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.
Crossings
3.1 Battery Culvert River Crossings

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 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.
Crossings
3.1 Battery Culvert River Crossings

**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.

**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.

**Other methods**

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

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*National Environmental Standards for Plantation Forestry*
Particular relevant provisions for crossings are Regulations 38 – 49.
Crossings
3.1 Battery Culvert River Crossings

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.

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Other Practice Guides in this series

3.1 Battery Culvert River Crossings
3.2 Drift Deck River Crossings
3.3 Ford Crossings
3.4 Single Culvert River Crossings
3.5 Single Span Bridge River Crossings
3.6 Temporary Crossings

Visit: https://docs.nzfoa.org.nz/forest-practice-guides/ to view all guides