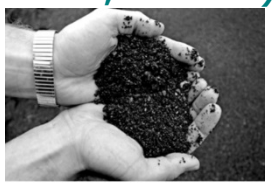
Appendix 3

Guidelines for the Crossing of Watercourses during the Construction of National Roads Schemes (NRA, 2008)

Forestry and Water Quality Guidelines (Forest Service, 2000)

Forest Harvesting and Environmental Guidelines (Forest Service, 2000)



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

NRA
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An tÚdarás um Bóithre Náisiúnta

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

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This document was prepared by NATURA Environmental Consultants in association with the National Roads Authority.

ENVIRONMENTAL SERIES ON CONSTRUCTION IMPACTS

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

INDEX

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.

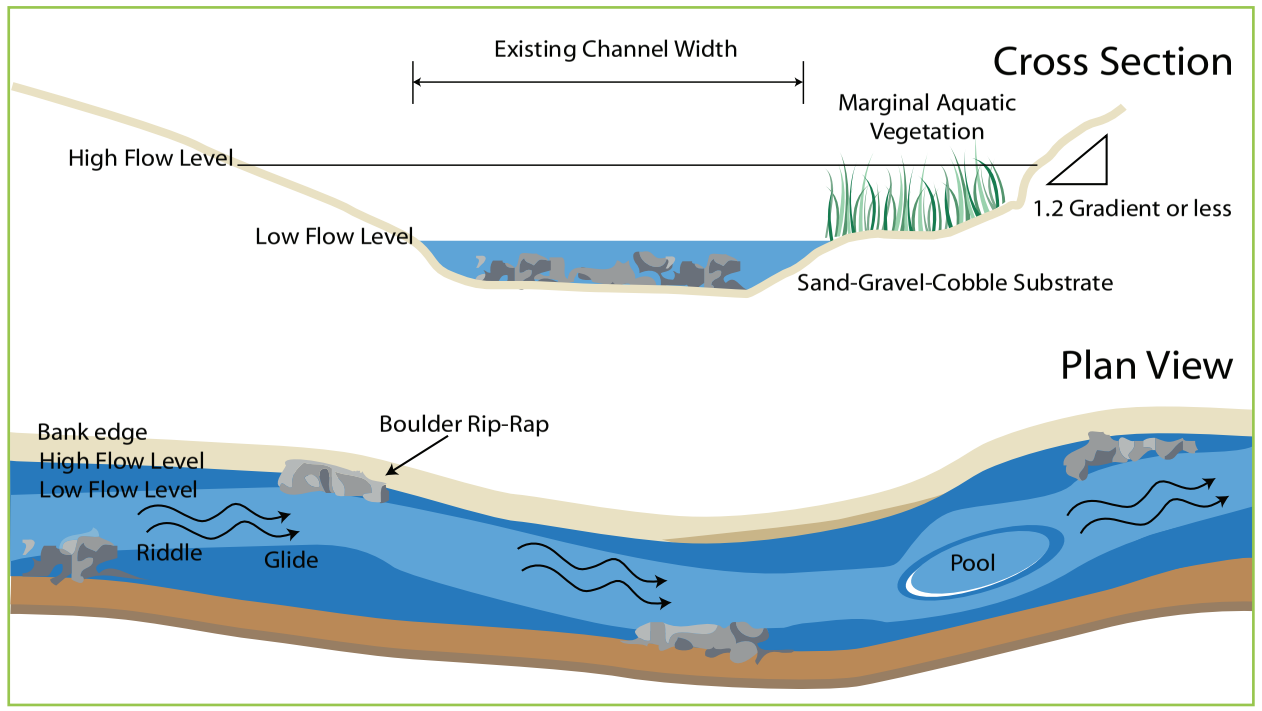
The compensation diversion channel should be designed in consultation with personnel with appropriate ecological expertise and to the satisfaction of the RFB and NPWS.

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)*.

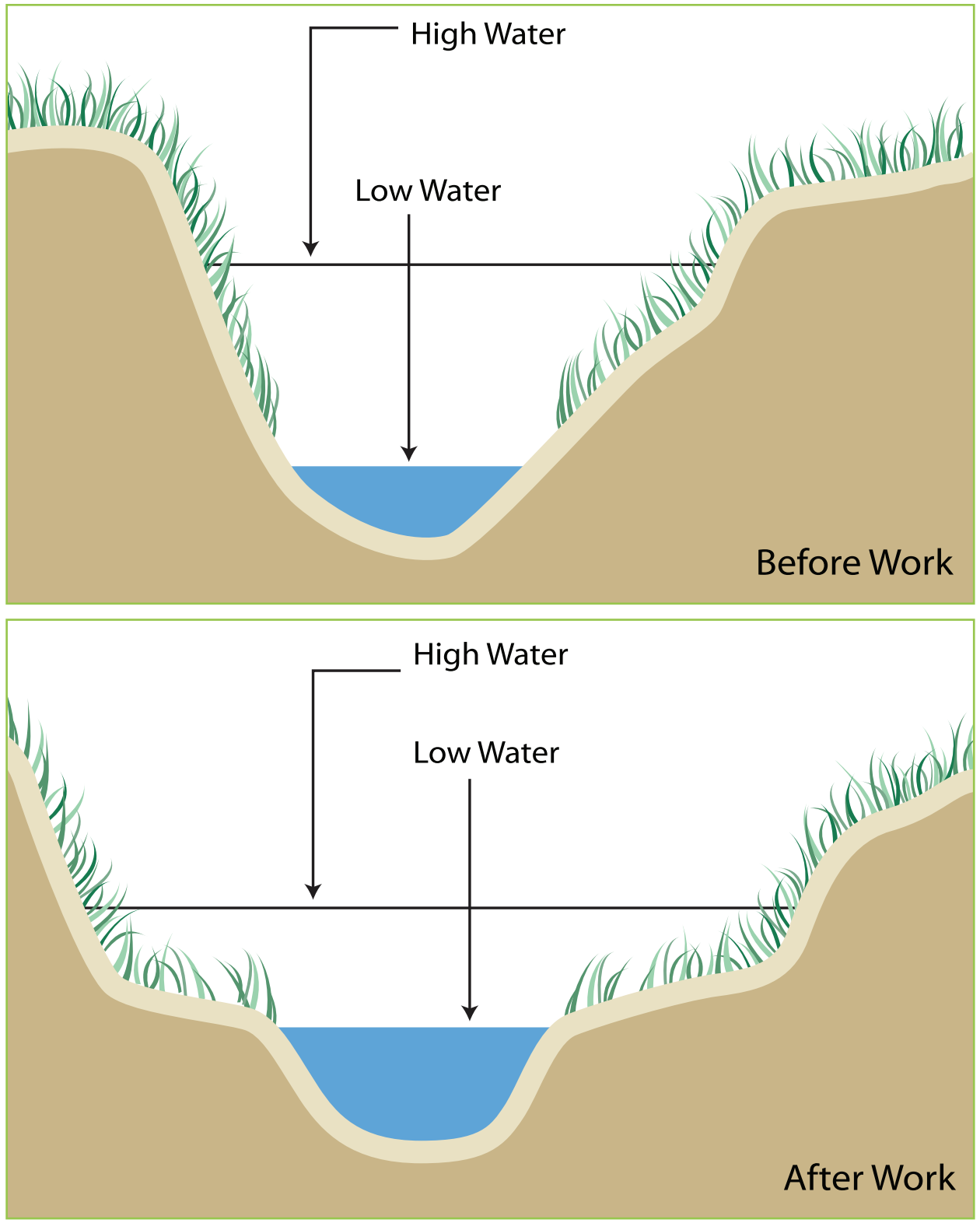
Maintenance of structures such as bridges and culverts should be preceded by a survey of the structure for utilization by wildlife such as roosting bats, breeding birds, etc.

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.



REFERENCES

Anon. 1998.
Fisheries Guidelines for Local Authority Works.
Dept. of the Marine and Natural Resources, Dublin.

Chillibeck, B., Chislett, G. and Norriss, G. (Eds). 1993.
Land Development Guidelines for the Protection of Aquatic Habitat.
Dept. of Fisheries and Oceans, Canada.

Cowx, I.G. and Welcomme, R.L. 1998.
Rehabilitation of Rivers for Fish.
FAO, Fishing News Books.

Enterprise Ireland.
Best Practice Guide (BPGCS005) Oil storage guidelines.
www.envirocentre.ie

Environment Agency (UK), 1996.
Flood Defense Information Sheet No. 4: Culverts.

Goldman, S.J., Jackson, K. and Bursztynsky, T.A. 1986.
Erosion and sediment control handbook.
McGraw-Hill Book Company. New York.

National Roads Authority, 2005.
Guidelines for the Treatment of Bats During the Construction of National Road Schemes.
National Roads Authority, Dublin.

National Roads Authority, 2005.
A Guide to Landscape Treatments of National Road Schemes in Ireland.
National Roads Authority, Dublin.

National Roads Authority, 2004.
Guidelines for the Assessment of Ecological Impacts of National Road Schemes.
National Roads Authority, Dublin.

Murphy, D.F. 2004.
Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites.
Eastern Regional Fisheries Board.

Ward, D., Holmes, N. and Jose, P. 1993.
The New Rivers and Wildlife Handbook. RSPB, NRA, RSNC.

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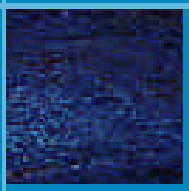
NOTES

Front Cover



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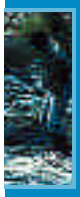
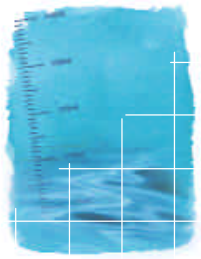




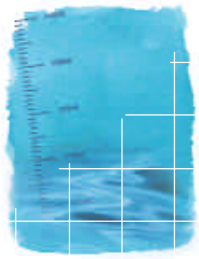
INTRODUCTION

The maintenance and enhancement of water quality is of utmost importance. Forestry activities have the potential to interact both positively and negatively with aquatic resources. Careful planning and management will mitigate against potential negative impacts while maximising the positive aspects of forestry, such as aquatic biodiversity enhancement and the creation of appropriate riparian ecosystems.

> An aquatic zone is defined as a permanent or seasonal river, stream or lake shown on an Ordnance Survey 6 inch map.

Each river or lake has a unique drainage basin or catchment area. Some catchments are more vulnerable than others to changes in water quality, due to their particular soils and underlying geology. The type of landuses and associated operations within the overall catchment area can also have a major bearing on the volume and quality of water flowing into that particular river or lake. All land owners, including forest owners, have a responsibility to play their role in conserving and enhancing overall catchment quality.

> The FORESTRY AND WATER QUALITY GUIDELINES have been developed through extensive consultation with a wide range of relevant parties. They set out sound and practical measures based on the principles of Sustainable Forest Management (SFM), and are firmly rooted in the best available scientific information. The guidelines will be kept under review to facilitate amendment in the light of new research findings.
>
> To ensure the successful implementation of SFM in Ireland, it is important that forest owners adhere to the guidelines and undertake all work in a way which is compatible with the protection of the environment.
>
> The guidelines describe a range of measures intended to cover all situations relating to forestry and water quality. Not all of the measures outlined will be applicable to every site. However, it is the responsibility of forest owners to identify and apply those measures which are appropriate to their particular forest.
>
> The FORESTRY AND WATER QUALITY GUIDELINES apply to all grant-aided projects and to all activities associated with a Felling Licence. Any breach may result in the forfeit of grant aid and premium payment or the withdrawal of a Felling Licence.
>
> It is essential that all forest workers and machine operators involved in any forest operation are made aware of and understand the guidelines, all relevant environmental issues relating to the site, and working practices which minimise environmental disturbance. All operators should have contact telephone numbers onsite for all relevant agencies (Local Authorities, Regional Fisheries Boards, Dúchas The Heritage Service, National Museum of Ireland, Garda Síochána, etc.) in case of accidental damage to aquatic zones, archaeological sites, important wildlife habitats and other environmental features.



SENSITIVE AREAS

SPECIAL AREAS OF CONSERVATION, SPECIAL PROTECTION AREAS AND PROPOSED NATURAL HERITAGE AREAS

Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) are protected by European Union and national legislation. Proposed Natural Heritage Areas (pNHAs) have been identified by National Parks and Wildlife of Dúchas as areas of value in the national effort to conserve biodiversity.

- Planting is not permitted in SACs and SPAs.
- Approval for planting in pNHAs is dependent on formal consultation between the Forest Service and Dúchas The Heritage Service.

AREAS SENSITIVE TO ACIDIFICATION

The Forest Service recognises the importance of water acidification arising from atmospheric pollution. It will continue its ongoing policy of consultation with Regional Fisheries Boards and Local Authorities on whether or not to proceed with forestry applications in areas where there is a perceived risk of acidification. These sensitive areas are designated on the basis of the following criteria:

- the aquatic zone is part of a recognised salmonid fishery and is a spawning, nursery or angling area, **and**
- the geology is base-poor, **and**
- in water samples taken regularly between 1st February and 31st May, **either**
  - pH readings are equal to or less than 5.5, **or**
  - water hardness, in mg calcium carbonate/litre, is less than 12, **or**
  - water alkalinity, in mg calcium carbonate/litre, is equal to or less than 10.

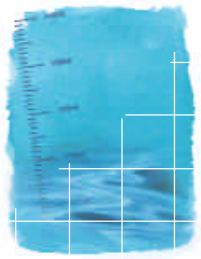
The Forest Service will also take account of new research findings as they become available.

AREAS SENSITIVE TO EROSION

Where certain soil types (e.g. peat, sandstone-derived soils) and steep slopes occur together, there is a greater risk of soil erosion and subsequent sedimentation. It should also be noted that subsoils may be more prone to erosion than the associated topsoil. In such areas, due care should be taken when

Left: Research and consultation are key elements in protecting water quality.

Right: Forest owners, as with all landowners, have a responsibility to play their role in conserving and enhancing overall catchment quality.



planning all forest operations. Correct buffer zone management will help reduce the risk of sedimentation. Sensitivity to acidification or erosion can be local or confined to a sub-catchment. These sub-catchments may be identified by their particular geology, soil and terrain.

BUFFER ZONE GUIDELINES

The buffer zone is an area adjacent to an aquatic zone and managed for the protection of water quality and aquatic ecosystems. A buffer zone includes the riparian zone, i.e. that area directly adjacent to an aquatic zone, representing the intermediate between the aquatic and terrestrial environments and having its own distinctive hydrological and ecological characteristics. The buffer zone may also occupy adjacent areas beyond the riparian zone. Within the buffer zone, natural ground vegetation is allowed to develop, with additional planting of suitable riparian tree species.

Within the buffer zone, ground preparation and other forest operations are curtailed in order to protect water quality. Furthermore, drainage channels leading from the site must taper out before entering the buffer zone. This ensures that discharged water gently fans out over the buffer zone before entering the aquatic zone, with sediment filtered out from the flow by ground vegetation within the zone. Buffer zones further enhance and protect water quality by:

- physically stabilising banks;
- acting as a source of leaf litter input into aquatic zones, which represents an important food source for a number of aquatic animals;
- providing cover and dappled shade.

Buffer zones should be in place throughout the rotation, and have particular relevance to establishment, road construction and harvesting.

Table 1. Buffer zone widths.

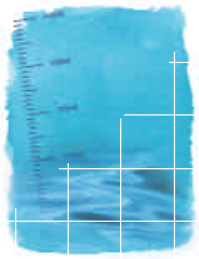
Average slope leading to aquatic zone	Buffer zone width on each side of the aquatic zone	Buffer zone width for highly erodable soils
Moderate (even to 1 in 7 / 0-15%)	10 m	15 m
Steep (1 in 7 to 1 in 3 / 15-30%)	15 m	20 m
Very steep (1 in 3 / >30%)	20 m	25 m

Buffer zone width is based on the following factors:

- the average slope of the area adjacent to the aquatic zone (buffer zone widths should be greater where slopes are steep);
- the sensitivity to erosion of the soil adjoining the aquatic zone.

- The width of the buffer zone may vary in certain situations, for example, to avoid straight edges for landscaping purposes. However, the minimum width, as set out above, must be maintained in all cases.
- Buffer zones should be actively managed to encourage sustainable vegetative growth and cover for the protection and enhancement of water quality. Well-vegetated banks are more resistant to undercutting and collapse. Vegetation shields the soil surface from rainfall impacts, slows run-off velocity and increases infiltration. Open and partially wooded conditions should be planned, so that bank vegetation thrives. Approximately half the length of a stream should be left open and the remainder kept under partial shade from trees and shrubs. Ground vegetation in buffer zones can be augmented by the planting of native tree species such as birch, willow and sally, with occasional alder, oak and ash. These species help to stabilise the riparian zone and protect it in times of flood. Such planting is permitted in the buffer zone and within 5 m of the aquatic zone, if this would, in the view of the Regional Fisheries Board, have a beneficial effect on that particular aquatic zone. On good fertile sites, natural regeneration of desirable species from local seed sources is likely to occur.

The development of natural riparian vegetation, including suitable tree species, will benefit water quality and aquatic life.



- All tree planting within the buffer zone should be carried out using pit planting only, except in wet areas where inverted mounding is allowed.
- Pruning and/or removal of undesirable trees should be carried out where required, inorder to maintain the riparian vegetation and aquatic conditions.

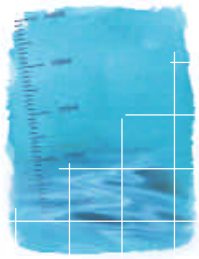
Afforestation plans should be made for all sites, regardless of size. Such plans should include the location and treatment of aquatic zones located on or adjacent to the site.

GROUND PREPARATION AND DRAINAGE

An essential element of protecting water quality is to ensure that sediment contained in water draining from the site does not enter the aquatic zone. Incorrect ground preparation and drainage can result in soil disturbance and subsequent sedimentation of nearby aquatic zones, particularly if ground preparation is followed by prolonged and heavy rainfall. For these reasons, ground preparation must be well-planned and drain layout/sediment traps correctly designed and installed. Mounding, moling, ripping and subsoiling will result in less soil disturbance than ploughing.

- Do not carry out ground preparation within the buffer zone. Where trees are being planted to restore or create riparian woodland, pit planting must be used, except in wet areas where inverted mounding is allowed. In general, trees should not be planted within 5 m of an aquatic zone.
- Where possible, ground preparation should be carried out when there is less of a risk of heavy rainfall.
- Where possible, do not disturb existing drains.
- Drains and sediment traps should be installed during ground preparation.
- Collector drains should be excavated at an acute angle to the contour (0.3%-3% gradient), to minimise flow velocities.
- Main drains to take the discharge from collector drains must be provided with waterdrops and rock armour where there are steep gradients, and should avoid being placed at right angles to the contour.
- Make sure that all drainage channels taper out before entering the buffer zone. This ensures that discharged water gently fans out over the buffer zone before entering the aquatic zone, with sediment filtered out from the flow by ground vegetation within the zone. On erodable soils, install sediment traps at the end of the drainage channels tothe outside of the buffer zone.

Buffer zones play a major role in underpinning water quality.



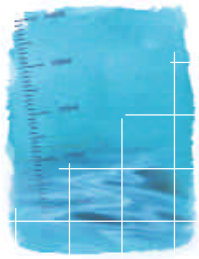
- Drains and sediment traps must be maintained throughout the rotation, ensuring that they are clear of sediment build-up and are not severely eroded. Correct drain alignment, spacing and depth will ensure that erosion and sediment build-up are controlled.
- Sediment traps should be sited outside the buffer zone and have no direct outflow into the aquatic zone. Their capacity can extend over the life of the forest or have limited storage. In the latter case, machine access is required to enable the accumulated sediment to be excavated. Sediment should be carefully disposed of away from all aquatic zones. Sediment traps must be clearly marked and securely fenced for safety.Where possible, sediment traps should be constructed on even ground and not onsloping ground.
- In areas particularly sensitive to erosion, it may be necessary to install double or triple sediment traps.

FERTILISER APPLICATION AND STORAGE

Complete all planting before fertiliser application takes place. Species selection together with site type and conditions determine fertiliser type and application rates. Phosphorus (P) is the main nutrient fertiliser applied, with nitrogen (N) and potassium (K) occasionally applied as remedial fertilisation. The following practices should be followed to minimise the risk of fertiliser run-off and transport to aquatic zones.

- Proposed fertiliser types and application rates should be included in the afforestation application.
- Fertiliser should not be applied within the buffer zone or within 20 m of an aquatic zone, whichever is greatest.
- Fertilisers should be prepared and securely stored under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone.
- Granular fertiliser formulations should be used, with the exception of muriate of potash which is not available in granular form.

Care in the storage and application of fertilisers and chemicals will avoid risk to water quality and aquatic life.



Watercourses are a major component of the environment, and their protection is an essential element of sustainable forest management.

- Phosphate application rates on peat soils should be kept to a minimum in any single application.
- Apply fertiliser manually or by ground-based machine, wherever possible. Fertiliser must be applied by hand in the 20-50 m area adjacent to the aquatic zone.
- Do not, under any circumstances, discharge fertilisers into an aquatic zone, drain orsediment trap.
- Where later fertilisation is required to counteract nutrient deficiencies, aerial application using helicopter can be considered where branch growth and onsite vegetation prevent manual application. However, a 50 m wide corridor adjacent to aquatic zones must be left unfertilised. Never undertake aerial fertilisation during high winds.
- Do not apply fertiliser during or following prolonged rainfall or if heavy rain is forecast.
- Fertiliser should only be applied during the months of April to August, inclusive.
- Remove all empty fertiliser bags and other rubbish from the site during and after the operation, for environmentally-acceptable off-site disposal.

CHEMICALS, FUEL AND MACHINE OILS

The on-site use of chemicals (herbicides, pesticides and urea), fuel and machine oils (hydraulic, engine, gearbox, lubricant or cutting oils) should be kept to a minimum. Accidental spillage or leakage can be detrimental to aquatic flora and fauna and can impair water quality. Training and safety are of primary importance to avoid hazards and to ensure the correct use of herbicides and pesticides.

- Do not apply chemicals if heavy rainfall is forecast or during high winds.
- Do not apply chemicals within the buffer zone.
- Refer to *Guidelines for the Use of Herbicides in Forestry*[1].
- Prepare and securely store all chemicals, fuel and machine oils under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone.
- Cleaning of equipment should not take place within 50 m of an aquatic zone. All wash waters must be disposed of carefully.
- Unused diluted herbicides must not be spread within the buffer zone.
- Remove all containers from the site and dispose of carefully.
- All maintenance and refuelling operations and machine repairs (if required and practical) should be carried out at least 50 m from the nearest aquatic zone on a dry, elevated site.
- Spent oil must be collected and retained for correct off-site disposal.
- Where possible, biodegradable oil should be used as a substitute for mineral oil.
- Do not, under any circumstances, discharge chemicals, fuel or machine oils into an aquatic zone.
- The relevant Local Authority must be informed promptly of any accidental chemical, fuel or machine oil spillage which threatens an aquatic zone.

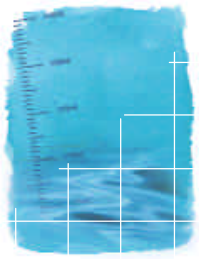
ROADS

Each stage of forest road construction has implications for water quality. Before road construction begins, the road network within the forest must be planned and outlined in the plan required by the FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES. Key actions required for this plan include:

- inspection of the area and the preparation of a map containing a broad terrain classification and details of all aquatic zones;
- determination of the appropriate density and spacing of the road network, based on the size and shape of the area, machinery employed and the nature of the terrain;
- delineation of aquatic zones and associated buffer zones.

- The FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES require a road and track network scheme as part of the harvesting plan. This plan should include a terrain classification which indicates all aquatic zones and buffer zones together with sources of public and private water supplies, access points, landings and, if

[1]Ward, D. (ed.) 1998. Guidelines for the Use of Herbicides in Forestry. 2nd Edition. Coillte, Forest Protection, Newtownmountkennedy, Co. Wicklow.



necessary, proposed stream crossings. The map will identify the site location and provide directions and distances to the nearest national road.

- Roads should be located at least 50 m from an aquatic zone, where possible. Road layout should aim to direct off-road traffic away from streams. If there is no other option but to cross an aquatic zone, construct an appropriate bridge or culvert.
- Where possible, roads should follow the natural contours of the terrain.
- All ancillary drainage associated with road construction should be designed to divert water away from buffer zones and should not be allowed to discharge directly into aquatic zones. Sediment traps will be necessary. Roadside drains should not directly intercept run-off from higher ground. Cut-off drains should be constructed to a flat gradient at least 5 m back from the upper edge of the road formation, to avoid erosion.
- Carry out construction during dry weather, ideally from April to October.
- Cement must not be discharged into the aquatic zone.
- Do not remove gravel from an aquatic zone. Gravel may be removed from a buffer zone only after consultation with the Regional Fisheries Board and fishery owner. The opening of a new quarry requires planning permission.
- The maintenance of roadside drains and sediment traps is essential. Inspect periodically to ensure that they are free of debris and sediment, undertaking remedial action if necessary.

BRIDGES, CULVERTS AND FORDS

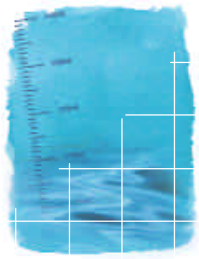
Aquatic zones may need to be crossed during forest operations. The construction of bridges and culverts, whether temporary or permanent, can cause soil and site disturbance, with subsequent soil erosion and the movement of sediment into the aquatic zone. The careful planning of these crossings is essential.

Where fish passage is important, e.g. spawning beds in the upper reaches of aquatic zones, bridge and culvert design should reflect this requirement. Fords are generally not appropriate, as their use can often result in the generation of considerable sediment and the restriction of fish passage.

Bridges are the most desirable structure as they allow unimpeded fish movement. Bridges also ensure that machines parts (and associated fuel and oils) are kept out of the aquatic zone.

Culverts can be open topped or embedded. In fish spawning aquatic zones, embedded culverts are favoured as they provide unrestricted passage for all fish sizes and retain the natural streambed and sediment. Embedded culverts are usually large diameter (greater than 1 m) culverts which aim to maintain the natural channel width, gradient and conditions.

- All water crossings should be marked and indicated in the road network plan.
- Minimise the number of crossings over a given aquatic zone. All crossings should be at right angles to the flow.
- Consult with the Regional Fisheries Board at the design stage of any crossing in a fish-bearing or potentially fish-bearing aquatic zone.
- Bridges should be constructed with minimum disturbance to the bank, channel or adjacent buffer zone.
- Do not build culverts or bridges over an aquatic zone in a way that would hinder fish passage.
- Use local stone for bridge kerbs and end treatments for culverts.
- Do not discharge cement into the aquatic zone. Uncured concrete can kill fish by altering water pH. When cast-in-place concrete is required, all work must be done in dry weather conditions and isolated from any water which may enter the aquatic zone, for a period sufficient to cure the concrete.
- Culvert ends should be tapered to match the embankment slope.
- Specifications for culvert design and size should reflect:
  - whether or not the aquatic zone is a spawning or fisheries watercourse;
  - the type of terrain;
  - the necessity to carry the ‘normal’ flow and to accommodate flash floods;
  - the requirement to embed culverts.



- Embedded culverts should be buried to a depth of 0.3 m or 20% of their height (whichever is greatest) below the streambed. The original bed material as well as boulder sized stones should then be placed in the culvert.
- Culverts should be maintained, removing debris which can cause clogging and eventual culvert failure.

HARVESTING

Harvesting (thinning and final harvesting) and associated activities such as extraction have the potential to adversely impact on water quality, through increased erosion rates, sedimentation and nutrient losses. These impacts can be mitigated through good planning and the implementation of the FORESTRY AND WATER QUALITY GUIDELINES. The factors that affect water quality at harvesting can be summarised as follows:

- soil type, sensitivity and slope;
- number and type of machine passes.

- All harvesting and extraction operations must be carried out in accordance with the FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES. Consult with the Regional Fisheries Board and Dúchas before commencing harvesting operations in areas of importance to fisheries and wildlife.
- Prepare a forest harvesting plan as detailed in the FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES, which will include:
  - a broad terrain classification detailing: the location of areas of potentially high erosion risk; the location of all aquatic zones and buffer zones; the identification of

A brash mat which has been used several times and now in need of renewal.

public/private water supplies; and existing and planned road network, landings, turntables, bridges and extraction routes;
- the identification of appropriate machines to minimise adverse impacts;
- the location of machine maintenance areas and storage areas for chemicals (herbicides, pesticides, urea), fuel and machine oils.

- Construct sediment traps prior to harvesting and maintain these traps throughout operations.
- Plan felling operations with the shortest possible extraction routes, designed to be compatible with the avoidance of sedimentation.
- Always fell trees away from the aquatic zone.
- Avoid machine extraction within the buffer zone.
- On sites where risk of erosion is high, brash mats must always be used to avoid soil damage, erosion and sedimentation. Brash mat renewal should take place when they become heavily used and worn. Provision should be made for brash mats along all off-road routes, to protect the soil from compaction and rutting.
- Where there is risk of severe erosion occurring, extraction should be suspended during periods of high rainfall. Cable extraction may be an alternative in these situations.
- Do not refuel or maintain machinery within 50 m of an aquatic zone.

	Classification	***Chlorophyll (mg/m³) Annual max.***	***Total P (µg P/litre) Annual mean***	***Phosphate (MRP) (µg P/litre) Annual median***
Lakes	Oligotrophic	Ž2.5 and <8	>5 and •10	
	Mesotrophic	Ž8 and <25	>10 and •20	
Rivers	Q5			15
	Q4-5 Q4			20
				30

S.I. 258 of 1998

- Do not pile logs within the buffer zone or on very low lying ground prone to water-logging. Select a dry area away from the aquatic zone.
- Do not allow branches, logs or debris to build up in aquatic zones. All such material should be removed when harvesting operations have been completed, but avoid removing natural debris deflectors.

APPENDIX
EXAMPLES OF WATER QUALITY INDICATORS

Catchment waters may be used for some or all of the following purposes: salmonid water; drinking water; or bathing water. Statutory Instruments are in place which set standards for each of these categories. The following water quality parameters may be measured by the Local Authority, depending on the intended use and the respective Statutory Instruments. The relevant Statutory Instrument for each indicator is quoted in brackets. Indicators marked with (*), although not mentioned in Statutory Instruments, denote the lowest standard *which current knowledge suggests* will not indicate damage to water quality.

The objective at all times is to ensure that forest operations do not cause a deterioration in water quality.

Eutrophication

Biological parameters

- *Phytoplankton/Cyanobacteria (lakes):* Critical limit: Composition and abundance consistent with those in unpolluted lakes(*).
- *Macrophytes (lakes and rivers):* Critical limit: Composition and abundance consistent with those in unpolluted lakes(*).
- *Macroinvertebrates (rivers):* Maintenance of existing EPA Quality (Q) rating, where it is Ž Q4 (Statutory Instrument 258 of 1998).
- *Fish:* Critical limit: Presence of 0+ salmonids(*).

Physico-chemical parameters

"The existing trophic status for any part of a lake shall be maintained" (S.I. 258 of 1998).

- *Nitrate (NO_3):* Critical limit: 11.3 mg N/litre (S.I. 81 of 1988).
- *Un-ionised ammonia:* Critical limit: <0.02 mg NH_3/litre (S.I. 293 of 1988).
- *Dissolved oxygen:* Critical limit: 80-120% saturation(*).

Acidification

Biological parameters

Production: Magner Communications

The Forest Service gratefully acknowledges the contribution of Dr Miriam G. Ryan, COFORD, National Council for Forest Research and Development, to the development of the FORESTRY AND WATER QUALITY GUIDELINES, made through the preparation of a commissioned report. Copies of this report can be obtained from the Forest Service, Department of the Marine and Natural Resources, Leeson Lane, Dublin 2.

Photos: All photos Forest Service, except COFORD, National Council for Forest Research and Development (pages 2 and 6) and T. Cummins, Forest Ecosystem Research Group, UCD (page 11).

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July, 2000

- *Macrophytes (lakes):* Critical limit: Presence of *Lobelia* and *Isoetes* spp.(*).
- *Macroinvertebrates:* Critical limit: Presence of several specimens of any or all of the following: *Baetis rhodani*, *Gammarus* spp., *Caenis* spp., *Centroptilum luteolum* and *Cloeon* spp. (Raddum,1999).
- *Fish:* Critical limit: Presence of 0+ salmonids(*).

Physico-chemical parameters

- *Total aluminium:* Critical limit: 0.2 mg Al/litre (S.I. 81 of 1988).
- *Labile monomeric aluminium:* Critical limit: 0.04 mg Al/litre (S.I. 293 of 1988).
- *pH:* pH Ž 6 and • 9 (S.I. 293 of 1988). pH between 5.5 and 8.5 (S.I. 294 of 1989).

Sedimentation

Parameter

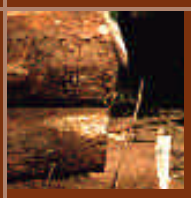
- *Suspended solids:* Critical limit: <25 mg/litre (S.I. 293 of 1988).

Hydrology

Hydrological parameter

- *Flow:* Critical limit: Maintenance of base flow level throughout the catchment(*).

S.I. 81 of 1988 European Community (Quality of Water Intended for Human Consumption) Regulations 1988.
S.I. 293 of 1988 European Communities (Quality of Salmonid Waters) Regulations 1988 (Note: List of relevant water bodies is included).
S.I 294 of 1989 European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations 1989.
S.I. 258 of 1998 Local Government (Water Pollution) Act 1977 (Water Quality Standard for Phosphorus) Regulations 1998.
Raddum, G.G. 1999. Large scale monitoring of invertebrates: Aims, possibilities and acidification indexes. *In* Proceedings of Workshop on Biological Assessment and Monitoring, Evaluation and Models. Raddum, G.G., Rosseland, B.O. and Bowman, J. (eds.) Zakopane, Poland. ICPWaters Report 50/99, NIVA, Oslo.



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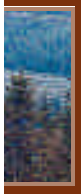

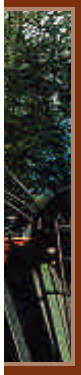

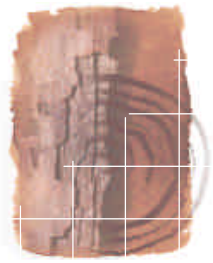

INTRODUCTION

As Ireland's forest estate continues to expand and mature, the amount of timber harvesting will increase. Forest harvesting and forest road construction and usage have the potential to impact adversely upon the environment. The adoption of sound planning procedures, operating techniques and control measures will considerably reduce any potential adverse effects.

The FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES address issues relating to:
- soil conservation;
- the protection of water quality, archaeological sites, biodiversity and the visual landscape;
- the maintenance of forest health and productivity.

The guidelines are presented in the context of timber harvesting and forest road construction and maintenance. They recognise the commercial nature of forestry in Ireland and the need for cost-effectiveness in harvesting operations.

Comprehensive planning combined with sound operating techniques will protect and enhance important environmental resources. This document gives guidelines for:
- harvest planning;
- harvest operation;
- harvest site restoration;
- road planning;
- road construction;
- machine servicing.

The FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES have been developed through extensive consultation with a wide range of relevant parties. They set out sound and practical measures based on the principles of Sustainable Forest Management (SFM), and are firmly rooted in the best available scientific information. The guidelines will be kept under review to facilitate amendment in the light of new research findings.

To ensure the successful implementation of SFM in Ireland, it is important that forest owners adhere to the guidelines and undertake all work in a way which is compatible with the protection of the environment.

The guidelines describe a range of measures intended to cover all situations relating to forest harvesting and the environment. Not all of the measures outlined will be applicable to every site. However, it is the responsibility of forest owners to identify and apply those measures which are appropriate to their particular forest.

The FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES apply to all grant-aided projects and to all activities associated with a Felling Licence. Any breach may result in the forfeit of grant aid and premium payment or the withdrawal of a Felling Licence.

It is essential that all forest workers and machine operators involved in any forest operation are made aware of and understand the guidelines, all relevant environmental issues relating to the site, and working practices which minimise environmental disturbance. All operators should have contact telephone numbers onsite for all relevant agencies (Local Authorities, Regional Fisheries Boards, Dúchas The Heritage Service, National Museum of Ireland, Garda Síochána, etc.) in case of accidental damage to aquatic zones, archaeological sites, important wildlife habitats and other environmental features.


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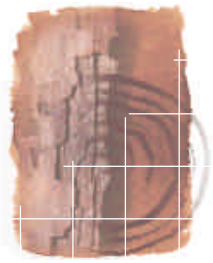


HARVESTING

The principal forms of harvesting undertaken in Irish forests are thinning and clearfelling. Thinning takes place to improve the quality of the remaining trees, to enhance growing conditions and to provide intermediate yields of timber in the form of small roundwood. Clearfelling involves the harvesting of all marketable trees in a stand at the end of the rotation, with reforestation subsequently undertaken to replace the harvested trees. Silvicultural systems which incorporate continuous forest cover may provide alternatives to clearfelling in particular situations.

HARVEST PLANNING GUIDELINES

The following outlines procedures for developing a harvest plan to minimise environmental disturbance. The plan is best represented and recorded on a map accompanied by a short written description.

Environmental issues

Identify all relevant environmental issues. Establish if the area to be harvested lies within or contains:

- an area identified as being environmentally sensitive in a County Development Plan;
- a part or whole of a Special Area of Conservation (SAC), Special Protection Area (SPA) or proposed Natural Heritage Area (pNHA);
- aquatic zones (see FORESTRY AND WATER QUALITY GUIDELINES);
- archaeological sites and monuments (see FORESTRY AND ARCHAEOLOGY GUIDELINES);
- important habitats retained for biodiversity purposes (see FOREST BIODIVERSITY GUIDELINES).

Liaise with the following for practical advice where important environmental issues are involved:

- the relevant Regional Fisheries Board;
- the relevant Local Authority;
- National Parks and Wildlife of Dúchas The Heritage Service;
- the National Monuments and Historic Properties Service of Dúchas The Heritage Service;
- other relevant bodies and non-government organisations.

Terrain inspection

Inspect the area and prepare a map (Ordnance Survey 6 inch scale is usually appropriate) which includes the following:

- The boundaries of the harvest area.
- The environmental features of the area, including all aquatic zones, archaeological sites and monuments, and important habitats.
- Additional features which may present difficulties or require particular attention when harvesting, e.g. landscape considerations, dwellings and associated buildings, overhead and underground utility lines (electricity, gas, telephone and water), public and private water supplies, rights-of-way.
- The location of buffer and exclusion zones within the felling coupe (as stipulated by FORESTRY AND WATER QUALITY GUIDELINES and FORESTRY AND ARCHAEOLOGY GUIDELINES), within which operations will be prohibited or restricted.
- The existing and planned road network and associated structures such as landings, turntables and bridges.
- The location of areas of potentially high erosion risk.
- The location of machine maintenance, refuelling and repair areas and storage areas for fuel, motor oils, lubricants and chemicals. These must be on dry, elevated sites at least 50 m from the nearest aquatic zone. See FORESTRY AND WATER QUALITY GUIDELINES.
- Machine routes and particularly ground haul extraction routes. Plan these so that they avoid all buffer and exclusion zones and, where possible, difficult terrain conditions. The length of extraction routes should be minimised, particularly on steep slopes.

A forest approaching final harvesting - the product of years of careful management.

The careful selection of felling coupe size and shape will minimise landscape impact and create opportunities to introduce age structure diversity within the forest.

Management regime

Select the management regime, including the harvesting system, to be adopted. The harvesting system will be determined primarily by the intended markets for the timber, the stand characteristics (including environmental issues), soil, topography, exposure and machine availability and cost.

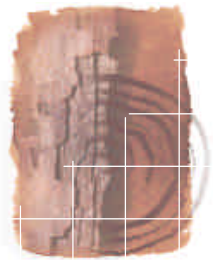
Size of the felling coupe

The size of felling coupes for both thinning and final harvesting is determined by many competing factors. These include the stability of the forest crop and surrounding forest crops, environmental issues such as water quality and landscape, social issues such as public road usage, and various commercial and silvicultural constraints. The following factors should inform the decision regarding the appropriate size of felling coupes:

- Smaller sized felling coupes tend to promote water quality, with greater care and planning needed as the coupe size increases (see FORESTRY AND WATER QUALITY GUIDELINES).
- Smaller felling coupes tend to promote biodiversity (see FOREST BIODIVERSITY GUIDELINES).
- Select coupe sizes which reflect the scale of the landscape (see FORESTRY AND THE LANDSCAPE GUIDELINES). Skylines in particular need to be treated on a large scale, with the forest either left standing or cleared fully to reveal the shape of the underlying landform.

The shape of the felling coupe

Water quality and archaeological sites demand buffer zones or exclusion zones (normally 10 m and 15 m respectively or as specified by the appropriate statutory authority - see FORESTRY AND WATER QUALITY GUIDELINES and FORESTRY AND ARCHAEOLOGY GUIDELINES) within which machine work is prohibited or, if unavoidable, carried out with extreme care. Biodiversity is enhanced through the retention of overmature trees, ideally scattered throughout the forest (see FOREST BIODIVERSITY



GUIDELINES). Landscape issues favour asymmetric and irregularly shaped coupes which follow landform, with edges diagonal to the contour, rising in hollows and descending on spurs (see FORESTRY AND THE LANDSCAPE GUIDELINES). As part of contingency planning, include non-sensitive areas within the felling coupe where harvesting may continue if it has to be postponed in sensitive areas.

Felling sequence

Adjoining felling coupes harvested in a short time scale are likely to have a cumulative impact on the environment. In large, even-aged stands, phased felling will minimise this cumulative effect and will ensure that succeeding rotations do not have the same undesirable structure. Staggered felling/reforestation also benefits biodiversity and the landscape (see FOREST BIODIVERSITY GUIDELINES and FORESTRY AND THE LANDSCAPE GUIDELINES).

Contingency planning

A contingency plan should be in place to cover harvesting. This should identify areas of the felling coupe where harvesting operations may continue, even if they have been halted in more sensitive areas of the coupe due to particularly adverse weather conditions, soils with high erosion risk or low bearing capacity, or accidents involving environmental damage. Consider imposing seasonal restrictions and scheduling operations to avoid wet weather and waterlogged soils or to minimise disturbance to important wildlife species.

Method of harvesting and the harvesting equipment

Select the method of harvesting and the harvesting equipment to be employed in each felling coupe. The choice of machinery will mainly depend upon the harvesting system, the nature of the terrain, environmental considerations, the forest road network, and machine availability and cost. Attach conditions on the machine type, permitted load size and the possible use of flotation and traction aids.

Buffer and exclusion zones

Identify the appropriate width of buffer and exclusion zones for aquatic and archaeological features within or adjoining the coupe. The minimum buffer zone for aquatic zones is usually 10 m; the minimum exclusion zone for archaeological sites is usually 15 m. These may need to be increased following discussion with the Regional Fisheries Board, Local Authority or the National Monuments and Historic Properties Service of Dúchas The Heritage Service, depending on the sensitivity involved. In general, all forestry operations are prohibited from these areas. Trees, if present (due to the absence of guidelines at the time of planting), should be removed from these areas at thinning and final harvesting. This operation must be carried out with extreme care.

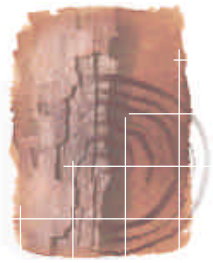
Ancillary structures

Anticipate the need and detail the specifications and locations for ancillary structures such as:

- temporary bridges where machine routes cross aquatic zones;
- sediment traps in drains where considerable sediment flow is expected;
- corduroy rafts to reinforce short sections of soft ground subject to high traffic usage;
- log steps on steep routes to prevent the flow of sediment-laden surface water along machine paths, especially where wheel ruts may form.

Site restoration procedures

Outline site restoration procedures to be undertaken at the completion of operations. These should include requirements regarding roads, replacing damaged culverts, clearing and repairing drains, cleaning sediment traps, correctly disposing of hazardous materials, and removing log bridges and other temporary structures.



HARVESTING OPERATION GUIDELINES

This section contains detailed information on low impact harvesting techniques which can be used to reduce the potential for adverse environmental effects.

Ensure that all personnel, particularly machine operators, are aware of:
- the harvest plan (including the contingency plan);
- environmental issues relating to the site;
- the outer perimeter of all buffer and exclusion zones.

Ancillary structures

Install all necessary ancillary structures (e.g. additional drainage, sediment traps, log steps, aquatic zone crossings, corduroy strips) before harvesting commences or, where appropriate, as harvesting progresses. Maintain these features throughout the operation.

Safety signage

Where harvesting operations adjoin public roads, appropriate warning signs should be in place to alert the public. Warning signs should also be placed within the forest, particularly if it is used for recreation.

Brash mats

Create and maintain dense, fresh brash mats on all machine routes, to avoid soil damage, erosion and sedimentation. Concentrate brash mats on primary routes. The junction of extraction paths and landing sites should also be supplied with a protective brash cover. Where the bearing capacity of the soil is low, specify prompt extraction to ensure that fresh brash is available for extraction machinery. In all cases, brash mats should be renewed when they become heavily used and worn.

Machine passage on forest roads

The passage of ground haul extraction on forest roads should be confined to unladen traffic gaining access to or exiting from the harvesting site. No forwarding or ground haulage operations should take place on either forest or public road surfaces. There should be no carrying over of soil or debris onto public roads. Keep roadside drains and culverts free of logs, debris and obstructions.

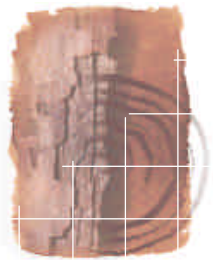
Buffer and exclusion zones

- The outer perimeter of all buffer and exclusion zones (see FORESTRY AND WATER QUALITY GUIDELINES and FORESTRY AND ARCHAEOLOGY GUIDELINES) should be marked clearly with a perimeter fence, brightly coloured paint marks on trees, or brightly coloured tape.
- Machines should not enter these zones during harvesting operations, except where it is unavoidable.
- Fell trees away from these zones.
- Ensure logs are presented in a way which avoids the entry of extraction machinery into these zones.
- Do not pile logs within these zones.

Drains and aquatic zones

Prevent the accumulation of brash, logs and debris in drains and aquatic zones. The installation of heavy duty plastic culverts with a protective brash cover is preferable for drain crossings. If logs are used for this purpose, they should be examined regularly and removed, if necessary, to avoid blockages and localised flooding. Remove temporary bridges and crossings as harvesting progresses.

Selecting the right machine for the operation and site conditions is a key element in protecting the environment during harvesting.



Urea application

Urea should be applied immediately after felling to all conifer stumps. Prepare and securely store urea under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone.

Load sizes

Load sizes specified in the harvest plan or recommended by manufacturers should not be exceeded. Overloading will damage extraction machinery and will increase the risk and severity of soil compaction and rutting.

Establish new buffer and exclusion zones and other open spaces

If absent and where tree stability and site conditions allow, use the opportunity afforded by harvesting to impose buffer and exclusion zones and other open spaces in relation to public roads, dwelling, habitats, etc. Refer to FORESTRY AND WATER QUALITY GUIDELINES, FORESTRY AND ARCHAEOLOGY GUIDELINES, FORESTRY AND THE LANDSCAPE GUIDELINES and FOREST BIODIVERSITY GUIDELINES for details.

Wildlife habitats and biodiversity

Ensure that important wildlife habitats retained for biodiversity purposes are protected during harvesting. Plan operations with due regard to the breeding and nesting seasons of important species, and associated features such as badger setts and heronries. Important species to consider include birds of prey (buzzard, eagle, falcon, harrier, hawk, kite, osprey and owl) and mammals badger, bat species, red deer, hare, hedgehog, otter, pine marten and red squirrel. If possible and where wind firmness and landscape considerations apply, retain some stems to grow on to old age, ideally scattered throughout the forest. Some deadwood should also be left *in situ* after both thinning and harvesting, in the form of standing dead stems or naturally fallen trunks, or as logs deliberately left behind on the forest floor. See FOREST BIODIVERSITY GUIDELINES.

Perimeter trees

Narrow belts of perimeter trees on the skyline tend to accentuate the negative visual impact of harvesting operations and should not be retained unless for biodiversity purposes. See FORESTRY AND THE LANDSCAPE GUIDELINES.

Unrecorded archaeological sites

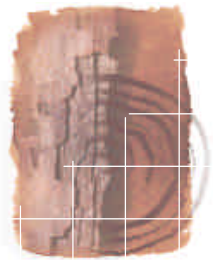
Any unrecorded archaeological site or artefact discovered during the course of the harvesting operations must be left undisturbed and the relevant authorities (the National Monuments and Historic Properties Service, the National Museum of Ireland and the Garda Síochána) notified immediately. A minimum exclusion zone of 20 m must be created until the site of the find has been investigated. Also, it is advisable to switch operations to some other part of the property until the investigation is complete. See FORESTRY AND ARCHAEOLOGY GUIDELINES.

Suspending operations

On sites which have a high risk of soil erosion or with soils of low bearing capacity, consider suspending mechanised operations during and immediately after periods of particularly heavy rainfall.

HARVEST SITE RESTORATION GUIDELINES

Harvesting operations can impact upon the forest infrastructure. Although the adoption of sensitive working practices will minimise any adverse effects, some disturbance is inevitable.



Road repairs

Road surfaces should be restored and reshaped as necessary to prevent erosion and sedimentation.

Drain repairs

Harvesting debris and sediment should be removed from drains, sediment traps and culverts. Drains damaged during the course of operations should also be repaired.

Temporary structures

All temporary structures, such as log bridges and corduroy rafts, should be removed immediately after use.

Hazardous compounds and refuse

Ensure that all hazardous compounds are removed from the site for correct disposal. All containers, machine parts and refuse generated by the operation should also be removed.

Water management on extraction routes

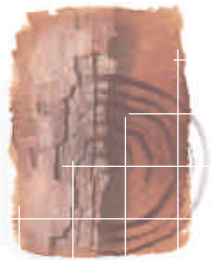
Immediately after operations, implement water control and soil ameliorating treatments on major extraction routes. These may include the creation of diversion channels across wheel ruts where there is a risk of erosion, or ripping in heavily compacted areas.

ROADING

Roading involves the construction and maintenance of forest roads, tracks and ancillary structures such as landings, turntables, bridges and culverts.

Forest roads and tracks provide access to the forest for management, recreation, harvesting and transport. They have the potential to adversely impact upon the environment. Therefore, during their construction, in the course of harvesting and immediately after the completion of operations, measures should be taken to minimise disturbance and the threat of sedimentation.

During harvesting and roading, ensure that all relevant measures are taken to avoid sedimentation and damage to aquatic zones.



ROAD PLANNING GUIDELINES

The following guidelines outline planning procedures for developing a forest road network with minimal environmental disturbance.

Environmental features are usually more readily identifiable before canopy closure. Road planning at an early stage of the forest rotation would therefore be desirable, but this may conflict with the need to await technological or market developments.

Environmental issues

Identify all relevant environmental issues. Establish if the area to be roaded lies within or contains:
- an area identified as being environmentally sensitive in a County Development Plan;
- a part or whole of a Special Area of Conservation (SAC), Special Protection Area (SPA) or proposed Natural Heritage Area (pNHA);
- aquatic zones (see FORESTRY AND WATER QUALITY GUIDELINES);
- archaeological sites and monuments (see FORESTRY AND ARCHAEOLOGY GUIDELINES);
- important habitats retained for biodiversity purposes (see FOREST BIODIVERSITY GUIDELINES).

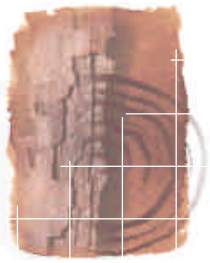
Liaise with the following for practical advice where important environmental issues are involved:
- the relevant Regional Fisheries Board;
- the relevant Local Authority;
- National Parks and Wildlife of Dúchas The Heritage Service;
- the National Monuments and Historic Properties Service of Dúchas The Heritage Service;
- other relevant bodies and non-government organisations.

Terrain inspection

Inspect the area and prepare a map (Ordnance Survey 6 inch scale is usually appropriate) which includes the following:
- The boundaries of the forest to be roaded.
- Main public access route(s) and any existing forest road and track network, including associated structures such as landings, turntables and bridges.
- The environmental features of the area, including all aquatic zones, archaeological sites and monuments, and important habitats.
- Additional features which may present difficulties or require particular attention when developing a road network, e.g. awkward bends and restricted bridges, landscape considerations, dwellings and associated buildings, overhead and underground utility lines (electricity, gas, telephone and water), public and private water supplies, rights-of-way.
- The location of buffer and exclusion zones within the area (as stipulated by FORESTRY AND WATER QUALITY GUIDELINES and FORESTRY AND ARCHAEOLOGY GUIDELINES), within which operations will be prohibited or restricted.
- Areas unsuitable for roading, due to potentially high erosion risk, topography, etc.
- The location of machine maintenance, refuelling and repair areas and storage areas for fuel, motor oils, lubricants and chemicals. These must be on dry, elevated sites at least 50 m from the nearest aquatic zone. See FORESTRY AND WATER QUALITY GUIDELINES.
- The location of any gravel source within the forest which is intended to be used for road construction.

Spacing and density

Determine the appropriate spacing and density for the road and track network. The extent of forest roads and tracks will depend on factors such as the size and shape of the forest, expected volume, current and potential value of the crop, the harvesting systems and machinery to be used, and the nature of the terrain.



Brash mats and suitable wheel attachments, such as tracks, will protect against soil damage and sedimentation during extraction operations.

Road design standards

Road design standards should be based on:
- the bearing capacity of the public road access routes;
- anticipated axle loads;
- traffic intensities;
- environmental considerations.

Subjecting a forest road to axle loads greater than those for which it was designed can lead to severe damage, greatly reducing the life of the road and creating the potential for serious environmental disturbance and community upset.

Plan the routes

Plan the routes of forest roads and tracks and the location of landings and turntables to minimise the potential for environmental disturbance.
- Routes should avoid archaeological sites and important habitats. Their encroachment in or near wet or unstable areas or within 50 m of aquatic zones should be minimised.
- Maintenance costs and erosion problems tend to increase greatly with steeper inclines. The gradient of roads should therefore be kept to a minimum, restricted where possible to short stretches of steep road which are considered necessary to reduce overall impacts.
- The layout of the road network should be designed with appropriate variation in curves and gradient to reflect landform. Routes should be unobtrusive and cross skylines at the lowest practical point. See FORESTRY AND THE LANDSCAPE GUIDELINES.
- Landings and turntables should be located on stable, well-drained sites at least 20 m from the nearest aquatic zone. Avoid locating them on prominent spurs or ridges.
- Road layout should aim to direct off-road traffic away from aquatic zones, and should follow the natural contours of the terrain.

Suitably located landing areas and well-presented timber will facilitate efficient haulage of material from the forest.

ROAD CONSTRUCTION GUIDELINES

This section contains detailed information on low impact road construction techniques which can be used to reduce the potential for adverse environmental disturbance from road and track construction.

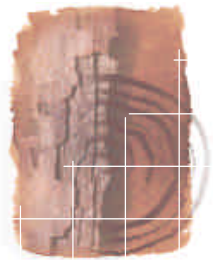
Minimise the total area of disturbance which results from road construction. The total length and average width of the road network should be the minimum required for efficient and safe transportation.

Timing of formation and construction

- Wherever possible, carry out formation and construction from April to October - the period when ground conditions tend to be drier.
- Where there is a risk of severe erosion occurring, construction should be suspended during periods of high rainfall.

Prior drainage and roadside drains

- Where the intended route of a road must pass through waterlogged or impervious soils, these areas should be drained before construction commences. This will stabilise the road bed and reduce the danger of failure during construction and use.
- Ensure that roadside drains do not intercept large volumes of run-off from higher ground.
- Cut-off drains should be constructed to a flat gradient at least 5 m back from the upper edge of the road formation, to avoid erosion.
- Roadside drains must never discharge directly into aquatic zones. As with all drainage channels, they must taper out before entering the buffer zone. This ensures that discharged water gently fans out over the buffer zone before entering the aquatic zone, with sediment filtered out from the flow by ground vegetation within the zone. If deemed necessary, install sediment traps at the end of the drainage channels.
- Adhere to drainage measures set out in FORESTRY AND WATER QUALITY GUIDELINES.



Buffer and exclusion zones

- The outer perimeter of all buffer and exclusion zones (see FORESTRY AND WATER QUALITY GUIDELINES and FORESTRY AND ARCHAEOLOGY GUIDELINES) should be marked clearly with a perimeter fence, brightly coloured paint marks on trees or brightly coloured tape.
- Machines should not enter these zones during roading operations, except where it is unavoidable.
- Fuel storage, maintenance, refuelling and repair work must not take place within 50 m of the nearest aquatic zone.

Culverts, bridges and fords

- Any work in an aquatic zone should be limited to the period May to September (inclusive).
- Crossings should be designed so that:
  - the number of crossings over a given aquatic zone is minimised;
  - disruption to the bank, bed and adjacent buffer zone is minimised;
  - the water flow is crossed at a right angle;
  - cement or uncured concrete is kept out of the aquatic zone, with cast-in-place concrete isolated from any water which might enter the aquatic zone, until the concrete is cured;
  - local stone is used for bridge kerbs and end treatments for culverts;
  - all timber treatment is carried out off-site.
- Consult with the Regional Fisheries Board at least six weeks prior to constructing any crossing over a fisheries aquatic zone.
- Bridge construction is necessary where culverts may restrict fish migration.
  - All supports and buttresses should be completely out of the stream.
  - Do not create shallow or shooting flow at the bridge aprons, to ensure that water velocities do not impede fish movement.
- Fords are not desirable and should only be used when the design is approved by the Regional Fisheries Board.
- All culverts should be well-bedded and of sufficient size to carry normal flow and to accommodate 25-year storm events, and to avoid blockages and washouts. Ends should be tapered to match the embankment slope. If greater than 1.0 m in diameter, they should be buried to a depth of 30 cm or 20% of their height (whichever is greater) below the streambed, and the original bed material as well as boulder-sized rocks placed in the culvert.

Embankments and cuttings

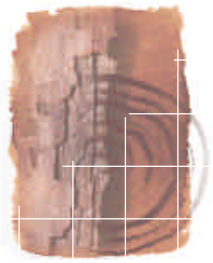
Maintain all roadside embankments and cuttings and encourage their revegetation (e.g. grass, willow), in order to improve stability and to prevent erosion. Divert drainage water from these to more stable vegetated ground.

Metalliferous or sulphide-rich material

Metalliferous or sulphide-rich material for road construction must not be used within 50 m of an aquatic zone. Any water flowing off such a surface should be directed onto vegetated soil and not allowed to flow directly into an aquatic zone.

Gravel removal

Gravel must not be removed from aquatic zones. Gravel should be removed from an aquatic buffer zone only after consultation with the Regional Fisheries Board and fishery owner. Any water discharging from a quarry or gravel source must pass through a sediment trap before entering the buffer zone.



Unrecorded archaeological sites

Any unrecorded archaeological site or artefact discovered during roading operations must be left undisturbed and the relevant authorities (the National Museum of Ireland, the Garda Síochána and National Monuments and Historic Properties Service) notified immediately. A minimum exclusion zone of 20 m must be created until the site of the find has been investigated. See FORESTRY AND ARCHAEOLOGY GUIDELINES.

Consolidation

All roads should be allowed to consolidate, dry out and settle before use, so that they do not become rutted from traffic.

Drain maintenance

Harvesting debris and sediment should be regularly removed from roadside drains, sediment traps and culverts to avoid blockages and washouts, particularly after extended periods of heavy rainfall.

Condition of roads

The condition of roads, drains and culverts should be assessed prior to and immediately after harvesting and transport operations. Photographic evidence gathered at this time may assist in any subsequent disputes.

Sediment traps

Sediment traps should be routinely inspected and cleared of sediment, preferably during May to September to avoid the sensitive salmonid spawning period.

Forest road entrances

Forest entrances off public roads should be sensitively designed and constructed, and well maintained.

MACHINE SERVICING

Machine maintenance and breakdowns require servicing and repair work to be performed during the course of harvesting and roadwork. It is vital that such operations, which can involve the spillage of potentially polluting materials, are undertaken at appropriate locations, and that the following procedures designed to limit potential environmental damage are adopted.

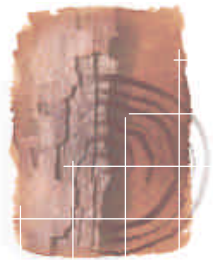
MACHINE SERVICING GUIDELINES

Hazardous compounds

Prepare and store all fuels and machine oils under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone. See FORESTRY AND WATER QUALITY GUIDELINES.

Maintenance and refuelling

All maintenance and refuelling operations and machine repairs (where possible) should be carried out at least 50 m from the nearest aquatic zone.



Ensure that all machine servicing is carried out at least 50 m from the nearest aquatic zone.

Spent compounds

Spent oils must be collected and retained for correct off-site disposal. Remove all containers from the site and dispose of carefully.

Accidental spillage

The relevant Local Authority and Regional Fisheries Board must be informed promptly of an accidental spillage of fuel or machine oil which threatens an aquatic zone. Do not, under any circumstances, discharge chemicals, fuels or machine oils into an aquatic zone.

MONITOR PERFORMANCE

The forest owner/agent should undertake inspections during the course of operations to allow for immediate corrective action to be taken in the event of deviations from the plan or unforeseen problems. An assessment should involve an evaluation of the location and condition of roads, landings and machine routes, particularly in relation to drainage, compaction and rutting. Sites should be visited in the aftermath of an extended period of heavy rainfall to ensure that, if merited, operations are suspended. An assessment should be undertaken to determine whether protected areas are undamaged, and that fuel, lubricants, anti-freeze, urea and other hazardous compounds are stored correctly and are removed from the site on the completion of operations.

The final product - quality timber harvested and extracted using environmentally sustainable techniques and operations.

The Forest Service gratefully acknowledges the contribution of Purser Tarleton Russell Ltd., Forest Industry Consultancy & Research, to the development of the Forest Harvesting and the Environment Guidelines, made through the preparation of a commissioned report. Copies of this report can be obtained from the Forest Service, Department of the Marine and Natural Resources, Leeson Lane, Dublin 2.

Photos: Forest Service.

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