J11 Scoping the environmental impacts of bridges and culverts

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 interbasin transfer of water. 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 relevant to *all* bridge and culvert projects:

- **A1** Construction work
- **A2** Demolition and decommissioning works
- **A4** Vegetation management and conservation enhancements
- **J1** River channel works and bank protection
- **J3** Flood diversion channels
- **J8** Restoration and enhancement of river channels

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

- **F6** Water-based recreation
- **F7** Angling and sport fishing, including fish stocking
- **J4** Flood storage areas and flood embankments
- **J6** Navigation works and canal restoration

Contents

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 bridge and culvert developments 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 the avoidance of sensitive areas, 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 bridge and culvert 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 bridge and culvert developments, followed by key references and further reading.

Background to development type

1.3 Bridge and culvert activities involve the construction of permanent engineering structures across watercourses and larger rivers. The construction of bridges may impact upon the local environment and river dynamics particularly where instream span supports are required. The construction of culverts may be required to contain the flow of a watercourse and to channel it below or around man-made structures. The type of culvert used will depend upon the engineering requirements of the site. Culvert designs may range from steel or concrete slab arranged at the sides of a watercourse, which may or may not be covered, to cylindrical four sided pipes where the stream bed is replaced. In the first instance some element of a natural watercourse is retained, the latter are examples of artificial water channels. The construction of bridges and culverts and their associated activities may have significant effects on the surrounding environment. A thorough scoping exercise and careful consideration of alternatives are, therefore, of prime importance.

2 Development control and EIA

Development control

2.1 Many activities associated with culverting do not fall under the town and country planning system. However, where such works are an integral part of a larger development that falls under these regulations, then the impact of any culverting should be addressed in an EA of the development proposal. Where proposed culverting does not require a formal environmental assessment as part of a larger development, it may nevertheless be worthwhile to undertake some form of assessment. With regard to bridges that are included as part of a proposed local authority highway development, these will fall under the town and country planning system and will require consent from a local planning authority. Bridges associated with highways and trunk roads promoted by the highways agency or by the National Assembly for Wales do not go through the local planning process but are subject to public consultation, draft orders and Public Enquiry.

Environmental Impact Assessment

2.2 The construction of bridges and culverts are not included as separate development types in the Town and Country Planning (Environmental Impact Assessment) (England and Wales) 1999 (SI 1999 No. 293). However, where these form part of a larger development, of a type included in these Regulations, then an EIA would be required of all aspects of that development. Several development types in particular are likely to require the construction of bridges or culverts, for example highway developments, railways and inland waterways. Developers should therefore consult these Regulations for further information on the thresholds applicable to their particular development type, to determine whether a full EIA might be required. Where EIA is required for a particular project, the construction of bridges and culverts must be included in the scoping phase and assessed and discussed in the environmental impact statement. EIA may also be required for any change to or extension of bridge and culvert activities, 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 local planning authority.

2.3 Whether or not a formal EIA for a proposed bridge and culvert development 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 licenses, consents and authorisations

2.4 Certain aspects of bridge and culvert construction projects may require prior permissions from the Environment Agency. These may include, for example, land drainage consents, abstraction licences, impounding licences and discharge consents. It is recommended that the developer seek independent legal advice and liaise with the Environment Agency during project design and subsequent stages to identify and confirm 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 The construction of bridges and culverts have the potential to affect the environment in many ways. They can differ widely in terms of their mode of operation 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 site is prepared and managed and following the end of operations. Developers and site operators should therefore consider the impacts arising from both construction activities and operational practices, and following the end of on-site activities.

3.3 Potential impacts are discussed here in broad terms only as their nature and intensity will depend on the physical characteristics of the project and the composition of any polluting materials. An EIA of proposed bridge and culvert construction activities should take these factors into account in assessing potential impacts on the environment.

3.4 The following paragraphs should be read in conjunction with Table J11. This details the activities involved in the construction, daily running and decommissioning of bridge and culvert developments, and the impacts arising from them.

Water environment

3.5 Surface water hydrology can be affected during all phases of bridge and culvert activities. Construction activities 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. Bridges and culverts can potentially alter the flow regimes of the river thereby affecting water velocity, depth, depositional patterns and channel morphology. Theses changes in turn may increase the risk of flooding and erosion.

3.6 Surface water quality could be affected by a number of factors during operations on site. Construction activities may encourage soil erosion and increase the sediment loads of nearby streams, while accidental leaks/spills of oil/fuel from storage tanks or construction, maintenance and decommissioning vehicles can also pollute surface waters.

3.7 Construction activities may also have significant impacts on groundwater hydrology and quality. The site may need to be drained to provide suitable conditions for the engineering works to occur, resulting in temporary changes to ground flow. Also, soil contaminated from a

previous land use may be disturbed during construction works, causing pollutants such as heavy metals to enter ground and surface waters.

3.8 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 such projects within source protection zones.

Land

3.9 Bridge and culvert projects will have implications for land-take, the physical characteristics and land use of the site. Issues to consider include the effect on landscape character from change in land use, soil erosion and compaction resulting from the construction and decommissioning phases of the development. The potential for contamination via runoff from roads and hardstandings must be addressed.

Air and climatic factors

3.10 The construction and decommissioning phases of bridge and culvert developments have the potential to affect local air quality and climate. During these activities, local air quality may decline as a result of gaseous and particulate emissions from vehicle movements on and off site.

Ecology

3.11 The removal of native vegetation and its replacement with bridge and culvert engineering structures can cause direct damage, disturbances, fragmentation or loss of terrestrial and aquatic habitats and ecology. Construction and decommissioning activities could also result in the increased sediment loading of streams and changes in turbidity may impact adversely upon aquatic populations. In addition to this, local ecological populations may be adversely affected by pollution incidents attributed to fuel leaks and oil spills associated with construction, maintenance and decommissioning operations on site. The physical presence of both bridge and culvert engineering structures may affect ecological populations in a number of ways. The local ecology may be disrupted as habitat corridors become severed. In addition, culverts may act as barriers to the migration of fish and small mammals. Bridges in particular will cause some shading of the river bank and bed thereby potentially altering the aquatic flora present in the river bed. Ecological impacts may operate over a longer time-scale, as populations take time to respond to environmental changes (time lag).

Human environment

3.12 The potential impacts of a development for bridges and culverts on the human environment may take a variety of forms. They are divided here into sections covering socio-economic and health issues; amenity, visual impact and nuisance issues; and culture, heritage and archaeology.

3.13 The potential for socio-economic and health impacts (real and perceived) arising from bridge and culvert developments is likely to be small. Such operations usually require comparatively small staffing levels and, as a result, employees are not likely to have a significant effect on local socio-economic issues. However, such social issues should be considered when scoping an EIA.

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 reference to experiences from other similar developments and any public representations to the local planning authority should be made.

3.15 Other issues that commonly need to be addressed are the visual impact of the engineering structures and any additional buildings associated with it. Any restrictions to access that may arise as a result of the development should also be considered, as should the creation of nuisances such as noise and vibration from traffic during the construction and decommissioning phases, dust in the air, and mud and slow vehicles on public roads. Also, the amenity use of nearby streams or lakes may be affected if reduced water quality causes harm to fish.

3.16 Impacts on architectural and archaeological heritage may arise from site preparation and construction, as features may be removed or disturbed. The likelihood of there being any unrecorded sites and their potential for discovery should also be examined.

Table J11

3.17 The impact identification table highlights:

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

3.18 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 J11 Summary of key potential impacts of bridge and culvert developments

Potential receptors of impact		Activities and potential impacts		
		Construction phase	**Operation phase/ongoing site maintenance**	**Decommissioning/post-operation**
WATER	Surface water hydrology and channel morphology	**Use of vehicles and machinery** • Increase in surface runoff from soil compaction **Works next to or near watercourses** • Change in flow velocities • Increased erosion and subsequent changes in bed and bank stability • Increased flood risk **Earthworks** • Increased sedimentation of watercourses	**Physical presence of bridge** • Upstream potential impediment to flow, decreased water velocity and increased depth – increased flood risk • Change in deposition regime upstream, caused by changes in flow and potential flood risk and changes to riffle/pools • Downstream potential increased water velocity, and turbulence and erosion **Physical presence of culvert** • Loss of pools/riffles, alteration of natural bed slope, decreased water turbulence and oxygenation, increased bank erosion downstream.	**Site drainage** • Increase in surface runoff from bank areas during decommissioning due to soil compaction • Possible increased flood risk
	Surface water quality	**Earthworks** • Pollution from suspended material • Disturbance of contaminated soil and subsequent pollution of watercourses **Materials management** • Pollution from spills or leaks of fuel, oil and construction materials	**Physical presence of bridge** • Upstream impounded waters will reduce oxygenation • Downstream water quality may be reduced by increased turbidity.	**Materials management** • Pollution of surface water by fuel and oil spillages from vehicular activities
	Groundwater hydrology	**Earthworks and site drainage** • Reduction in water table • Changes to groundwater distribution and flow	**Physical presence bridge/culvert** • No significant impacts	

Potential receptors of impact		Activities and potential impacts		
		Construction phase	**Operation phase/ongoing site maintenance**	**Decommissioning/post-operation**
WATER *continued*	Groundwater quality	**Earthworks** • Disturbance of contaminated soil and subsequent groundwater pollution **Materials management** • Pollution from spills or leaks of fuel, oil and building materials	**Physical presence of bridge/culvert** • No significant impacts **Maintenance work and materials management** • Contamination from spills or leaks of fuel and oil from routine maintenance work	**Materials management** • Pollution of groundwater by fuel and oil spillages from the decommissioning vehicular activities
LAND	Landscape	**Excavations and earthworks** • Creation of a new landform	**Physical presence of bridge/culvert** • Change in character of landscape	**Decommissioning** • Temporary visual impacts from work being carried out on site
	Soils	**Use of vehicles and machinery on site** • Compaction • Erosion **Earthworks** • Further erosion of exposed soil • Removal or alteration of soils on site for bridge/culvert construction	**Use of vehicles and machinery for on site maintenance** • Soil compaction • Soil erosion **Physical presence of bridge/culvert** • No significant impact	**Use of vehicles and machinery on site** • Compaction • Erosion **Decommissioning earthworks** • Further erosion of exposed soil • Removal or alteration of soils on site for bridge / culvert removal
	Geology	**Excavations** • Removal of rock by excavation works		
AIR	Local air quality	**Use of vehicles and machinery** • Emissions from construction site traffic • Dust generation	**Use of vehicles and machinery for on site maintenance** • Short-term exhaust emissions no significant impact	**Decommissioning activities** • Temporary vehicular emissions associated with site remediation
	Regional/ global air			

Potential receptors of impact		Activities and potential impacts		
		Construction phase	Operation phase/ongoing site maintenance	Decommissioning/post-operation
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, cement or other substances entering watercourses	**Physical presence of culvert** • Interruption of river corridor isolating habitats with potential decrease in species numbers and local biodiversity • Potential barrier created to the upstream migration of wildlife • Reduced daylight in enclosed culvert tunnel inhibit plant life • Increased water velocities in culvert may impede fish migration and spawning upstream **Physical presence of the bridge** • Changes to deposition, depth and water velocities may result in the loss of sensitive plant, invertebrate and fish species • Turbidity may contribute to reduced ecological diversity • Potential downstream changes to the aquatic community • Shading of the watercourse may reduce aquatic flora in the vicinity of the bridge • Potential barrier to fish migration and the movement of aquatic mammals along the river corridor **Materials management from ongoing site maintenance** • Direct and indirect effects from oil, fuel or other substances entering the aquatic environment	**Decommissioning activities** • Negative impact on aquatic flora and fauna from increased sediment loading of streams **Materials management** • Harm to aquatic flora and fauna from oil, fuel, cement or other substances entering watercourses **Restoration design** • Opportunity for enhancement of nature conservation value

Potential receptors of impact		Activities and potential impacts		
		Construction phase	Operation phase/ongoing site maintenance	Decommissioning/post-operation
FLORA AND FAUNA *continued*	Terrestrial ecology	**Earthworks and excavations** • Habitat removal, fragmentation or severance • Disturbance to, or loss of, species (including rare and sensitive species)	**Physical presence of culvert** • Alteration or loss of terrestrial habitats • Creation of barriers to mammals • Alteration of the channel bank habitat **Physical presence of bridge** • Loss of riparian habitat by virtue of land use adjacent to a watercourse for development • Upstream impoundment may cause an inundation of terrestrial and riparian habitats • Destabilisation of nearby wetlands - potential waterlogging of riparian areas – death of mature trees, shrubs and flowers	**Decommissioning activities** • Negative impact on terrestrial flora and fauna from vehicular activities, disturbance and habitat severance. **Materials management** • Harm to terrestrial flora and fauna from oil, fuel, cement or other substances entering watercourses **Restoration design** • Opportunity for enhancement of nature conservation value
HUMAN ENVIRONMENT	Socio-economic[1]	**Earthworks and excavations** • Disruption of services and roads where construction activities occur near to highways • Construction-related employment	**Physical presence of bridge** • Potential for disruption to commercial and recreational navigation • Changes to the angling quality	**Restoration design and after-use** • Public perception of the area may improve following sensitive restoration plans
	Health and safety[1]	**Earthworks and excavations** • Risk of injury on construction site • Risk of injury through construction traffic **Negative publicity** • Adverse reaction to perceived health issues	**Physical presence of bridge/culvert structures** • Risk of harm to humans falling from the structure into the watercourse	**Decommissioning activities** • Risk of accident or injury to authorised and unauthorised persons on site

[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*.

Potential receptors of impact		Activities and potential impacts		
		Construction phase	**Operation phase/ongoing site maintenance**	**Decommissioning/post-operation**
HUMAN ENVIRONMENT *continued*	Amenity	**Earthworks and excavations** • Temporary loss of amenity during construction phase	**Physical presence of bridge/culvert structures** • Possible alteration of rights of way or reduction in access to riparian habitats • Reduced recreation opportunities e.g. angling and boating • Loss of visual amenity	**Restoration design** • Provision of amenity/recreational area
	Nuisance	**Use of vehicles and machinery** • Noise from construction traffic and operations • Mud on roads	**Use site maintenance vehicles and machinery** • Noise **Physical presence of bridge / culvert structures** • Collection of unsightly litter behind the structures	**Decommissioning activities** • Temporary noise nuisance caused to communities proximal to the decommissioning activities • Temporary visual intrusion
	Architectural and archaeological heritage[1]	• Damage to known or unknown features of archaeological or cultural importance	• Bridges of archaeological or architectural importance may have restrictions on certain types of use/maintenance.	• Damage to known or unknown 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 bridge and culvert engineering operations. These should avoid 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. It is strongly recommended therefore that developers undertake an assessment of alternative sites.

Mitigating the impacts of construction activities

4.3 Construction and site preparation activities have the potential to affect all environmental receptors. However, the following list summarises the mitigation measures of most relevance for these types of engineering structures:

- phasing of construction work to minimise disturbance to wildlife at sensitive times of year, such as during the breeding season or when young are being raised;
- use of techniques to minimise compaction of soil, such as restricting access during wet conditions, and using protective boarding and low ground pressure machinery. If necessary, soil should be carefully removed and stored for subsequent reinstatement;
- use of dust control strategies;
- storage of fuel, equipment and construction materials so as to minimise the risk of soil contamination or water pollution (see Environment Agency Pollution Prevention Guideline 1, *General Guide to the Prevention of Water Pollution*);
- setting the route and timing of construction traffic so as to avoid residential areas or other sensitive human receptors (e.g. schools, hospitals, nursing homes);
- access roads should avoid riparian zones and should be built using appropriate construction materials.

Mitigating the impacts of the operational phase

4.4 Although sensitive siting and design of a development for bridges and culverts are the primary means for avoiding or reducing its environmental impacts, further measures can be introduced to minimise impacts occurring from the ongoing management of the site. An overall consideration is that the design and operation of the development are in accordance with planning conditions, the Environmental Protection (Duty of Care) Regulations (SI 2839) and other relevant legislation. Developers should seek independent legal advice to ensure that all legal requirements 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, correct storage, use and disposal of chemicals used for site maintenance would reduce the risk of soil contamination, pollution of surface and groundwaters, and harm to terrestrial and aquatic ecology.

Protecting the water environment

4.6 In order to minimise potential impacts on the water environment in the design and running of bridge and culverting operations, the project proponent must ensure that:

- culverts should be inserted below an existing river bed level to allow for bed formation within the culvert;
- culverts should incorporate a low flow channel within its base to retain sufficient water depth for aquatic life at such times;
- watercourses should not be deepened or widened up or downstream of culverts;
- artificial bank reinforcement should be avoided if possible;
- with regard to bridges, open parapets should be used to allow some over-deck flow in the event of the bridge opening becoming blocked in a major flood event;
- bridge soffit levels and flood spans should be at least 1 metre above the maximum known flood level to allow floating debris to pass freely through the structure;
- an appropriate water management system is used during the construction period, including, for example, efficient land drainage and the use of constructed ponds for receiving site runoff to reduce the impact of runoff on nearby watercourses;
- oil interceptors or drip trays are used in vehicle parking areas, and are inspected and cleaned regularly;
- a risk assessment is carried out for each substance to be used or stored on site, and the appropriate containment measures installed.

Protecting the land environment

4.7 Impacts on soils and landscape may be mitigated by the following:

- appropriate designs for buildings/structures on site;
- appropriate screening for visual impacts;
- effective stabilisation of altered landforms so as to minimise soil erosion and the potential for water pollution from suspended solids;
- with regard to bridge construction, where the substratum of a watercourse is disturbed by construction, this should be replaced.

Protecting the air environment

4.8 Developers should consider the aspects of the development that are likely to lead to air emissions.

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:

- 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 for the site;
- culverts should be wide enough to allow for ledges approximately 500mm wide and 300mm above the normal water level for the passage of mammals and should link to the banks up and downstream of the culvert;
- baffles should be incorporated into the design of the culvert base to provide shelter for fish as they pass through the culvert;
- holes and ledges should be incorporated onto the design of culverts for use as nesting sites;
- bat and bird boxes should be provided within the riparian areas;
- where clear span bridges are not a feasible design then a ledge, either in the form of a concrete shelf or gravel side bar, or mammal tunnels should be provided;
- consideration should be given to the provision of features within the bridge design to encourage nesting birds and bats.

Protecting the human environment

4.10 Some of the measures noted above can also reduce possible impacts on humans. Mitigation measures more specific to the human environment are listed below:

- management operations should aim to minimise disturbance to adjacent residential and recreational uses;
- where access restrictions result, arrangements for alternative access should be made with the provision of gates, bridges or stiles;
- safety concerns should be addressed by such measures as implementing strict health and safety procedures, and the installation of adequate fencing and other site security to prevent trespass and vandalism;
- 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.

5 References and further reading

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14 **Environment Agency (2000b)** *River Rehabilitation: Practical Aspects from 16 Case Studies.* EA Conservation.

15 **Environment Agency (2000c)** *Pollution Incident Response Planning. Pollution Prevention Guidelines No. 21.* Environment Agency, Bristol.

16 **Environment Agency (2000d)** *Low Flow Alleviation: Benefit Assessment Guidelines: version 3. EA Water Resources.* Environment Agency, Bristol.

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18 **Environment Agency (1999a)** *Maintenance of Structures over Water. Pollution Prevention Guidelines No. 23.* Environment Agency, Bristol.

19 **Environment Agency (1999b)** *Environment Agency Policy Regarding Culverts – Explanation of Policy.* Environment Agency, Bristol.

20 **Environment Agency (1999c)** *Environment Agency Policy Regarding Culverts – Policy Statement.* Environment Agency, Bristol.

21 **Environment Agency (1999d)** *Environment Agency Policy Regarding Culverts – Technical Guidance on Culverting Proposals.*

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26 **Environment Agency (1998e)** *Policy and Practice for the Protection of Groundwater (second edition).* Environment Agency, Bristol.

27 **Environment Agency (1997)** *River Works.* Environment Agency, Bristol.

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