B1 Scoping the environmental impacts of afforestation and deforestation projects

Explanatory note

For projects which require Environmental Impact Assessment (EIA), a scoping exercise should be undertaken early in the planning stages of the project. This enables the project to be designed to avoid or minimise negative environmental impacts and provides an opportunity to incorporate positive environmental enhancements into the project. Early consultation with all interested parties, including the Environment Agency, is an essential part of scoping. Even if a project does not require EIA under EIA legislation, it may be advisable (and in some cases necessary) to undertake a scoping exercise in any case (e.g. to support applications for other relevant consents and authorisations needed to carry out the project).

This guidance note aims to promote a good practice approach to scoping as part of the EIA process which in some respects goes beyond the statutory EIA requirements. When scoping a project, developers, or their consultants, should satisfy themselves that they have addressed all the potential impacts and the concerns of all organisations and individuals with an interest in the project.

This guidance note provides information on the most likely potential environmental impacts of afforestation and deforestation projects. However, each project must be considered on a case-by-case basis as the detailed characteristics of the proposal and the site will determine the potential impacts.

This guidance is based on the main legal requirements on EIA stemming from the EC Directive and the UK Regulations. However, developers should seek independent legal advice to ensure that the proposed development is carried out in compliance with the requirements of this and any other relevant legislation relating to planning as well as to pollution control.

This guidance note must be read in conjunction with the *Scoping Handbook*, which provides general guidance on the EIA process and the scoping of projects.

ENVIRONMENT AGENCY

This guidance note must be read in conjunction with the *Scoping Handbook*, which provides general guidance on the EIA process and the scoping of projects.

In addition, the following scoping guidance notes are also relevant to *all* afforestation and deforestation projects:

- A1 Construction work
- A4 Vegetation management and conservation enhancements

The following scoping guidance notes *may* be relevant in certain circumstances:

- A3 Redevelopment of contaminated land
- B3 Control of pest species, including disease vectors
- B4 Deliberate introduction of non-native and genetically modified species

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1 Introduction

1.1 This guidance note, in conjunction with the *Scoping Handbook* and the notes listed on the previous page, seeks to help developers and other interested parties identify the potential impacts of afforestation and deforestation projects on the environment as a whole. It should be emphasised that the list of impacts is by no means exhaustive and that a full investigation into positive and negative impacts should be undertaken. Early consultation with the Environment Agency, and other relevant organisations, will enable the identification of environmental issues and constraints and allow sensitive areas to be avoided, thus reducing the need for redesigning and mitigating avoidable impacts at a later stage.

1.2 Following this brief introduction, an overview of the legal requirements for EIA in relation to afforestation or deforestation projects is provided. The potential environmental impacts of such projects are identified in Section 3. The text and summary table in this section will enable the reader to begin to identify the likely impacts arising from the particular proposal under consideration. The subsequent sections present the mitigation measures that may be relevant to afforestation and deforestation projects, followed by key references and further reading.

Background to development type

1.3 Afforestation and deforestation projects involve the conversion of an area of land for the planting, growth and harvesting of a commercial timber crop. As such, the following discussion does not relate to the felling of native deciduous woodland. However, some of the information in this document will be relevant to such situations, as well as to the conversion of forest to some other use where felling is not followed by restocking. Afforestation provides a habitat for certain plants and animals, a recreational resource, a valuable product and a source of employment in rural areas. However, the change in land use and management operations on the forest site, including deforestation activities, may have significant effects on the surrounding environment. A thorough scoping exercise and careful consideration of alternatives are, therefore, of prime importance.

1.4 While this guidance focuses on the environmental impacts arising from large-scale commercial forestry operations, the impacts identified and the measures suggested to avoid or reduce those impacts may also apply to smaller-scale tree planting or removal activities.

2 Development control and EIA

Development control

2.1 Forestry activities do not fall under the town and country planning system, but are regulated by the Forestry Act 1967 and subsequent Regulations made under this Act. Developers should contact the Forestry Commission to confirm whether or not their proposals for planting or felling require consent.

Environmental Impact Assessment

2.2 Afforestation and deforestation are covered by the Environmental Impact Assessment (Forestry) (England & Wales) Regulations 1999 (SI 1999 No. 2228). Such activities are defined as, "initial afforestation and deforestation for the purposes of conversion to another type of land use." The Regulations also apply to the construction, alteration and maintenance of forest roads, and to operations to obtain materials for those roads (termed "forest quarry works").

It is likely that an EIA would be required if the proposed forestry project exceeds the following thresholds (see table below.)

Type of project	Threshold	
	Any part of the land is in a sensitive area	No part of the land is in a sensitive area
Afforestation	2 hectares, where the sensitive area is a National Park or Area of Outstanding Natural Beauty	5 hectares
	No threshold in the case of other sensitive areas*	
Deforestation	0.5 hectare, where the sensitive area is a National Park or Area of Outstanding Natural Beauty	1 hectare
	No threshold in the case of other sensitive areas*	
Forest road works	No threshold	1 hectare
Forest quarry works	No threshold	1 hectare

*Other sensitive areas include Sites of Special Scientific Interest (SSSIs); the Norfolk Broads; land subject to a nature conservation order; property appearing on the World Heritage List (kept under Article 11(2) of the 1972 UNESCO Convention for the Protection of World Cultural and Natural Heritage); scheduled monuments within the meaning of the Ancient Areas and Archaeological Areas Act 1979; and European sites within the meaning of Regulation 10 of the Conservation (Natural Habitats etc.) Regulations 1994 (as amended).

Furthermore, EIA may be required for any change to or extension of forestry operations already authorised, where the change or extension may have significant adverse effects on the environment. Responsibility for determining whether an EIA is required lies initially with the Forestry Commission.

2.3 Whether or not a formal EIA of proposed forestry works is required, the Environment Agency and other statutory consultees and regulators may request environmental information concerning the proposal. An EIA may provide the most appropriate method for a developer to collate the necessary information.

Other licences, consents and authorisations

2.4 Certain aspects of a forestry project may require prior permission from the Environment Agency. These may include, for example, land drainage consents, abstraction licences, impounding licences and discharge consents.

2.5 Certain aspects of decommissioning and demolition operations may require prior permission from the Environment Agency. These may include, for example, the handling, storage and disposal of waste materials on or off site, which may require a waste management licence, and the discharge of water from the site, which will require a discharge consent.

It is recommended that the developer seek independent legal advice and liaise with the Environment Agency during project design and subsequent stages to identify the consents, licences and authorisations that will be required.

3 Potentially significant environmental effects

3.1 The EIA Directive requires the EIA to "identify, describe and assess the direct and indirect effects of a project on the following factors: human beings, fauna and flora; soil, water, air, climate and the landscape; material assets and the cultural heritage; [and] the interaction between the factors." Socio-economic issues, health and safety in the workplace, material assets and cultural heritage are all considered in EU *Guidance on Scoping* (ERM, 2001a) but are not impact categories for which the Environment Agency is the principal competent authority. Advice on these issues is presented in this guidance note without prejudice to the advice of the relevant competent authority, but the relevant competent authority should be consulted for each of these categories in all cases (further advice on the appropriate competent authority to contact is given in the *Scoping Handbook*).

3.2 An EIA of any proposed afforestation or deforestation work should determine the potential impacts on the environment of each aspect of the project, including location and management. Careful scoping facilitates this process. This section provides a non-exhaustive description of the environmental issues that might arise during the scoping of an afforestation or deforestation project. The *Scoping Handbook* provides guidance on how to conduct a scoping exercise.

3.3 Afforestation and deforestation projects have the potential to affect the environment in many ways. They can differ widely in terms of their design and location and key issues are likely to vary from site to site. Therefore, it is recommended that expert advice on detailed technical issues be obtained. The issues arising for all environmental receptors will change over time as the forest stand grows, matures and is harvested. Developers and site operators should consider the impacts arising from ground preparation, planting, ongoing management and harvesting activities.

3.4 Potential impacts are discussed here in broad terms only, as their nature and intensity will depend on the physical characteristics of the afforestation or deforestation project and the characteristics of the receiving environment. An EIA of any forestry-related works should take these factors into account in assessing potential impacts on the environment.

3.5 The following paragraphs should be read in conjunction with Table B1. This details the activities involved in the preparation and ongoing management of a forestry project, and the associated impacts.

Water environment

3.6 Surface water hydrology can be affected during all phases of forestry operations. During site preparation, road-building and vehicle movements on the proposed site can result in compaction of soils and an increase in impermeable (or slowly permeable) surfaces. The subsequent increase in surface runoff may, in turn, increase the risk of flooding and soil erosion. Surface drains, installed chiefly to prevent water-logging of the soil, may also increase flood risk. Stream flows become less flashy as the forest matures due to decreased surface runoff and increased interception and evapo-transpiration losses (i.e. the evaporation of water from the surfaces and through the pores of leaves). Following deforestation, a return to bare ground conditions will cause increased runoff and a more rapid response to rainfall events within nearby streams, possibly increasing flood risk.

3.7 Surface water quality could be affected by a number of factors during forestry operations. Ground-preparation and planting activities may encourage soil erosion and increase the sediment loads of nearby streams, while spills or leaks of oil, fuel, pesticides or herbicides from planting and harvesting vehicles can also pollute surface waters. As the trees grow and mature, pollution from sediments will decrease, but inappropriate use of fertilizers and pesticides may reduce surface water quality. Also, the forest canopy acts as an effective trap for acidifying pollutants such as oxides of sulphur and nitrogen. Rainwater reaching the ground may have a reduced pH and contributes to the increased mobilisation of heavy metals in soils. This in turn can cause acidification and heavy metal pollution of nearby streams and lakes. During harvesting there are also risks from fuel and chemical spillage and following harvesting the return to bare ground will encourage soil erosion and could increase sediment loads of nearby streams.

3.8 Afforestation and deforestation activities may have significant impacts on groundwater hydrology and quality. There are some indications that the afforestation of some species on certain geology and soil types will significantly reduce the quantity of recharge reaching groundwater. The site may need to be drained to provide suitable conditions for tree growth, resulting in a lowering of the water table. As the stand matures, the water table may rise as interception increases. However, uptake by trees will cause increased evapo-transpiration, which may result in seasonal reductions in groundwater flows. The main threat to groundwater quality is the increased mobilisation of heavy metals and aluminium caused by acidified water percolating through the soil.

3.9 In order to protect vulnerable groundwater resources it is the policy of the Environment Agency to encourage new developments to locate in areas of low vulnerability to groundwater pollution. However, this policy does not imply an automatic prohibition on afforestation and deforestation projects within source protection zones (see Environment Agency, 1998).

Land

3.10 Forestry projects will have implications for the physical characteristics and land use of the site. By their nature, such projects have the potential to change the site significantly. Activities such as cultivation, planting and felling can cause soil disturbance, compaction and increased erosion, while the character of the landscape will vary depending on whether the area is newly planted, comprises mature trees, or has recently been felled. Most sites will require some degree of cultivation prior to planting in order to achieve a favourable environment for tree survival and early growth. Cultivation techniques include mounding, scarification, subsurface treatments and more uncommonly ploughing, with the overall emphasis on achieving cost effective tree establishment with least impact upon the environment. Associated with repeated rotations of the forest crop there is potential for soils to become acidified and depleted of nutrients. However, impacts on soils do not necessarily result in long-term soil degradation as long as compaction, nutrient removal and erosion rates are less than, or of a similar magnitude to, the recovery capacity (soil formation, nutrient input, etc.) of the soils. The physical planting of a prepared site usually involves manual spadework and therefore causes little disturbance to the site. Where sewage sludge is used as a soil amendment in forestry, there is a risk of heavy metal accumulation. When soils are acidic, often the case in soils under conifers, these metals may be mobilised and leached into watercourses.

Air and climatic factors

3.11 Afforestation and deforestation have the potential to affect local air quality and climate, and to contribute to global climate change. During ground preparation, planting and harvesting, local air quality may decline

as a result of dust from vehicle movements on and off site. However, the principal impacts of forestry works can be described as net-positive during growth and maturation of the crop, and net-negative following deforestation. During growth, there is an uptake of carbon dioxide (CO_2), a major "greenhouse gas." This provides some compensation for CO_2 emissions from activities using fossil fuels. Deforestation, while not contributing directly to global warming, does remove this beneficial effect until the next cycle is initiated with replanting.

Ecology

3.12 The removal of native vegetation and its replacement with a forest crop (either broad-leaved/deciduous or coniferous/evergreen) can cause direct damage to, or loss of, semi-natural terrestrial and aquatic habitats. Commercial forestry often occupies relatively infertile sites, such as moorland, heath and sand dune communities. It, therefore, replaces open-ground conditions and associated open-ground flora and fauna, so while a new habitat is provided, there will be an overall loss of biodiversity.

A change in species numbers and composition can be expected as the habitat changes from open ground to mature woodland and back to open ground.

Human environment

3.13 The potential impacts of a forestry project on the human environment may take a variety of forms. Impacts are divided here into sections covering socio-economic and health issues; amenity, visual impact and nuisance issues; and culture, heritage and archaeology.

3.14 The identification of which of these issues are significant or are perceived to be significant is an important function of public involvement during the scoping exercise. Understanding likely public concerns is a key issue and experience from other forestry projects and any public representations to the local planning authority should be taken into consideration.

3.15 The potential for socio-economic and health impacts (real and perceived) arising from a forestry project is likely to be small. Such projects usually require comparatively small staffing levels and, as a result, employees are not likely to have a significant effect on local socio-economic characteristics. However, in sparsely populated areas, forestry is an important source of employment and income.

3.16 Other issues that commonly need to be addressed include the visual impact of the site before and after planting, during tree growth and following deforestation. Also, noise and vibration nuisance may arise from traffic during both site preparation and felling phases. Any restrictions on access that may arise as a result of the development should also be considered, as should the creation of nuisances such as mud on roads and slow-moving vehicles. The forest has the potential to provide an amenity resource, with possibilities for forest walks, cycle paths or bridleways.

3.17 Impacts on architectural and archaeological heritage may occur in the form of damage to features during site preparation, planting and harvesting phases. Tree root growth may also damage archaeology. Also, there is the possibility of growing or mature trees obscuring sites of archaeological interest. Effects on such archaeological and historical features should be taken into account. The likelihood of there being any unrecorded sites and their potential for discovery should also be examined.

Table B1

3.18 The impact identification table highlights:

- sources of impact (development activities);
- potential impacts;
- receptors for these impacts.

3.19 It is recommended that the table is annotated and used during consultations with other interested parties. Reference should also be made to the prompt lists detailing impacts and sources of impacts in the *Scoping Handbook*.

Table B1 Summary of key potential impacts of afforestation and deforestation projects

Potential receptors of impact		Activities and potential impacts		
		Site preparation and planting phase	Growth phase/ongoing site practices	Harvesting/deforestation
WATER	Surface water hydrology and channel morphology	**Use of vehicles and machinery** • Increase in surface runoff from soil compaction • Physical damage to banksides and stream beds from vehicle movements **Ploughing and drainage works** • Increased surface runoff • Increased sedimentation of watercourses **Works next to or near watercourses** • Change in flow velocities • Increased erosion and subsequent changes in bed and bank stability • Increased flood risk	**Site drainage** • Rapid transfer of rainwater to watercourses via drains • Changes to flow regimes of watercourses • Downstream change in deposition regime, caused by changes in flow and possible increase in sediment input from soil erosion • Increased flood risk **Presence of mature/maturing forest** • Gradual decrease in surface runoff with increased tree growth, as interception of precipitation increases	**Use of vehicles and machinery** • Compaction of soils leading to an increase in surface runoff **Removal of forest cover** • Reduced interception of precipitation and increased surface runoff • Possible increased flood risk • Blockage of watercourses due to fallen trees and debris may cause flooding
	Surface water quality	**Ploughing and drainage works** • Pollution from suspended material • Possible disturbance of contaminated soil and subsequent pollution of watercourses **Materials management** • Pollution from spills or leaks of vehicle fuel, oil and chemicals • Surface preparation • Pollution of surface waters by inappropriate use of fertilizers, pesticides and herbicides	**Presence of mature/maturing forest** • Capture of acidifying pollutants in the forest canopy causing a reduction in the pH of water reaching the forest floor, leading to an increase in the acidity of surface waters • More acidic water causes increased mobilisation of metals such as aluminium **Management practices** • Use of fertilizers, herbicides and pesticides may cause pollution of surface waters	**Removal of forest cover** • Increase in suspended solids in runoff • Increase in sediment-loading of receiving water bodies

Potential receptors of impact		Activities and potential impacts		
		Site preparation and planting phase	Growth phase/ongoing site practices	Harvesting/deforestation
WATER *continued*	Groundwater hydrology	**Ploughing and drainage works** • Reduction in water table • Changes to groundwater distribution and flow	**Presence of mature/maturing forest** • Water table gradually restored as forest matures • Potential to reduce the quantity of recharge reaching groundwater reserves	**Use of vehicles and machinery** • Compaction of soil and increase in runoff • Lowering of water table
	Groundwater quality	**Earthworks** • Possible disturbance of contaminated soil and subsequent groundwater pollution **Materials management** • Pollution from spills or leaks of vehicle fuel, oil and chemicals	**Presence of mature/maturing forest** • Increasing acidity of groundwater • Increasing metal concentrations in groundwater **Management practices** • Use of fertilizers, herbicides and pesticides may cause pollution of groundwater	

Potential receptors of impact		Activities and potential impacts		
		Site preparation and planting phase	Growth phase/ongoing site practices	Harvesting/deforestation
LAND	Landscape	**Ploughing and site drainage** • Removal of existing vegetation	**Physical presence of maturing forest** • Progressive change in appearance and character of landscape	**Removal of forest cover** • Sudden change from forest landscape to open ground • Change in landscape character
	Soils	**Use of vehicles and machinery** • Compaction • Erosion • Loss of soil on access roads **Ploughing and site drainage** • Further erosion of exposed soil	**Physical presence of maturing forest** • Gradual reduction in soil erosion as tree cover matures • Increase in organic matter at the soil surface • Capture of acidifying pollutants in the forest canopy may lead to acidified soil water, increased leaching of nutrients from the soil, and increased mobilisation of heavy metals and aluminium • Possible change in soil type as former vegetation cover replaced with that of forest (e.g. soil may become more podzolic under an upland conifer plantation)	**Use of vehicles and machinery** • Compaction • Erosion of newly exposed soil **Whole-tree harvesting** • Removal of nutrients, especially with short rotation on infertile sites • Soil disturbance • Increased leaching losses
	Geology	**Construction of access roads** • Removal of rock	**Construction and maintenance of access roads during harvesting** • Removal of rock	
AIR	Local air quality	**Use of vehicles and machinery** • Dust generation		**Use of vehicles and machinery** • Dust during felling and extraction activities
	Regional/global air quality	**Use of vehicles and machinery** • Contribution to climate change through 'greenhouse gas' emissions e.g. CO_2	**Physical presence of maturing forest** • Uptake of carbon dioxide by trees, helping to offset emissions from vehicles and industrial processes that contribute to global warming	**Sudden removal of forest cover** • Loss of carbon dioxide "sink"

Potential receptors of impact		Activities and potential impacts		
		Site preparation and planting phase	Growth phase/ongoing site practices	Harvesting/deforestation
FLORA AND FAUNA	Aquatic ecology	**Drainage works and use of vehicles** • Negative impact on flora and fauna from increased sediment loading of streams **Materials management** • Harm to aquatic flora and fauna from oil, fuel, or substances such as fertilizers or pesticides entering watercourses	**Presence of maturing forest cover** • Increase in acidity of surface waters may adversely affect aquatic flora and fauna • Increase in aluminium concentrations in surface waters may adversely affect aquatic flora and fauna **Site drainage** • Indirect effect on aquatic flora and fauna from ongoing changes to stream hydrology and morphology	**Physical presence of felled area** • Adverse impact on aquatic flora and fauna from increased sediment loads in streams **Post-felling land use** • Opportunity for enhancement of nature conservation value
	Terrestial ecology	**Site clearance and road building** • Habitat removal, fragmentation or severance • Disturbance to, or loss of, species (including rare and sensitive species) **Ploughing and site drainage** • Drying out of ground may cause loss of species associated with wet conditions	**Physical presence of maturing forest** • Before the canopy closes, some open ground songbirds may increase in number (e.g. whinchat, stonechat, tree pipit, willow warbler and whitethroat) • Increased vegetation provides food and shelter for certain animal species (e.g. short-tailed vole, red deer, roe deer) • Change in species number and composition, as the habitat type changes from open ground to woodland • After 10-15 years, the increasingly dense growth of the trees eventually suppresses other vegetation and the associated animal communities **Tree-thinning operations** • Thinning of maturing forest allows light to reach the forest floor and ground flora to develop, with an associated increase in animal species (invertebrates, birds and mammals)	**Physical presence of felled area** • Continued habitat fragmentation or severance • Increase in abundance of certain plant species as clearings are colonised (e.g. rosebay willowherb, foxglove, bramble, buckler fern, woodrush) • General loss of ecological diversity in the open ground communities of subsequent rotations **Post-felling land use** • Original flora and fauna may recover if site is left undisturbed • Impacts during site preparation and growth phase will be repeated for subsequent rotations

Potential receptors of impact		Activities and potential impacts		
		Site preparation and planting phase	Growth phase/ongoing site practices	Harvesting/deforestation
HUMAN ENVIRONMENT	Socio-economic[1]	**Ploughing and drainage works** • Disruption of services such as electricity, gas, water, or telecommunications due to the presence of underground cables and pipes • Forestry-related employment • Employment in provision of recreational and amenity facilities	**Management operations** • Employment in brashing and thinning activities • Forestry/recreation/nature conservation-related employment	**Felling operations** • Employment in tree felling and subsequent processing of timber **Post-felling land use** • Forestry/nature conservation-related employment
	Health and safety[1]	**Ploughing, drainage and other site works** • Risk of injury on plantation site	**Management operations** • Risk of harm to humans from brashing and thinning activities (e.g. injury from falling trees, or from felling equipment used) **Changes in water quality** • Increase in heavy metal concentrations in streams and lakes may pose a health risk if used for drinking water supplies	**Changes in water quality** • Heavy metals may persist in surface waters and continue to pose a health risk if such waters are used for potable supplies **Post-felling land use** • Continued forestry operations will repeat the impacts of site preparation and growth phases
	Amenity	**Ploughing, drainage and other site works** • Possible alteration of rights of way or reduction in access	**Presence of mature forest** • Provision of recreational facilities (e.g. footpaths, cycle paths and bridleways) • Possible alteration of rights of way or reduction in access • Increased acidity and metal concentrations in surface waters may affect enjoyment of wildlife and recreation areas	**Felling operations** • Temporary disruption to rights of way • Negative visual impact of cleared area **Post-felling land use** • Provision of recreational area • Continued impact on fishing of adjacent water bodies as fish may be affected by effects of acidity and metal toxicity over a long timescale

Potential receptors of impact		Activities and potential impacts		
		Site preparation and planting phase	Growth phase/ongoing site practices	Harvesting/deforestation
HUMAN ENVIRONMENT *continued*	Nuisance	**Use of vehicles and machinery** • Noise from construction traffic and operations • Mud on roads		**Felling operations** • Noise of vehicles and machinery • Mud on roads adjacent to site • Slow-moving traffic on public roads
	Architectural and archaeological heritage[1]	**Site clearance, ploughing and road building** • Damage to features of archaeological or cultural importance	**Physical presence of maturing forest** • Damage to archaeological features by root growth	**Felling operations** • Damage to features of archaeological or cultural importance

[1] The Agency considers that key impacts to be identified and assessed are likely to include the following, but further advice and guidance should be sought from the relevant competent authority, as indicated in the *Scoping Handbook*.

Additional site-specific issues:

4 Mitigation measures

4.1 Following the scoping exercise and the identification of potential environmental effects, mitigation measures should be proposed to avoid or reduce potential negative impacts to air, water, land, ecology and humans, or to introduce positive aspects to the development. Guidance has been provided by the Environment Agency to assist developers on a range of relevant subjects in the form of pollution prevention guidelines (see the *Scoping Handbook*). Other relevant publications are listed in Section 5.

4.2 A primary consideration in impact mitigation must be the siting of a forestry project so as to avoid acid-sensitive areas, damage to important ecological sites and high-quality landscapes. Also, it is Environment Agency policy to seek the preferential location of developments in areas which are not vulnerable to groundwater pollution (Environment Agency, 1998). It is strongly recommended, therefore, that project proponents undertake an assessment of alternative sites.

Mitigating the impacts of site preparation and planting activities

4.3 Site preparation and planting activities have the potential to affect all environmental receptors. However, the following list summarises the mitigation measures most relevant to afforestation projects:

- phasing of site preparation and planting works to minimise disturbance to wildlife at sensitive times of year, such as during the breeding or spawning season or when young are being raised;
- drains should be constructed to end 15 to 20 metres short of natural watercourses. This enables water to be filtered through soil or ground vegetation before reaching streams, thereby reducing the rate of runoff and the amount of sediment transported and nutrient loss, as well as helping to neutralise water acidity where the local geology provides adequate buffering;
- contour ploughing or use of ripping or spot-scarification reduces surface runoff and disturbance to soils and hydrology;
- use of techniques to minimise compaction of soil, such as restricting access during wet conditions, and using protective boarding, brash mats and low ground pressure machinery;
- the forest margin should be kept back from the edges of larger streams (a distance of ten times stream width, up to 30 metres). This prevents shading effects and reduces disturbance to aquatic flora and fauna, and also reduces the acidification of water caused by litter accumulation;
- storage of fuel, chemicals and equipment so as to minimise the risk of soil contamination or water pollution (Environment Agency, 2000a);
- setting the route and timing of site traffic so as to avoid residential areas or other sensitive human receptors (e.g. schools, hospitals, nursing homes);
- use of dust control strategies;
- access roads should avoid riparian zones and should be planned to minimise the number and frequency of watercourse crossings. They should be built using appropriate construction materials;

- planning should take account of sites of archaeological and architectural value. There may be the need to employ an archaeological 'watching brief' during operations.

Mitigating the impacts of the maturing forest

4.4 While potentially the most severe environmental impacts occur during the site preparation, planting and harvesting phases, there is scope for reducing some of the adverse effects arising during the growth and maturation of the forest. Although sensitive siting and design of forestry projects are the primary means for avoiding or reducing their environmental impacts, further measures can be introduced to minimise impacts occurring from the growth and ongoing management of the forest. An overall consideration is that a project's design and management are in accordance with any conditions imposed by the Forestry Commission, the Department for Environment, Food and Rural Affairs (DEFRA) (for projects in England), or the National Assembly for Wales Agriculture Department. Developers should seek independent legal advice to ensure that all legal requirements relating to the proposed development are identified and complied with.

4.5 The measures have been arranged according to their primary receptor; however, it should be noted that many of the following mitigation measures are interrelated. For example, techniques employed to reduce soil erosion would also reduce the sediment loading of nearby streams and would, in turn, benefit aquatic flora and fauna. In addition, it should be noted that some of the impacts of afforestation, especially on visual intrusion and on ecological resources, are the cumulative effects of a number of separate projects. Thus, some impacts have to be assessed at a macro-landscape scale.

Protecting the water environment

4.6 In order to minimise potential impacts on the water environment during the ongoing management of a forestry project, owners and operators must ensure that:

- an appropriate water management system is used, including, for example, efficient land drainage and the use of constructed ponds for receiving site runoff to reduce the impact on nearby watercourses;
- sustainable drainage systems should be used to alleviate flooding, improve water quality and ensure recharge of groundwater base flows;
- in order to mitigate the effects of reduced groundwater recharge, afforestation should avoid areas where water resources are currently over-abstracted;
- where ponds are not constructed, drains should be stopped 15 to 20 metres short of natural watercourses to allow runoff to be filtered through soil or ground vegetation. This reduces the amount of surface runoff entering streams, thereby reducing flood risk. It also reduces sediment and nutrient inputs to watercourses and helps to neutralise acidified runoff;
- hazardous or potentially polluting materials such as fuel, oil or wastes are sited on an impervious base away from water, properly bunded, and kept locked when unattended;
- if materials such as fertilizers, pesticides or herbicides are necessary, they are used in accordance with relevant guidance (see Section 5, below);
- a risk assessment is carried out for each substance to be stored on site, and the appropriate containment measures installed;
- an emergency plan is formulated and tested through exercises to ensure that procedures to prevent or mitigate impacts due to accidents

or spillages are in place and operate effectively (some developments may require such plans to be formulated and the Environment Agency should be consulted to identify where this is the case).

Protecting the land environment

4.7 Certain measures noted above for protecting the water environment, such as the correct storage and use of potentially polluting substances, will also reduce the likelihood of soil contamination. Impacts on soils and landscape may also be mitigated by:

- appropriate design of buildings and structures on site;
- effective stabilisation of any new or altered landforms so as to minimise soil erosion and, in turn, the potential for water pollution from suspended solids;
- planting of mixed tree species to avoid negative visual impact of single-species areas of forest;
- techniques such as liming and fertilizing which may counteract the effects of increasing acidity of soils and associated leaching of nutrients and metals. However, it should be noted that these methods also have potential environmental impacts (see Scoping Guidance Note B2).

Protecting the air environment

4.8 Although impacts on air quality are likely to be minimal while the forest is maturing, dust from vehicles and machinery used during management operations may still reduce local air quality.

Protecting ecology

4.9 Measures designed to prevent or reduce impacts to water or land will also help to prevent adverse impacts on ecology. The following list identifies further measures to reduce or avoid impacts to terrestrial and aquatic species and their habitats:

- with a mature forest cover, conditions for flora and fauna will be improved by brashing (lopping off individual branches) and thinning (felling whole trees). This creates gaps in the canopy, allowing more light to reach the forest floor and an increased growth of ground flora, which in turn supports animal species (e.g. invertebrates, small rodents and deer). Thinning also favours certain bird species, such as woodcock, carrion crow, tawny owl, long-eared owl and sparrowhawk;
- afforestation needs to be assessed from a broader landscape perspective, as certain open-habitat species, such as kites and ravens, are displaced when the overall cover of forests exceed particular thresholds;
- thinning and brashing operations should be timed so as to minimise disturbance to flora and fauna at sensitive times (e.g. flowering, breeding);
- allowing dead and dying wood to remain in the forest favours fungi and invertebrates, and provides feeding habitat for birds such as woodpeckers;
- existing habitat features should be incorporated into site design and protected from change;
- further habitats should be created to compensate for habitat losses and to improve the landscape and ecological potential of the site;
- bird and bat populations may be encouraged by mounting nest boxes on trees;
- restoration plans should incorporate measures to improve the ecological status of the former forest site.

Protecting the human environment

4.10 Some of the measures noted above can also reduce possible impacts on humans, notably the risk assessment and emergency planning measures. Further mitigation measures more specific to the human environment include:

- management operations should aim to minimise disturbance to adjacent residential and recreational areas;
- where access restrictions result from the forestry project, arrangements for alternative access should be made with the provision of gates, bridges or stiles as required;
- safety concerns should be addressed by such measures as implementing strict health and safety procedures for forestry operatives;
- sites of archaeological or cultural interest should be preserved in situ where possible. As relocation is rarely possible, thorough archaeological investigations should be carried out where damage is unavoidable.

Mitigating the impacts of deforestation

4.11 As deforestation involves the sudden conversion from woodland vegetation to open ground, such activities have the potential for causing severe environmental impacts. Many of the mitigation measures listed above for the site preparation and planting phase are also applicable for deforestation. For example, water resources may be protected by the use of artificial ponds to receive excess runoff and by stopping drains short of watercourses to minimise flood risk and reduce sediment loading, acidification and chemical pollution of streams. Soil compaction and erosion may be minimised by using low-ground pressure machinery or restricting access during wet conditions. A general consideration is the felling regime, as the timing of harvesting activities and the pattern and amount of land cleared will affect the impacts on all environmental receptors.

Protecting the water environment

4.12 In addition to the measures described above, the impacts of deforestation on the water environment may be minimised by using continuous cover techniques or small block rotation in preference to clear felling. If a smaller area of the total is felled each year, surface water flows from the whole forest area will tend to even out.

Protecting the land environment

4.13 The main impacts of deforestation on soils are those of nutrient removal and further erosion and compaction. These may be mitigated by:

- using fertilizer to compensate for nutrient loss, but this may create additional environmental impacts;
- ensuring use of sewage sludge as a soil amendment and source of nutrients follows Forestry Commission guidance (Forestry Commission, 1992);
- use of longer rotations to allow more time for natural recharge of nutrients in the forest system;
- ensuring harvesting methods are dictated by site topography as well as soil type and conditions. Thus, harvesting methods should be selected to minimise and avoid damage to soils and leaching of nutrients following Forestry Commission guidelines, as listed in Section 5 below.

Protecting the air environment

4.14 As noted above, deforestation removes the beneficial effect of CO_2 sequestration. Forestry operations reinstate this effect with replanting.

Protecting ecology

4.15 The measures proposed for reducing impacts to water and land will also benefit terrestrial and aquatic ecology. Additionally, felling operations should be planned to avoid sensitive times of year such as flowering or breeding, while further disturbance may be reduced by felling smaller areas.

Protecting the human environment

4.16 As in the site preparation and planting phase, the following are important considerations:

- the route and timing of site traffic;
- the visual impact of the felled area;
- adequate warnings and alternatives to access during felling periods.
- the loss of recreational and amenity land whilst felling is taking place will require the provision of alternatives;
- sites of archaeological or cultural interest should be preserved in situ where possible. As relocation is seldom feasible, thorough archaeological investigation should be carried out.

5 References and further reading

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