GUIDELINES FOR THE CROSSING OF WATERCOURSES DURING THE CONSTRUCTION OF NATIONAL ROAD SCHEMES

NRA
National Roads Authority
An tÚdarás um Bóithre Náisiúnta

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ENVIRONMENTAL SERIES ON CONSTRUCTION IMPACTS

GUIDELINES FOR THE CROSSING OF WATERCOURSES DURING THE CONSTRUCTION OF NATIONAL ROAD SCHEMES

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INTRODUCTION

The construction of structures crossing watercourses (e.g. bridges and culverts) is one of the more common engineering activities undertaken during road scheme development. Common impacts on natural watercourses that can potentially result from the construction and operation of such structures include:

- interference with fish migration and spawning, mammal movement, rare plants and their habitats and with riparian and linear wildlife corridors,
- loss of aquatic and riparian habitat,
- alteration of flow regime,
- harmful discharges during construction and operation, and
- interference with angling or obstruction of angler's movement along a channel.

These impacts can, however, be minimised by applying sound design principles to the structures and by following good work practices during their construction. During road scheme planning and the Environmental Impact Assessment (EIA) process, consideration will have been given to the avoidance of sensitive stretches of watercourses (such as freshwater mussel, salmonid or lamprey spawning areas) and, where feasible, to minimising impacts through appropriate mitigation measures, e.g. design of crossings with fish-passage facilities. This approach to mitigation is outlined in the *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (National Roads Authority, 2004).

While this current document may prove useful during the preparation of an Environmental Impact Statement (EIS), it is intended primarily to provide guidance during the detailed design stage and construction phase of national road schemes.

The measures outlined in these guidelines are aimed at minimizing impacts that can result from road scheme development and construction works on the general ecology of watercourses, with particular reference to protecting fish stocks, flora, angling amenity and providing for the passage of mammals. In addition, the guidelines aim to provide information to facilitate dialogue during consultation with relevant statutory bodies with the objective of achieving the most effective design and construction practices for biodiversity conservation.

It should be noted that the measures outlined in this document are recommended for the treatment of watercourses in general. However, specific or additional measures may be necessary for the protection of certain sensitive sites. All works should be agreed and documented in consultation with the Central Fisheries Board (CFB), relevant Regional Fisheries Board (RFB), the National Parks and Wildlife Service (NPWS) of the Department of the Environment, Heritage and Local Government, the Engineering Services, Department of Communications, Marine and Natural Resources (DCMNR), Office of Public Works (OPW) and the relevant local authority.

RELEVANT LEGISLATION AND RESPONSIBLE AUTHORITIES

Table 1 outlines legislation that relates to operations which may impact on species, habitats or water quality in Irish watercourses.

TABLE 1: Irish legislation relating to watercourses with the relevant responsible authority.

RELEVANT LEGISLATION	RESPONSIBLE AUTHORITY
Wildlife Act, 1976 (as amended 2000)	**National Parks and Wildlife Service**
Flora Protection Order, 1999	**National Parks and Wildlife Service**
Fisheries (Consolidation) Act, 1959 (as amended 1999)	**Regional Fisheries Boards**
EU Birds Directive (79/409/EEC)	**National Parks and Wildlife Service**
EU Habitats Directive (92/43/EEC)	**National Parks and Wildlife Service**
EU Freshwater Fish Directive (78/659/EEC)	**Local Authority**
EU Surface Water Directive (75/440/EEC)	**Environmental Protection Agency**
European Communities (Water Policy) Regulations, 2003	**Environmental Protection Agency and Local Authorities**
Local Government (Water Pollution) Acts, 1977 and 1990	**Local Authority**
Local Government (Planning and Development) Act 2000	**Local Authority**

GENERAL MANAGEMENT

All design and operating protocols should be agreed with the relevant statutory authorities (CFB, RFB, NPWS, OPW, etc.) and included in the Contractor's method statements.

The Contractor should ensure that all sub-contractors and site supervisors are aware of the various environmental commitments made in relation to the specific scheme. Responsible personnel and communication lines should be established and documented in the Environmental Operating Plan prior to the commencement of on-site works. Where feasible, monthly site meetings may be appropriate to review construction activities on watercourses.

Works other than those agreed at the design stage should not be undertaken unless there is a written agreement between the relevant statutory authority and the Contractor's project management team.

A site inspection should be undertaken on completion of site works to assess and confirm the implementation of the agreed mitigation measures. In addition, as part of periodic post-construction structure inspections, measures should be assessed for continued effectiveness, especially after significant flood events.

BRIDGE AND CULVERT DESIGN AND CONSTRUCTION

BRIDGES

All internationally or nationally important watercourses (see Evaluation Criteria in *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (National Roads Authority, 2004) should, where possible, be bridged rather than culverted, ideally employing clear-span design so as to leave the natural bed and banks undisturbed, and leaving a natural bank-path of at least 3m wide at each side for mammals and anglers and which can facilitate the natural recolonisation of native vegetation.

Where feasible, access for angling and other amenity users should be retained where they currently exist at sites. In addition, the local amenity plan for the area should be consulted and riparian access should be retained, where possible, to accommodate future amenity development along river corridors such as Greenways. See *A Guide to Landscape Treatments for National Road Schemes in Ireland* (National Roads Authority, 2005).

Watercourses and river banks, above and below the crossing, should not be disturbed unless directly associated with the bridge/road structure. The extent of bank-side interference and vegetation removal should be agreed, identified, documented and demarcated with appropriate fencing in advance of undertaking any construction works. The riparian and aquatic marginal vegetation identified for removal may be required during the implementation of landscape treatments for the revegetation of the new river channel.

During the land acquisition stage, it is important that agreements are not entered into with adjoining landowners that will result in an extension of the impacts on the riparian zone through dredging, drainage, or other such activities outside of the specific land-take for a road scheme.

In-stream works and bank-side clearance in the immediate area of the crossing should be kept to a minimum and adequate measures should be put in place to control or minimize the risk of siltation. This may include such measures as:

- bunding and diversion of site run-off to settlement ponds,
- stripping of topsoil. See *Soils in A Guide to Landscape Treatments for National Road Schemes in Ireland* (National Roads Authority, 2005), and where necessary, surfacing of site with granular material, and,
- covering of temporary stockpiles.

In situations where in-stream piers are required, they should be designed to minimize loss of the natural channel bed and streamlined to avoid turbulence.

If stone pitching of the bed is essential, it should be laid at the natural grade and well below bed level. In addition, it should remain back-watered throughout, so as not to impede fish passage.

The use of raised aprons on any bridge designs should be avoided because they act as an impediment to fish movement during low-flow conditions.

A well designed clear-span bridge retaining the existing river channel with piers set back from the river bank.

CULVERTS

Where bridging is not an economic option and culverts are required, their length should be kept to a minimum. This may require localised realignment of stream channels which should be carried out in accordance with the measures described below. Any modification to an existing channel will require consideration of flood conveyance.

Where economically feasible, the use of open-bottomed type culverts should be adopted, leaving the stream-bed undisturbed and maintaining some natural bank on both sides to allow for the passage of mammals. Where natural banks cannot be accommodated, as in smaller culverts, ledges may be required to facilitate mammal passage. Ledges shall be at least 500mm wide, constructed at least 150mm above the 1 in 5 year flood event. There should be a minimum of 600mm of headroom and the ledge must be accessible at both ends from the bank and the water (for example, by ramps).

The diameter of any culvert providing for the passage of fish should not be less than 900mm. The culvert should be installed so that it has a constant slope through its length, except for an appropriate camber allowance where settlement is anticipated. Water velocities in the culvert/bridge apron below discharges of three times average daily flow should not exceed the following values:

- 1.2m/s for culverts less than 24m in length,
- 0.9m/s for culverts greater than 24m in length.

It should be noted that culverts greater than 60m in length would need special consideration for fish passage.

All culverts should be installed so that the bottom (invert) is at least 500mm below the grade line of the natural stream bed. Where fish passage facilities are required, an outlet pool of adequate dimensions with tail-water control should be installed at the culvert entrance and exit.

In situations where closed culverts are used, the following criteria should be applied:

- All culverts should be over-sized so that they can be set a minimum of 500 mm below bed-level. This requirement should be assessed on a case-by-case basis where a crossing is on bedrock.
- The culvert should be of similar width to that of the natural low-flow channel. The use of multiple units of lesser width is unacceptable.

A culvert with an otter ledge attached on brackets. This section of artificial channel has a stonepitched base on which sand and gravel will lodge more readily than concrete.

An example of a well designed oversized arched culvert with mammel ledges. The natural bed of this watercourse was maintained.

- In all cases, the culvert should be laid at a level and grade which allows the upstream invert to remain drowned (by back-watering) under low-flow conditions, to a depth suitable for the easy passage of the largest species frequenting the stream, (e.g. 100mm for trout, 150mm for salmon). This requirement can be readily met where the natural bed gradient is shallow.
- The effective slope of the culvert should generally not exceed:
  - 0.5% for a culvert greater than 24m in length, unless baffles are added
  - 1.0% for a culvert less than 24m in length, unless baffles are added
  - 5.0% at any time, even with the addition of baffles
  - Where >5.0%, site specific design will be required
- If the gradient is too steep, the drowning effect should ideally be met by way of a fish pass, where appropriate. Notched baffles may be required throughout the culvert. All fish passes should be suitable for lamprey as well as salmonids.
- In situations where a culvert has to be laid at a steep gradient, special provision must be made to allow fish to swim upstream without undue effort. Baffles should be laid so as to provide a low-flow channel along the central axis and to reduce velocity of flow to correspond to the swimming capability of the weakest species frequenting the system. Ribbed culverts may be appropriate in some non-salmonids systems.
- Pools should be formed at each end of the culvert to provide for transition from the shape of the ope to the shape of the river downstream. Pools should, ideally, be built in natural rock and be designed to provide take-off conditions for upstream migrants entering and leaving the culvert. The downstream pool should be designed to act as a stilling-chamber that will prevent erosion of the banks below and provide quiescent take-off conditions for fish, and to serve the purposes above.
- It is desirable to provide light-opes in long and dark culverts where there is adequate width in the central median.
- Culvert screening should be avoided, but where required, should be designed to permit fish passage.
- Where culverts are not amenable to the provision of mammal passage, separate facilities may have to be provided for the species in question (e.g. by an adjacent pipe culvert). Ramps may be required to ensure accessibility to the mammal passage facility.
- If a stream runs parallel to the line of the road and inside the toe of the embankment, it may be preferable to divert it laterally than to culvert it.

A well designed culvert which has a stepped profile to accommodate fish passage and an outlet pool to allow fish to pass upstream into the first of the steps. The culvert incorporates a cast mammal ledge.

IN-STREAM WORKS

In-stream works should not be carried out in watercourses frequented by salmon or trout during the Annual Close Season. The duration of the season varies regionally within the period from the beginning of October to the end of February. The timing of works should always be considered on a site specific basis and in agreement with the RFB because some rivers have late spawning salmonids.

Restrictions as to the operating window for in-stream works may also apply in the case of watercourses containing significant populations of other species including lamprey, freshwater pearl mussel, freshwater crayfish, coarse fish, etc., as determined by the relevant statutory authority (NPWS, RFB).

In-stream containment and dewatering operations may facilitate activity within closed periods. Having created a temporary diversion during the open season, construction of a culvert can proceed during the closed season in the original channel. Subsequent rediversion of the stream back to the original channel must be undertaken in the open season. Dewatering, however, will not normally be an option where species protected under the Wildlife Act or the EU Habitats Directive occur in significant numbers. Where dewatering is to be undertaken, it should be preceded by a fish salvage operation carried out by the relevant Fisheries Board or by fully qualified and authorised personnel. All dewatering flows should be passed through settlement ponds or tanks to remove sediments in order to minimize any potential environmental impacts.

It is important to note that all electro-fishing procedures require a licence issued by the Department of Communications, Marine and Natural Resources.

Operation of machinery in-stream should be kept to an absolute minimum. All construction machinery operating in-stream should be mechanically sound to avoid leaks of oils, hydraulic fluid, etc. Machinery should be steam-cleaned and checked prior to commencement of in-stream works.

Where in-stream bed material is to be removed, coarse aggregates, if present, should be stockpiled for replacement in the reformed or new channel. (Note that care should also be taken with in-stream vegetation if required for landscape treatments. See *A Guide to Landscape Treatments for National Road Schemes in Ireland* (National Roads Authority, 2005).

All in-stream works must be carried out in accordance with an approved method statement and under the direction of Fisheries Board personnel.

All electro-fishing procedures require a licence issued by the Department of Communications, Marine and Natural Resources.

TEMPORARY WATERCOURSE CROSSINGS

Temporary watercourse crossings should:

- Not impede fish passage through the system,
- Have access constructed of suitable material and in a manner that will not give rise to rutting, ponding and silt run-off,
- Have silt laden run-off directed to silt lagoons. Silt control measures should be increased with increasing gradient and buffer zones should be incorporated between the ponds and watercourse.

Fording of watercourses to gain access to the opposite bank should only be considered where no alternative option exists and under approval of the RFB, or the NPWS where species protected under the Wildlife Act, Habitats Directive or the Freshwater Fish Directive occur in significant numbers. Where required, access should be restricted to one crossing point and where feasible, traffic movements should be limited. In-stream and bank-side preparation and rehabilitation will be required.

Concrete should not be used for preventing erosion of stream beds and banks where a softer option is available e.g. natural bank stabilisation techniques such as willow-faggoting, stone armour, logs, conifer tops or composite protection using products such as coir-matting or geoweb with appropriate planting (reeds, willow, etc.). See *A Guide to Landscape Treatments of National Road Schemes* (National Roads Authority, 2005).

Where concrete is used, it must be sufficiently back-watered at all times to accommodate fish movement.

Bank stabilisation, erosion protection and drainage outfalls, if required, should be designed in consultation with the RFB and NPWS. These works should be designed to avoid downstream impacts and to promote natural recolonisation of the original riparian and aquatic marginal vegetation.

Concrete should not be used for preventing erosion of stream beds and banks where a softer option is available.

A poor example of a realigned watercourse with a highly uniform trapezoidal profile and flow regime. This limits the ecological potential of the river as well as reducing landscape quality through a "loss of naturalness" within the landscape.

WATERCOURSE DIVERSIONS

Permanent diversions of watercourses should be avoided where possible. However, where new permanent diversions are required, they should be designed, where possible, to replicate the existing natural watercourse and should incorporate meanders, riparian vegetation and other features of a natural watercourse (see Figure 1). In situations where stock has access to planting, fencing of diversions will be necessary in order to allow the regeneration of native riparian and aquatic marginal vegetation.

The creation of the new river channel should be carried out in the dry, in isolation from the existing watercourse.

Temporary diversion channels should provide for fish passage, be non-eroding, and be of similar width to the natural stream channel.

Diversion of water to and from temporary or permanent channels should only take place during the period March to September. (Note that the timing of such works should always be considered on a site specific basis and in agreement with the relevant RFB because some rivers have late spawning salmonids.)

RFB personnel should be present on-site when the watercourse is initially diverted.

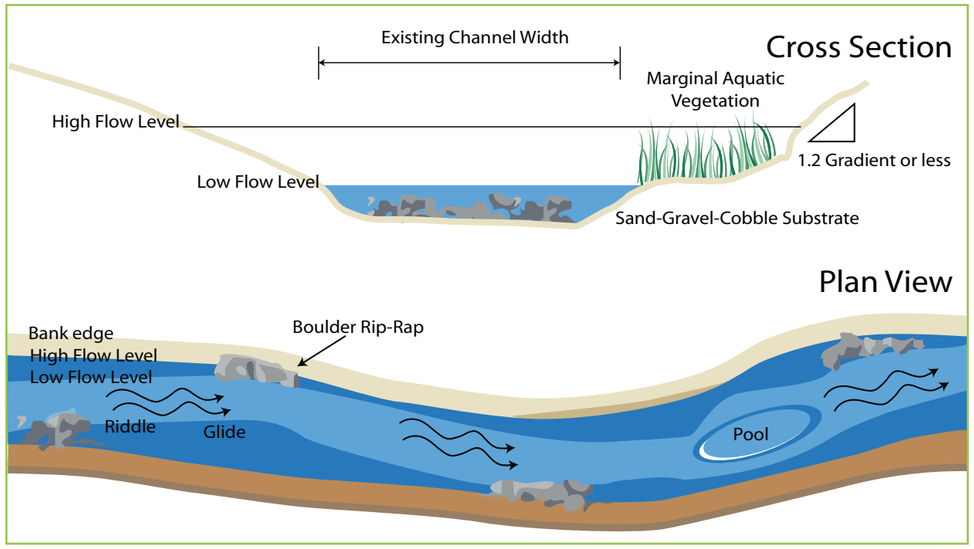
The compensation diversion channel should be designed in consultation with personnel with appropriate ecological expertise and to the satisfaction of the RFB and NPWS.

Once construction of the structure is completed, reconnection to the existing watercourse can be made and this should only occur within the approved operational window for in-stream works.

The salvage of fish from the section of watercourse to be temporarily abandoned should be carried out by, or on behalf of, the relevant Fisheries Board, by qualified personnel. Fish salvage should be carried out in consultation with the NPWS where species protected under the Wildlife Act, EU Habitats Directive or the EU Freshwater Fish Directive occur in significant numbers.

FIGURE 1

A schematic drawing of a section of realigned watercourse channel showing the necessary features to be incorporated, including meanders, variation in flow regime and gently profiled banks which will allow for the establishment of a native riparian and aquatic marginal vegetation and to allow access to the stream bed for wildlife.



POLLUTION PREVENTION PRIOR TO AND DURING CONSTRUCTION

Prior to earthworks commencing, all watercourses and drains should be temporarily culverted to avoid movement of vehicles across watercourses. Larger watercourses may require the provision of measures for temporary crossings. Site, surface drainage and silt control measures should also be established prior to commencing earthworks.

Run-off from the working site or any areas of exposed soil should be channelled and intercepted at regular intervals for discharge to silt-traps or lagoons with over-flows directed to land rather than to a watercourse.

To avoid siltation of watercourses from crossing point locations, silt traps should be placed beside temporary crossing points with an associated buffer strip. Silt-traps should be maintained and cleaned regularly during the course of site works.

A maintenance schedule and operational procedure should be established by the Contractor for silt and pollution control measures during the construction period. This should be undertaken in consultation with the relevant statutory authorities.

Pouring of concrete for aprons, sills, and other works should be carried out in the dry and allowed cure for 48 hours before re-flooding. Pumped or tremied concrete should be monitored carefully to ensure no accidental discharge into the watercourse. Mixer washings and excess concrete should not be discharged to surface water.

Oil storage tank(s) and the associated filling area and distribution pipe work should be at least 10m distant from surface watercourses (rivers, lakes, streams, field drains) and 50m from wells or boreholes.

Storage tanks should have secondary containment provided by means of an above ground bund to capture any oil leakage irrespective of whether it arises from leakage of the tank itself or from associated equipment such as filling and off-take points, sighting gauges, etc., all of which should be located within the bund. Bund specification should conform to the current best practice for oil storage (Enterprise Ireland, BPGCS005).

Oil booms and oil soakage pads should be maintained on-site to enable a rapid and effective response to any accidental spillage or discharge.

Abstraction of water from watercourses for dust control should be from dedicated watering points; these should preferably be from silt lagoons located on site or from an excavated site, replenished by ground infiltration and not by stream infiltration. No abstraction should occur on small watercourses.

MAINTENANCE WORKS FOR BRIDGES AND CULVERTS

A schedule and protocol for the maintenance of bridges and culverts will form part of the National Roads Authority's EIRSPAN bridge management system. Maintenance of bridges crossing watercourses and culverts should be undertaken in consultation with the relevant statutory authorities and the RFB and NPWS should be notified in advance of all maintenance works.

Machinery access to the watercourse should be confined to a single bank where possible with no access permitted into the watercourse (see section on in-stream works on page 6).

Where there is a requirement to control aquatic vegetation to improve flood conveyance in a watercourse or in attenuation ponds, the following principles should be applied:

- Works should avoid impacting on woody vegetation, where possible.
- At least one third of the native riparian and aquatic marginal vegetation should be left untouched with margins retained on both sides of the channel.
- Cutting of woody vegetation should be undertaken during the autumn period to avoid impacting on spawning of salmonids, breeding birds, coarse-fish eggs, etc.
- All cut vegetation should be removed from the watercourse to avoid de-oxygenation of the water during decay, and blockage of downstream structures.
- Cut material can be heaped in areas of low ecological interest away from the watercourse to provide habitat for invertebrates and small mammals. Where willow and alder has been identified to be used for the stabilization of stream banks, cut material can also be used as "live plant" cuttings.
- Re-profiling of banks should not be undertaken as part of vegetation clearance.
- Where de-silting is required, coarse sediments should not be removed from the watercourse.
- Where increased flood conveyance is required beyond the existing capacity of a watercourse, re-profiling should aim to retain the existing channel as a "low-flow" channel and develop a raised step as a "flood channel" (see Figure 2).
- Herbicides should not be used in or adjacent to watercourses unless application is targeted in the control of invasive species such as giant hogweed *(Heracleum mantegazzianum)*.

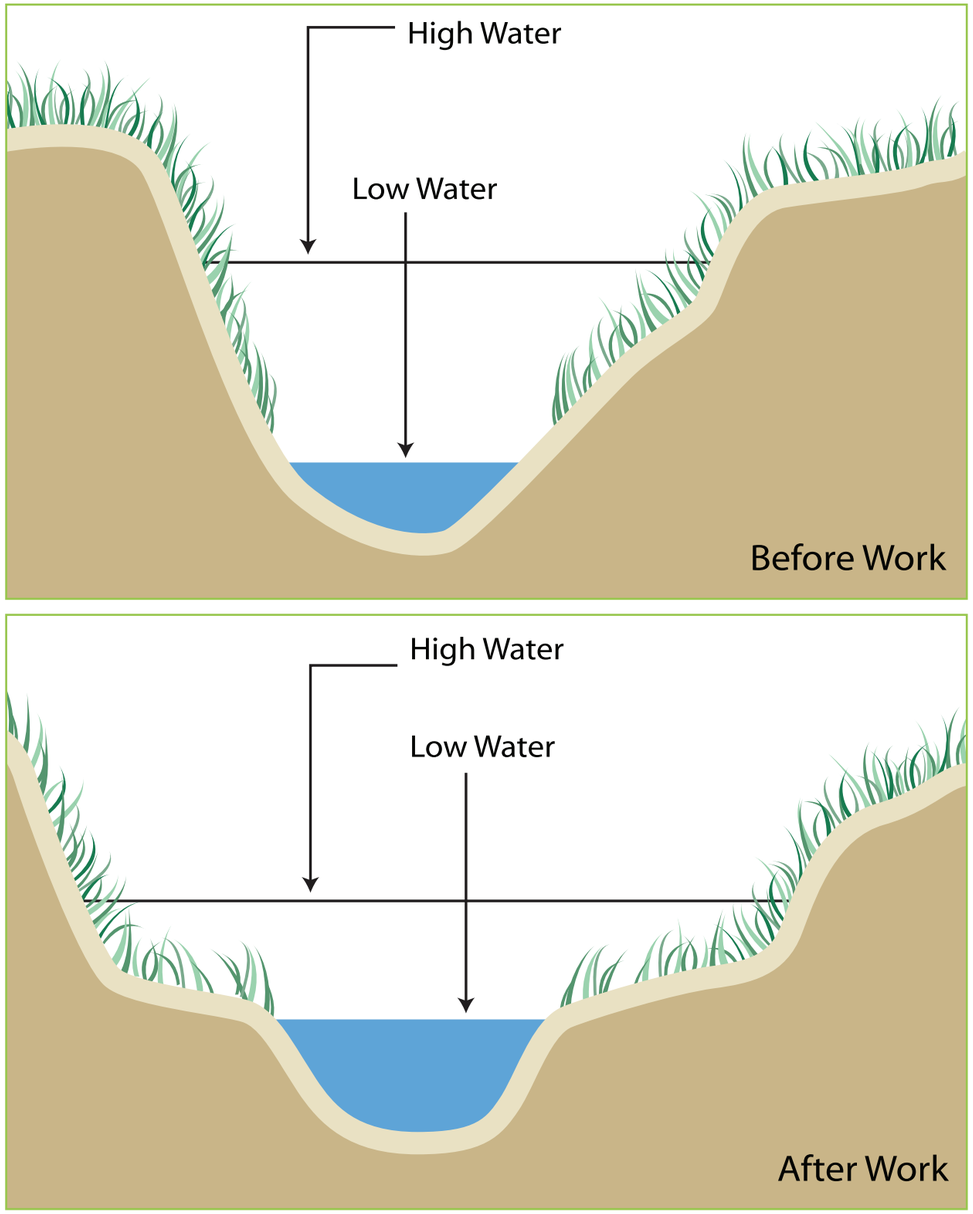
Maintenance of structures such as bridges and culverts should be preceded by a survey of the structure for utilization by wildlife such as roosting bats, breeding birds, etc.

Shot-creting of masonry structures should not be undertaken without an appropriate assessment for bats. Where bats are present, a licence to disturb them should be obtained from the NPWS (under the Wildlife (Amendment) Act 2000) in advance of the works. The works should aim to retain the key roosting cavities within the structure where these do not compromise the safety of the structure. In cases where there is a significant loss of roost sites, artificial roosts should be provided. See *Guidelines for the Treatment of Bats During the Construction of National Road Schemes* (National Roads Authority, 2005).

In circumstances where existing bridges with raised aprons require rehabilitation, fish-passes should be incorporated as necessary to overcome any impediment to fish passage.

FIGURE 2

A schematic drawing showing how previously modified existing watercourse channels can be enhanced by re-profiling where works are necessary to increase flood conveyance capacity. The stepped profile allows for the retention of the existing low-flow channel dimensions while the steps on either bank provide conditions suitable for native riparian and aquatic and marginal vegation as well as providing access to the stream/river bed for wildlife. Gently profiled banks are more stable, safe and provide easier access for future maintenance works.



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