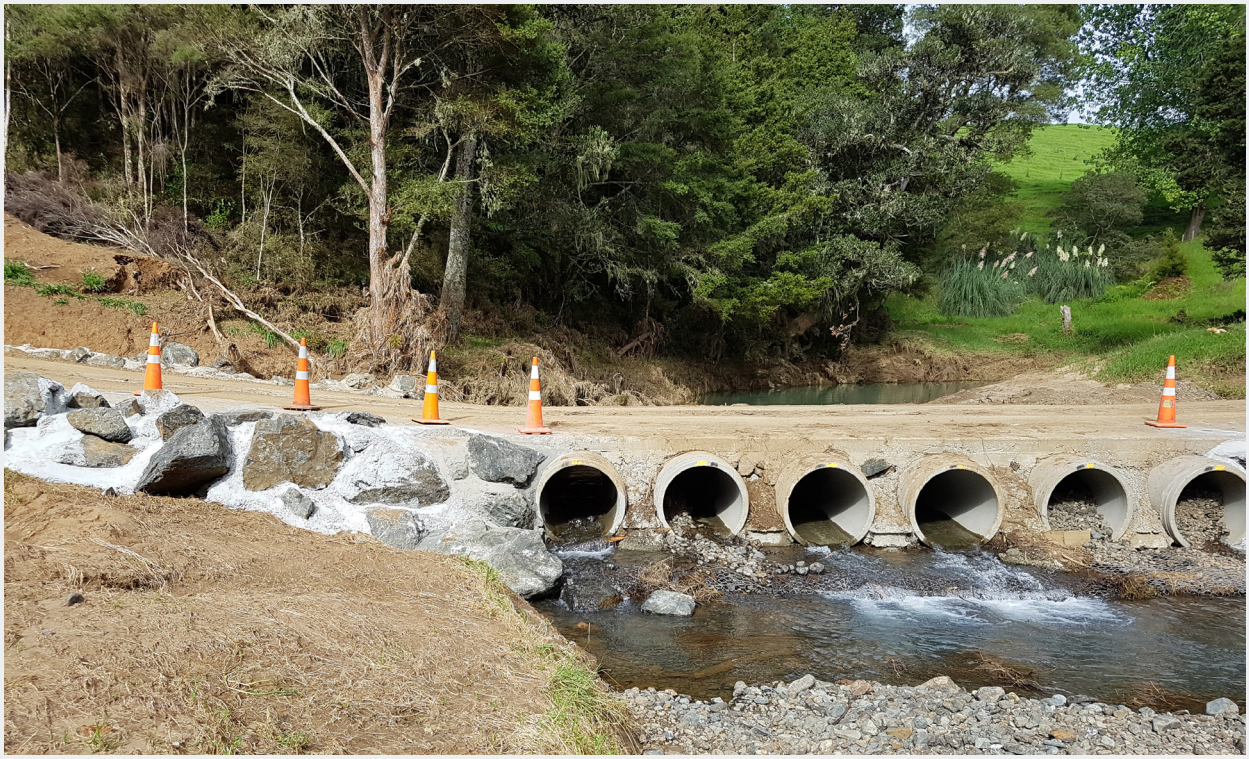
Example



Battery *culverts* must provide for the *river's* base flow, with at least one pipe buried 100 mm into the *river* bed. Note the side wall overflow protection works.

Contact

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