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Project 351.

ENVIRONMENTAL ASSESSMENT BY EXTERNAL DEVELOPERS AND ORGANISATIONS (PHASE II)

NRA

National Rivers Authority

WRc plc

Project Record 351/7/T

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J Gulson, R Ashby-Crane

Research Contractor:
WRc plc
Henley Rd Medmenham
Marlow
SL7 2HD

National Rivers Authority
Rivers House Waterside Drive
Almondsbury Bristol BS12 4UD

National Rivers Authority
Rivers House Waterside Drive
Almondsbury Bristol BS12 4UD

Tel: 01454 624400
Fax: 01454 624409

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This document was produced under R&D Contract by:

WRc plc
Henley Rd Medmenham
Marlow
SL7 2HD

Tel: 01491 571531
Fax: 01491 579094

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NRA Project Leader
The NRA's Project Leader for R&D Contract 351:

Dr Andrew Brookes - Thames Region

Additional copies
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Environmental Assessment (EA) is a process that may be used as a tool by the National Rivers Authority (NRA) to protect the water environment from impacts arising from development activity. The statutory basis for EA lies in planning legislation, in which the NRA has a relatively minor statutory role as a consultee on planning applications for a limited range of development types. However, the process of EA within the NRA has many applications beyond that of commenting on planning applications alone, including the consideration of applications for licences and consents. Also, the NRA are increasingly being asked to comment on development proposals at an early stage by both developers and planning authorities, a trend enforced by recent government guidance. This research has been conducted to develop a more proactive and consistent response by the NRA to development proposals with the use of EA.

The report summarises the current status of the use of EA in the NRA and evaluates the use of current guidance available. Due to a wide variety of development types in which the NRA has an interest, scoping guidance has been produced for use by both developers and the NRA in the early stages of a project.

The scoping guidance will also service as development-specific review criteria to assess the adequacy of an Environmental Statement (ES) or other environmental information produced by developers in relation to a particular development. General review criteria are also presented. The use of these review criteria will facilitate a consistently-based approach to critiques of ESs and other environmental information presented to the NRA.

Consultation with the NRA and Local Planning Authority staff also identified a number of other areas in which the NRA may practise EA more effectively.

KEY WORDS

Environmental assessment, environmental appraisal, environmental statement, scoping, scoping, review criteria, development, developer, local planning authority, statutory consultee, planning liaison.

GLOSSARY

Audit - The comparison of impacts predicted in the ES with the actual changes.

Baseline Surveys - Surveys and data gathering carried out to indicate the current (i.e. pre-development state of the environment both at the site and in other localities, usually nearby, likely to be affected by the development.

Environmental Appraisal (ea) - The assessment of impacts upon the environment of plans and activities, including proposed development. The term is more generally applied to smaller scale development than environmental assessment and to applications for licence/consents.

Environmental Assessment (EA) - The assessment of impacts upon the environment of plans and activities, including proposed development. Formal EA relates to EA required under planning legislation.

Environmental Statement (ES) - Documentation of a formal EA.

Mitigation - Ways of reducing or eliminating impacts. This can include incorporating enhancement measures into the project.

Monitoring - The process of ensuring that planning conditions such as mitigation measures have been implemented means of generating a continuous record of change in the environment as a result of the project.

Scoping - The identification of key issues for an EA.

Screening - The decision as to whether the project will require an EA.

Glossary of Acronyms

ACC	Association of County Councils
ADC	Association of District Councils
AMA	Association of Metropolitan Authorities
CCW	Countryside Council for Wales
CIRIA	Construction Industry Research and Information Association
CMP	Catchment management plan
CPRE	Council for the Protection of Rural England
DoE	Department of the Environment
DoT	Department of Transport
DTI	Department of Trade and Industry
ea	Environmental appraisal
EA	Environmental Assessment
ES	Environmental Statement
EC	European Community
EH	English Heritage

EN	English Nature
ETSU	Environment Technology Support Unit
FC	Forestry Commission
GDO	General Development Order
IDB	Internal Drainage Board
IEA	Institute of Environmental Assessment
JNCC	Joint Nature Conservation Committee
LA	Local authority
LPA	Local planning authority
MPG	Mineral Planning Guidance
NPLG	National Planning Liaison Group
MAFF	Ministry of Agriculture, Fisheries and Food
NRA	National Rivers Authority
PPG	Planning Policy Guidance
RPG	Regional Policy Guidance
RSPB	Royal Society for the Protection of Birds
SACTRA	Standing Advisory Committee on Trunk Road Assessment
SEA	Strategic environmental assessment
SI	Statutory Instrument
SNH	Scottish Natural Heritage
SDD	Scottish Development Department
SOEnD	Scottish Office Environment Department
T&CP	Town and Country Planning
UK	United Kingdom
WO	Welsh Office

1. INTRODUCTION

The National Rivers Authority (NRA) has a variety of statutory duties relating to the aquatic environment, including conservation, fisheries, pollution control, water resources and flood defence. Development activity can have a variety of impacts on the environment. Therefore the NRA has an interest in assessing the effects of development on aspects of the environment relevant to these duties. Within the NRA, the process of assessing the input of development activity is known as environmental appraisal (ea) or environmental assessment (EA), the later term generally applying to larger-scale development. This report deals with both ea and EA, using to some extent the term environmental assessment in a general sense to cover both. The report focuses on the EA of development activity carried out by external bodies.

The NRA has the ability to influence the impacts of development by other organisations or individuals through a variety of means, through its role as a licensing body, and as a consultee both on development or structure plans and on individual planning applications. In each of these roles the NRA may apply EA.

Within the planning system, the planning authority concerned may formally request that an Environmental Assessment[1] (or formal EA) is carried out in order to ensure environmental considerations are taken into account for a proposed development. The legislative background to this arises from the European Community (EC) Directive on Environmental Assessment (85/337/EEC). The Directive requires that EA is carried out on a variety of specified development types, and that the results of the assessment are produced as a written Environmental Statement (ES) containing certain environmental information, some of which is relevant to the statutory responsibilities of the NRA. The Directive was implemented in the United Kingdom (UK) by a variety of regulations, primarily the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1199). Under further planning legislation (the Planning and Compensation Act 1991) the statutory requirement for EA may be extended to development types other than those set out in the Directive. However, where a proposed development is not of a type requiring formal EA or where the impacts are not judged to be significant, a request from the LPA for an EA is not justified. In such cases, planning authorities may still request certain environmental information to assess planning applications.

The NRA may thus be asked to comment on a ES in connection with development proposals or may receive environmental information less wide in scope. In addition, the NRA may itself request further information via the planning authority or directly from a developer, particularly in response to licence applications from the latter. (The process within the NRA of assessing the impacts of development outside the scope of formal EA is the aspect of EA also known as environmental appraisal or ea.)

This project was established to enable a more proactive role by the NRA with developers (and, to a lesser extent, local planning authorities) in both EA and ea, with a view to ensuring

[1] synonymous with Environmental Impact Assessment

that NRA concerns are addressed at an early stage in the planning process, rather than later through, often more confrontational, input and through regulatory functions. Such configuration may particularly arise where there is lack of consultation at an early stage with the NRA, such that planning approval may already given by the planning authority when licences/consents are sought from the NRA who have had no prior knowledge of a potentially damaging scheme. This report builds on earlier work, Phase I, by the University of Wales, Aberystwyth in which was produced, amongst other outputs[2], a manual *Environmental Assessments Undertaken by External Developers - An Interim Handbook for Staff*, perhaps more widely known as "R&D Note 76".

2 Phase 1 outputs were in King and Wathern (1992a, 1992b, 1992c)

2. PROJECT DEFINITION AND OBJECTIVES

The original objectives as set out in the terms of reference (August 1992) are reproduced in Table 2.1. Due to a variety of developments within the NRA and delays in initiating the project there was some alteration to these objectives and the corresponding work programme. For example, the development of training materials was addressed by an alternative project and current NRA training initiatives. The changes are not discussed here in detail, but developed through regular meetings between the contractor, WRc, and the Project Leader[1]. The resulting objectives were essentially:

- to assess guidance notes produced by other organisations;
- to road test R&D Note 76;
- to review procedures and methods concerning EA used within the 10 Regions of the NRA;
- to liaise with Head Office staff and the Planning Liaison Group
- to investigate the relationships between the NRA and Local Planning Authorities in the planning process;
- to produce development-specific guidance notes;
- to develop ES review criteria;
- to identify trends and further research; and
- to produce material for a brochure for external release.

The emphasis on the other objectives was reduced, and for others eliminated.

Note: [1] The Project Leader, Dr. Andrew Brookes, is both a contributor of the national steering group on EA and a Regional EA contact. Contact with the steering group was via the Project Leader

Table 2.1 Objectives in original terms of reference

Overall project objective

To provide further appropriate guidance to ensure that environmental assessments submitted by external developers and organisations correctly address the issues of concern to the National Rivers Authority.

Specific objectives

To develop further guidance and standards for external developers and organisations on those components if Environmental Assessments (EA) likely to involve issues of concern to the National Rivers Authority.

(a) To review and evaluate the procedures, methods and training concerning EA employed by each Function within the 10 Regions of the NRA.

(b) To closely liaise with Head Office staff and members of the Steering Group concerning the policy and procedural change implications of the work and to establish a clear link with the Planning Liaison Group.

(c) To liaise with external bodies, such as English Nature, who might be developing parallel guidance on environmental issues arising from projects.

(d) To monitor the applicability of the guidance notes produced in the first phase of this project.

(e) To explore the working of Local Authorities, particularly in relation to screening and scoping of Environmental Assessment in the broadest sense.

(f) To address the image of the NRA with respect to Local Authorities and external developers and their consultants.

(g) To produce a comprehensive set of multi-functional guidance notes, which will form the basis of a manual for internal use.

(h) To develop and apply a procedure to review the quality and contents of Environmental Statements and other documentation.

(i) To identify and develop training materials for NRA staff.

(j) To produce material for incorporation in a brochure on EA for release externally.

(k) To evaluate the emerging trends and needs for further EA research.

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3. METHODS OF WORKING

3.1 Review of other guidance

The availability of guidance on environmental assessment produced by other organisations was explored by a combination of literature review, personal contact with relevant personnel in a variety of organisations. Literature reviews included computer searches in established databases and perusal of relevant journals.

3.2 Road testing

Consultations were held with staff in the four Regions (Anglian, Severn-Trent, Thames and Welsh) to which R&D Note 76 had been released via their respective EA contacts. Consultation involved the use of a questionnaire (reproduced as Appendix A) and was used to achieve several goals:

- to establish Regional procedures, methods and training with respect to EA and ea;
- to investigate the use of R&D Note 76; and
- to identify suitable contacts in local planning authorities.

Consultation was primarily by personal visit although some consisted of written responses to the questionnaire passed on by Regional EA contacts. Consultees are listed in Appendix B.

3.3 Review of procedures in NRA Regions

EA contacts in the four Regions not subject to road testing were also contacted (Appendix B) for information on Regional EA procedures. A reduced questionnaire was issued.

3.4 Liaison with Head Office and Planning Liaison Group

The NRA staff consulted included the Head of Operators and National Planning Liaison Group Members (see Appendix B).

3.5 LPA approach

Consultations with LPAs occurred again through a mixture of personal visits and postal contact. Also, a questionnaire was used as the basis for discussion (Appendix C). Given the potential sensitivity of the subject of NRA involvement with planning, consultation only was made with those LPA staff suggested by NRA contacts. LPA consultees are listed in Appendix D.

3.6 Guidance notes

A list of 27 development types requiring guidance was developed (Table 3.1) following liaison between the Project Leader, WRc, national steering group members and Regional EA contacts. This included the revision of notes in R&D Note 76. Some of the development types were based on those in the EA Regulations (SI 1199); some others were based on specific NRA licensing activity.

Table 3.1 development types requiring guidance notes

General Construction
Reservoirs
Marinas
Barrages
Fish farms
Pipelines
Sea outfalls
Points of large abstraction
Points of large discharge
Sewage Treatment Works - extension and installation
Large residential developments
Large industry/manufacturing development
Golf courses
Power stations
Windfarms
Hydro power
Oil refineries/oil exploration
Forestry
Redevelopment of contaminated land
Waste disposal sites
Mineral extraction - mining and quarrying
Roads and road widening
Railways
Airports
Cemeteries
Navigation issues

There was some discussion as to what level of detail and format the guidance notes should be in. When the emphasis of the project was first changed to the production of guidance notes, it was felt that guidance notes might be required with three different levels of detail, i.e.:

(i) brief notes or checklists indicating key impacts

(ii) more detailed notes describing key impacts and similar to the guidance notes produced in R&D Note 76.

(iii) detailed guidance, describing not only key impacts but also preferred assessment and modelling techniques, suggested water quality standards etc.

After discussion within the NRA it was decided to produce notes on levels (i) and (ii). It was felt that level (iii) guidance may not only become outdated by changes to legislation, current techniques etc., but also were best left to expert working groups within the NRA to formulate as there was a risk of duplicating effort with such groups.

The format for the brief (level (i)) notes was the subject of some debate within the NRA, but the format proposed by the NRA was based on that of Table 3.2 which includes lists of issues and potential impacts. Sources of impact and other guidance are very case specific and could not be included in this general template.

Table 3.2 Standard basis for brief guidance

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics		Increased surface runoff Decreased surface runoff Increased flow velocities Decreased flow velocities Changed flow velocities Increased flooding Convergence/divergence of flow Increased frequency of flooding Increased duration of flooding Increased hydraulic roughness Decreased hydraulic roughness Increased magnitude of flooding Decreased flooding Changed hydraulics roughness Regulated flow Low flows Wave - generation Reduce tidal flow/flushing/mixing Riparian drainage affected	
Channel Morphology/ Sediments		Increased stability Decreased stability Bank degradation/erosion Erosion of bed and/or banks Deposition/siltation Change of slope	

Issues	Sources of impact	Potential Impacts	Other Guidance
		Change of planform/pattern Disturbance to bed forms (pools, riffles) Downstream erosion Domino effect Downstream deposition/siltation Upstream erosion Reduced channel size Increased channel size Upstream deposition/siltation Increased suspended sediment load Decreased suspended sediment load Increased bed load Decreased bed load	
Groundwater Hydraulics		Increased flow Decreased flow Loss of infiltration Changed direction Rise in water-table Fall in water-table Barrier to flow Altered flow	
Surface Water Quality		Acute chemical pollution Chronic chemical pollution Oil/fuel pollution Altered salinity Improved quality Chemical pollution Deoxygenation Oxygenation Thermal pollution Eutrophication Algal bloom Increased turbidity Decreased turbidity Microbial contamination Stratification	

Issues	Sources of impact	Potential Impacts	Other Guidance
		Re-suspension of contaminated sediments	
		Rubbish/trash	
		Increased dilution capacity	
		Decreased dilution capacity	
		Organic pollution	
Groundwater Quality		Movement of contaminated water	
		Reduced contamination	
		Saline intrusion	
		Chemical pollution	
		Oil/fuel pollution	
		Aquatic Ecology	
		Disturbed habitat	
		Degraded habitat	
		Habitat removal	
		Improved habitat	
		Increased fish biomass	
		Decreased fish biomass	
		Increase of invertebrates	
		Loss of invertebrates	
		Plant removal	
		Increased plant biomass	
		Loss of plants	
		Reduced species diversity	
		Effect on fish behaviour	
		Change in the fish community	
		Increased species diversity	
		Barrier to fish migration	
		Obstacle to fish migration	
		Fish kill	
		Introduction of alien eggs, larvae, fry	
		Effects on fish spawning	
		Disturbance of sensitive species	
		Gross habitat change	
		Loss of flora and fauna of flowing waters	
		Barrier to mammals	
		Loss of sensitive species	
		Disease/parasitic infection	
		Reduced bird/mammal populations	

Issues	Sources of impact	Potential Impacts	Other Guidance
Terrestrial Ecology		Disturbed habitat Changed habitat Degraded habitat Improved habitat Destruction of flora Tree removal Tree loss Loss of bird habitat Loss of bat habitat Wetland changes Improved riparian habitat Disturbance of sensitive species Decreased number of species Habitat loss	
Human-Related		Increased noise Increased vibration Adverse odour Dust Disrupted access Improved safety Health risks Nuisances Reduced flood risk Increased flood risk Increased water resource Decreased water resource Disruption to commercial navigation Flooded cellars	
Land Use Change		Arable intensification Increased urban area Deforestation Afforestation Loss of riparian land Change in grade of agricultural land Restriction to future developments Development of floodplain	

Issues	Sources of impact	Potential Impacts	Other Guidance
Visual Amenity		Aesthetic deterioration Aesthetic improvement Change in aesthetic value Altered landscape	
Recreation -Related		Restricted access Improved access Improved facilities Degraded facilities for water users Disrupted access Disruption to navigation Disruption to anglers Change in angling quality Disruption to cyclists Disruption to walkers Restricted access for water users	
Heritage & Archaeology		Destruction and damage of known/ unknown features Visual disturbance Loss of historical landscape Re-creation of historical landscape Change to historic landscape	

The format for level (ii) guidance notes was agreed to be a similar structure to those appearing in R&D Note 76. However, there was debate as to whether the description of impacts should be by NRA function (e.g. water quality, water resources, fisheries etc.) or should be by issues, such as phases of construction. It was decided that generally it would be easier for developers to relate to issues than functions and, besides, Planning Liaison staff should be suitably experienced to deal with either approaches. However, some notes were alternatively arranged following comments from relevant NRA staff.

3.7 Development of review criteria

Existing review criteria were assessed with respect to their value for EA within the NRA. Based on these further review criteria were developed.

3.8 Production of brochure material

Existing NRA literature on EA was examined and suggested text for a brochure produced.

3.9 Identification of trends and research ideas

Monitoring of literature was carried out to identify developing trends in legislation, planning and EA practice. From this, and the findings of the project, research requirements were also identified.

4. GUIDANCE NOTES PRODUCED BY OTHER ORGANISATIONS

Guidance produced by government and non-government sectors is discussed below. The information is summarised as Table 4.1.

Government Departments:

The Department of the Environment (DoE), commissioned research into impact assessment before the European Legislation was passed in 1985. In 1973, the DoE commissioned research which resulted in a report *Assessment of Major Industrial Applications - A Manual* published in 1976. Subsequently, further research was commissioned along with the Welsh Office (WO) and then Scottish Development Department (SDD), now Scottish Office Environment Department (SOEnD), and a report *A Manual for the Assessment of Major Development Proposals* was published in 1981. The latter report includes some useful technical notes in the appraisal of major development, e.g. on hydrological considerations, ecological impacts, and water pollution. The environmental impacts of a limited number of development types are outlined, e.g. water related developments (including reservoirs) and linear developments (including pipelines).

The DoE has produced the primary guidance on EA in relation to the EC Directive 85/337. In 1988, the Department produced a Joint Circular (15/88, WO 23/88), on the EA Regulations, i.e. the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1199), that implemented the Directive. The Circular was directed principally at local planning authorities and provided guidance as to ascertaining the significance of projects listed on Schedule 2 of the Regulations. The DoE (and WO) published a booklet in 1989 entitled *Environmental Assessment: A Guide to the Procedures* which explains the EA procedures in a more full and digestible fashion and reproduces information indicating the type and scale of developments requiring formal EA. This document and its updates has acted as the main guidance on EA since 1989. The DoE has also issued a free leaflet *Environmental Assessment*. The Welsh Office and Scottish Office have also produced similar leaflets.

The DoE are currently preparing guidance on good practice on the preparation of ESs, which was released in July 1994 as a consultation-document *Guide on Preparing Environmental Statements for Planning Projects*.. The guidance is "directed primarily at developers and their advisers who need to prepare environmental statements". Guidance on the evaluation of environmental information produced in connection with development proposals was also produced in 1994, the *Evaluation of Environmental Information for Planning Project - A Good Practice Guide*. This followed research described in *Good Practice on the Evaluation of Environmental Information for Planning Projects - A Research report* and was targeted primarily at development control officers in planning authorities, although it was thought to be also of assistance to representatives of statutory consultees (i.e. including the NRA).

Guidance on more strategic application of environmental considerations was produced by the DoE in 1991 as *Policy Appraisal and the Environment*. The intended use of this includes that by local authorities in formulating development plans.

Table 4.1 Guidance produced by external organisations

Organisation		Title
Department of Environment	1.	*Assessment of Major Industrial Applications - A Manual (1976)*
	2.	*A Manual for the Assessment of Major Development Proposals*(1981)
	3.	*Environmental Assessment (*Circular DoE 15/88, *WO 23/88)* (1988)
	4.	*Environmental Assessment: A Guide to the Procedures* (1989)
	5.	*Guide on Preparing Statements for Planning Projects (1994)*
	6.	*Evaluation of Environmental Information for Planning Project - A Good Practice Guide* (1994)
	7.	*Good Practice on the Evaluation of Environmental Information for Planning Projects - A Research report* (1994)
	8.	*Policy Appraisal and the Environment* (1991)
	9.	Press Release *Offshore Dredging for Minerals: Review of the procedure for determining production licence application* (1989)
Department of Transport	1.	*Manual of Environmental Assessment* (1983)
	2.	*Design Manual for Roads and Bridges, Volume 11, Environmental Assessment* (1993)
	3.	*The Good Roads Guide* (1992)
	4.	*Transport and Works Act 1992: A Guide to Procedures for obtaining orders relating to transport systems, inland waterways and works interfering with navigation* (1992)
Highways Agency	1.	*MCD Special Requirements for the National Rivers Authority & Revised MCD Clause 29* Guidance Note 27
Department of Trade & Industry	1.	*Guidelines on the Environmental Assessment of Cross-Country Pipelines* (1992)
Welsh Office	1.	*Roads in Upland Areas: a Design Guide* (1990)
	2.	*Roads in Lowland Areas: a Design Guide* (in preparation)

Organisation		Title
Scottish Office	1.	*Scottish Traffic and Environmental Appraisal Manual* (1986)
	2.	SOEnD Circular 29/1991 *Environmental Assessment and Private Legislation Procedure*
	3.	(As SDD) *Development of Contaminated Land* SDD Planning Advice Note 33. (1988)
Ministry of Agriculture, Fisheries and Food	1.	*Conservation Guidelines for Drainage Authorities*[1] (1991)
	2.	*Environmental Procedures for Inland Flood Defence Works:* a guide for managers and decision makers in the *National Rivers Authority, Inland Drainage Boards and Local Authorities* (1992)
	3.	*Coastal Defence and the Environment: A strategic guide for managers and decision makers in the National Rivers Authority, Local Authorities and other bodies with coastal responsibilities* (1992)
	4.	*Coastal Defence and the Environment: A guide to good practice* (1993)
	5.	*Guidelines for assessing marine aggregate extraction* (1993)
Government Committees		
SACTRA[2]	1.	*Assessing the Impact of Road Schemes* (1992)
Government Agencies		
Her Majesty's Inspectorate of Pollution	1.	*Environmental Assessment of Waste Disposal Facilities* (Draft Waste Management Paper 1989)
English Nature	1.	*Nature Conservation in Environmental Assessment*[3] (1993, 1994)
	2.	Internal EA Handbook
	3.	*Environmental Assessment - English Nature's Role and A Guide to Best Practice* (1995)
	4.	*Roads and Nature Conservation* (1994)
	5.	*Nature Conservation Guidelines for Renewable Energy Projects* (1994)
	6.	*On Course Conservation* (1991)

Organisation		Title
Joint Nature Commission	1.	*Scoping Guidelines for Ecological Impacts in Coastal Conservation Zones* (in preparation)
	2.	*Handbook for Phase 1 habitat survey - A technique for environmental audit* (Book and Field Manual) (1993)
English Heritage	1.	*Conservation Issues in Strategic Plans* (1993)[4]
Countryside Commission	1.	*Environmental Assessment* (1991)
	2.	*Landscape Assessment Guidance* (1993)
	3.	*Landscape and Visual Assessment: Guidelines* (in draft)
	4.	*Roads in the Countryside* (1995)
Forestry Commission	1.	*Environmental Assessment of New Woodlands* (1993)
	2.	*Forest and Water Guidelines* (1988, 1991, 1993)
Non-Governmental Organisations		
Crown Estate	1.	*Fish Farms: Guidelines on siting and design of marine fish farms in Scotland* (1987)
	2.	*Marine Fish Farms in Scotland: Guidelines on siting procedures and principles* (1989)
	3.	*An Environmental Assessment of Fish Farms*[4] (1987)
	4.	*Marine Aggregate Extraction and the Government View Procedure* (undated)
Institute of Environmental Assessment	1.	*Guidelines for the Environmental Assessment of Road.Traffic* (1993)
	2.	*Guidelines for the Baseline Ecological Input to Environmental Assessment in the UK* (1995)
	3.	*Landscape and Visual Impact Assessment Guidelines* (1995)
	4.	Water quality (planned)
	5.	Archaeology (planned)
Manchester University	1.	*Environmental Assessment Guide for Passenger Transport Schemes* (1991)
	2.	*The Environmental Impact of Opencast Coal Mines* (1991)
	3.	*Reviewing the quality of environmental statements* (1990)

Organisation		Title
CIRIA[5]	1.	*Environmental Assessment*
RSPB[6]	1.	*Strategic Environmental Assessment* (1992)
CPRE[7]	1.	*Environmental Statements: Getting Them Right* (1990)
Local Authorities		
Kent County Council	1.	*Kent Environmental Assessment Handbook* (1991)

Notes:
1 Produced in conjunction with the DoE and WO
2 CCW and SNH also contributed to this document
3 Jointly produced with EN and CC
4 Produced by Cobham Resource Consultants/Fisheries Development Limited
5 Construction Industry Research and Information Association
6 Royal Society for the Protection of Birds
7 Council for the Protection of Rural England

Although not directly concerned with EA, the DoE also produce Planning Policy Guidance (PPG) notes relating to various aspects of planning (e.g. *Planning and Pollution Control, The Countryside and Rural Economy, Development on Unstable Land and Coastal Planning*). A further PPG *Renewable Energy* discusses wind farms in some detail. The DoE have also produced relevant Circulars, e.g. Circular 30/92 (WO 68/92) *Development and Flood Risk*, which states not only the duties of the NRA with respect to flood defence, but also the need for consultation between NRA and planning authorities with respect to development plans.

For the environmental assessment of road schemes the Department of Transport (DoT) produced the *Manual of Environmental Assessment* in 1983. This was superseded in 1993 by the *Design Manual for Roads and Bridges, Volume 11, Environmental Assessment*. Other useful information on sympathetic road schemes may be found in relevant sections of *The Good Roads Guide*, such as those on nature conservation (HA 59/92) and on motorway widening (HA 62/92). Best practice guidance for developers/contractors with respect to protecting NRA interests has also been produced by the Highways Agency (HA 1994). Some guidance on the environmental assessment of other transportation schemes such as railways and inland waterways is available in *Transport and Works Act 1992: A Guide to Procedures for obtaining orders relating to transport systems, inland waterways and works interfering with navigation* (DoT 1992). As the title suggests the Act and guidance also covers works interfering with navigation, such as barrages.

In 1992 the The Department of Trade and Industry (DTI) Oil and Gas Division produced *Guidelines on the Environmental Assessment of Cross-Country Pipelines*, but no guidelines have been produced in relation to electricity proposals (power stations or overhead lines).

The Environment Technology Support Unit (ETSU) who provide advice to the DTI on renewable energy sources are in the process of producing general guidance on the EA of energy projects.

The Welsh Office produced *Roads in Upland Areas: a Design Guide* in 1990; this addresses the impacts on landscape of roads in often-sensitive upland areas. The designs concentrate largely on visual effects though some drainage aspects are illustrated. The Welsh Office is also currently preparing *Roads in Lowland Areas: a Design Guide.*

The Scottish Office has issued Circulars in parallel to those from DoE/WO. In addition, in 1986 it produced the *Scottish Traffic and Environmental Appraisal Manual* (STEAM) which has now been largely superseded by the DoT's *Volume 11*.

The former Scottish Development Department has produced *Development of Contaminated Land,* in 1988. This provides advice to local authorities and developers and, although not specifically referring to EA, highlights the pollution risks involved.

The Ministry of Agriculture, Fisheries and Food (MAFF) have produced a number of documents relating to flood defence (*Conservation Guidelines for Drainage Authorities* and the complementary *Environmental Procedures for Inland Flood Defence Works*) and coastal defence (two documents entitled--*Coastal Defence and the Environment*). *Conservation Guidelines for Drainage Authorities* (produced in 1991 in conjunction with the DoE and WO) describes statutory responsibilities under the Water Resources Act 1991 (WRA 1991) and EA requirements under SI 1988 Nº 1217. The guidelines set out the responsibilities of relevant bodies (NRA, English Nature etc.) and general good practice with respect to protecting conservation interests. *Environmental Procedures for Inland Flood Defence Works* produced in 1992, outlines the procedural steps in flood defence works and illustrates the EA procedures for improvement works. *Coastal Defence and the Environment: A strategic guide for managers and decision makers in the National Rivers Authority, Local Authorities and other bodies with coastal responsibilities* was also produced in 1992 and similarly describes procedural steps in considering and carrying out coastal defence works and illustrates the EA procedures. The more detailed *Coastal Defence and the Environment: A guide to good practice* produced in 1993 considers design options for coastal defences, their environmental impacts and environmental opportunities arising.

MAFF have also produced in 1993 Guidelines for assessing marine aggregate extraction to set out what is required in the assessment of effects on fishing and the marine environment.

Government Agencies:

In 1989, Her Majesty's Inspectorate of Pollution (HMIP) produced a Draft Waste Management Paper entitled *Environmental Assessment of Waste Disposal Facilities*. This provided guidance on the requirement of the EA regulations with respect to waste disposal facilities with an emphasis on landfill sites, although there is no information on likely impacts.

English Nature (EN) and the other country agencies commissioned a 1992 report *Nature Conservation in Environmental Assessment* which describes the Environmental Assessment process, good practice and role of the agencies. The document provides scoping matrices for ecological impacts associated with activities and activities associated with development types. Also, optimal times of year are given for surveys of various groups of organisation (e.g. vascular plants, wintering birds, breeding birds, Lepidoptera). This document has provided the basis for an internal EA Handbook on what EN responsibilities are and what to look for in reviewing ESs. The document has been updated and published in 1994 for wider dissemination under the same title, *Nature Conservation in Environmental Assessment.* A recent brochure *Environmental Assessment - English Nature's Role and a Guide to Beat Practice* has also been produced which is aimed at Local Planning Authorities, developers and their consultants. Other relevant publications include: *Roads and Nature Conservation (1994); Nature Conservation Guidelines for Renewable Energy Projects*, (1994) which concentrates on windpower; and *On Course Conservation* (1991) on conservation considerations for golf courses.

EN has also contributed to the Construction Industry Research and Information Association (CIRIA) guidelines and the forthcoming Institute of Environmental Assessment (IEA) guidance on incorporating ecological data into ESs.

In practice, EN has developed a regional network of EA experience which is called upon to back up policy initiatives. In addition, EN has a rolling training programme for staff.

In addition to contributing to *Nature Conservation in Environmental Assessment*, the Countryside Council for Wales (CCW) has produced *Interim Guidance on Landscape Assessment* which draws on the Countryside Commission's *Landscape Assessment Guidance.*

Scottish Natural Heritage (SNH) also contributed to *Nature Conservation in Environmental Assessment* but the agency does not seem to have exclusively produced any guidelines.

The Joint Nature Conservation Committee (JNCC) was in the process of preparing *Scoping Guidelines for Ecological Impacts in Coastal Zones*, although the precise content of this is not known. The JNCC has also produced a *Handbook for Phase 1 habitat survey - A technique for environmental audit* in 1993. The former Nature Conservancy Council were involved in the appraisal of EAs, and submitted *The Treatment of Nature Conservation in the Appraisal of Trunk Roads* to the Standing Advisory Committee on Trunk Road Assessment in 1990.

English Heritage (EH) have not produced any specific EA guidance but do routinely examine EAs in the context of major planning applications and EH had 'considerable input' into the DoT's revised EA guidelines. EH have prepared jointly with English Nature and the Countryside Commission *Conservation Issues in Strategic Plans* (1993) which is intended to present the views of these organisations to those involved in developing plans before statutory consultations occur. The document was produced following the publication of the DoE's PPG 12 *Development plans and regional planning guidance* and focuses on the key theme of sustainable development. The document refers to the need to examine the implications of regional development requirements for water supply, with scrutiny of the environmental effects of the alternative methods of meeting these requirements. Also, river catchments and coastal zones are specifically mentioned as examples of environments that would benefit from an integrated approach at the regional level. The role of the NRA and principle of catchment management plans are considered. Nature conservation is discussed at a general level, with the importance of SSSIs emphasised.

In 1991, the Countryside Commission produced *Environmental Assessment,* which provides guidance on the treatment of landscape and countryside recreation issues in EA. The report includes advice on the need for an EA, its content, and considerations of alternatives and mitigation measures. The Commission also published in 1993 *Landscape Assessment Guidance* which provides a recommended approach to landscape assessment. The latter report was not specifically addressed to EA and the commission is currently co-funding research (with CCW and SNH) to produce guidelines on landscape and visual assessment within the EA process. In 1995 the Commission published *Roads in the Countryside*, guidelines on road schemes and the landscape aimed at those responsible for planning roads at a county level.

The Forestry Commission has produced a booklet *Environmental Assessment of New Woodlands* and (three) editions of *Forest and Water Guidelines*. The booklet describes requirements for EA under SI 1988 Nº 1207, the Environmental Assessment (Afforestation) Regulations 1988. These include the general information required in the EA, such as considerations of the possible impact on water, estimations of the type and quality of residues and emissions (including pollutants of water). The *Forest and Water Guidelines* (1993), although not specifically targeted at EA, advise owners and managers how woodlands and forests influence the freshwater ecosystem and gives guidance on how operations should be carried out in order to protect and enhance the water environment. Other guidelines produced by the Forestry Commission include those in forest recreation, forest nature conservation and forest landscape design.

Non-Governmental Organisations

The Crown Estate have issued guidelines relating to fish farm developments in Scotland, i.e. *Fish Farms: Guidelines on siting and design of marine fish farms in Scotland (1987)* and *Marine Fish Farms in Scotland: Guidelines on siting procedures and principles* (1989) The latter include guidance on the EA requirements under SI 1988 Nº 1218, the Environmental Assessment (Salmon Farming in Marine Waters) Regulations 1988. The Crown Estate guidelines are currently being updated by SOEnD (Ian Pritchard, Crown Estate, pers. comm.). The origins of the above guidelines are a report An Environmental Assessment of Fish Farms commissioned by the Crown Estate Commissioners along with the Countryside Commission for Scotland, The Highlands and Islands Development Board and the Scottish Salmon Growers' Association. The report, produced in 1987, concentrated on Scotland and considered potential landscape, recreational and nature conservation effects of fish farming and also includes good practice in farm siting, design and management as mitigative measures.

The Crown Estate are responsible for licencing exploration and where appropriate, marine aggregate extraction, but are not responsible for decisions as to whether extraction can take place. As a result they have produced *Marine Aggregate Extraction and the Government View Procedure* explaining the process by which applications are approved, including the stage at which an EA may be required. The procedures are also explained further in a 1989 DoE Press Release *Offshore Dredging for Minerals: Review of the procedure for determining production licence application* which includes criteria to be used by the Crown Estate and the DoE in assessing the need for an EA. Impact assessment guidelines have been issued by MAFF.

Assessment in the UK and *Landscape and Visual Impact Assessment Guidelines* in 1995. Guidance on issues relating to water quality and archaeology are planned.

Manchester University have produced various EA documentation including *Environmental Assessment Guide for Passenger Transport Schemes* (Lee and Lewis 1991), *The Environmental Impact of Opencast Coal Mines* (Walsh *et al.* 1991) and *Reviewing the Quality of Environmental Statements* (Lee and Colley 1990).

The CIRIA has recently produced in 1994 *Environmental Assessment* which contains EA guidance (including likely impacts and suggested mitigation measures) for a variety of broad categories of schemes, i.e. building developments, river and coastal engineering, water engineering, linear development, electricity generation, minerals extraction and waste management.

The Royal Society for the Protection of Birds (RSPB) has contributed to the forthcoming IEA ecological guidelines and has co-produced a book on strategic environmental assessment (SEA) *Strategic Environmental Assessment* (Therivel *et al.* 1992). The organisation has not produced guidance notes *per se*. However, much of the RSPB's work on EA has comprised of submissions or talks for conferences etc. on policy or legal matters. The Society are involved in the EA of development plans and appraisal of EC structural funds.

The Council for the Protection of Rural England (CPRE) is a keen supporter of the EA process and has actively engaged in lobbying for improvements to EA legislation and implementation at the EC and UK levels. In relation to this, CPRE have produced various documents including a guidance brochure *Environmental Statements: Getting Them Right* (1990) to encourage developers and consultants to improve the quality of ESs.

Local Authorities

Kent County Council produced an EA handbook, the *Kent Environmental Assessment Handbook*, which provides guidance to developers in the county as to when EA is required and EA procedures. The document includes a section on what should be included in an ES and covers topics of Ground and Surface Water Resources, Water Pollution and Land Drainage/Flood Defence. Although the NRA is mentioned as the competent authority for some of these issues, the document barely refers to the NRA as a possible consultee, particularly for early discussions. The Planning Authority only states that copies of the ES and planning application would be sent to the NRA as required by Article 18 of the 1988 General Development Order (i.e. as a statutory consultee), although it does suggest that additional copies of the ES should be supplied as a variety of organisations may have an interest in the application, and presumably this could include the NRA as a non-statutory consultee.

CCW (1993) refer to a variety of landscape assessment techniques including Warwickshire County Council's Landscape Guidelines, Dyfed County Council's landscape analysis for assessing the scope for wind turbine development, the Agricultural Development and Advisory Service's Environmental Sensitive Area landscape assessments and Forest Enterprise forest design plans. In addition, CCW were being consulted in the production of a landscape assessment for an Indicative Forest Strategy by Clwyd County Council and the Forest Authority.

Water Industry

The water industry has historically funded much research, often in relation to the environmental impact of various schemes, although not in relation to EA *per se*. An example is research funded by the Foundation for Water Research on the effects of sea outfalls on the environment (Nixon 1990).

Coal Industry

In 1991, British Coal produced a framework policy on the environment. The policy document is not restricted to environment assessment, but discusses in broad terms environmentally sound approaches to the business areas of deep mines, opencast, coal products and coal in use.

5. NRA CONSULTATIONS AND ROAD TESTING

5.1 Introduction

In practice, the NRA comments on a variety of development proposals from external sources. The form of information received, upon which to comment is generally one of three types:

- a planning application with Environmental Statements (ESs) arising from formal Environmental Assessment (EA);
- planning applications without an ES; and
- applications for consents or licences associated with the development (before or after a decision on planning permission).

In addition, there may be pre-submission enquiries relating to each of the above from developers and/or local planning authorities (LPAs). Generally, most are dealt with entirely by Area offices.

In effect, there is a continuum of the scale and/or environmental significance of applications from relatively minor consent or licence applications to large scale development proposals. The principles of environmental appraisal or assessment apply to proposals across the continuum. Guidance in the form of R&D Note 76 has been produced to assist staff, particularly in their response to planning applications although should be used for all projects as appropriate. Planning applications are generally dealt with by Planning Liaison staff and licence/consent applications by relevant (core) functions. Land drainage consents are generally dealt with by Flood Defence or Development Control (titles may vary). Some Regions rely on LPAs to assess which planning applications the NRA should be asked to comment upon, others operate a visitor system, whereby NRA staff visit LPA offices to review lists of planning applications received to assess which should be referred to the NRA.

Although the NRA may be able to control to some extent the outcome of planning applications through its regulatory powers (i.e. it may indicate refusal of consents or licences if the NRA is aware of a planning application before its approval), the NRA's influence on planning applications may be limited to recommendations to LPAs. These comments may be incorporated, in turn, to recommendations made by planning officers to planning committees consisting of elected representatives. It is these committees who generally decide the outcome of planning applications, unless, for example, there is intervention by the Secretary of State. Once a planning application is approved, it may become more difficult for the NRA to refuse consent or licence applications. It is clear that a good working relationship with local planning authorities is necessary to ensure that the NRA's concerns are not only taken seriously, but are incorporated at an early stage.

Consultation with NRA staff was undertaken to 'road test' R&D Note 76. In addition, consultation with NRA staff and local planning authorities (LPAs) explored the relationships between the NRA and LPAs.

5.2 Convevance of NRA interests to external bodies

Although the bulk of NRA work consists of the day to day responses to individual development proposals (Section 5.3), the NRA is also involved proactively in various ways with LPAs and developers to more strategically convey its interests to these bodies.

5.2.1 Strategic approaches to LPAs

In most Regions regular meetings (usually annually) were held with LPAs at an Area or Regional level. One Region (Welsh) reported that meetings had been held with LPAs soon after the formation of the NRA but had not been repeated. Another Region (Severn-Trent) had produced a video on general environmental awareness and accompanying briefing notes on NRA requirements that were thought useful at meetings with LPAs. Meetings in some Regions may include other bodies (e.g. English Nature).

In some Regions, the NRA were invited to local planning forum at which NRA staff presented model policies. Such policies issued to LPAs provided strategic information that could easily be incorporated into structure plans, which have become more significant in determining the outcome of development proposals since the enactment of the Planning and Compensation Act 1991. Model policies are suggested in the nationally-produced document *Guidance Notes for Local Planning Authorities on the Methods of Protecting the Water Environment through Development Plans* (NRA 1994). This document sets out the statutory responsibilities of the NRA and provides information on NRA concerns with respect to: water quality and water resources; flood defence; fisheries, recreation and conservation in river corridors and coastal margins; and mineral workings and waste disposal. The document suggests the inclusion in statutory development plans of the policies, which reflect the Authorities concerns and responsibilities. The document has also enabled the NRA to respond to LPAs in a consistent manner in its role as statutory consultees on structure plans. (Draft plans are received from LPAs by strategic or forward planners and circulated within the NRA for comment). There were mixed opinions between NRA staff as to whether plans took into account the NRA's needs.

LPAs operate under the Town and Country Planning (T&CP) framework. Regionally, T&CP Liaison Procedures are produced (using a common basis) setting out the types of development the NRA would seek to be consulted. Table 5.1 presents those types typically included, although there were Regional differences. The NRA are statutory consultees for some of the development types listed under the General Development Order (GDO; Table 5.2), for some others it is the relevant licensing authority. For others there may be no statutory basis for consultation, although the development types are clearly of interest to the NRA.

Table 5.1 Development types typically in T&CP Liaison Procedures

General:

1. Development which departs significantly from published Development Plans.
2. Development within or adjacent to any water course on flood plains including coastal plains and tidal lengths of rivers, washlands and in areas where there may be drainage problems.
3. Development on, under or adjacent to or protected by any flood bank, sea defence or other flood control structure.
4. Development which may affect an aquatic/wetland site of conservation interest.
5. Development of contaminated land.
6. Development involving the disposal of sewage (other than to a public sewer) including the use of septic tanks, cesspits, sewage treatment plants and private sewers.
7. Development which could effect groundwater protection zones.
8. Development which could exacerbate existing sewerage or sewage disposal problems.

Specific:

9. Petrol filling stations or other storage facilities for petroleum products, chemicals, etc., including fertilisers and pesticides (above or below ground).
10. Timber treatment plants.
11. Intensive livestock and poultry units.
12. Kennels, catteries, stables etc.
13. Mineral workings and exploratory works including restoration.
14. Waste disposal operations (including landfill, waste transfer stations, incinerators, scrap yards, bailing and recycling plants and solvent recovery plants).
15. Burial grounds.
16. Development of water based recreation facilities.
17. Vehicle parks and plant hire depots.
18. Major residential, industrial and commercial developments.
19. Fish farming activities including fish stocking or relocation of fish or works which will restrict the movement of fish.
20. Camping and caravan sites.
21. Golf courses.
22. Swimming pools.
23. Water reservoirs and conservation lakes.
24. Development requiring an environmental assessment.
25. Highways, railways, power stations, airports and tunnels and any associated facilities.

Note:

Brief notes justifying each type accompany the list.

Table 5.2 Developments for which the NRA in a statutory consultee under the General Development Order[1]

Development involving or including mining operations
Development involving the carrying out of works or operations in the bed of or on the banks of a river or stream
Development for the purposes of refining or storing mineral oils and their derivatives
Development involving the use of land for the deposit of refuse or waste
Development involving sewage, slurry or sludge treatment or disposal
Development relating to the use of land as a cemetery
Development for the purposes of fish farming

Notes:

[1] The GDO is currently being consolidated; no changes to consultation requirements are expected.

Other strategic contacts made by the NRA include meetings with national associations (i.e. Association of County Councils, Association of District Councils and Association of Metropolitan Authorities (ACC, ADC and AMA)), and representation on the National Planning Forum. In addition, contact with the Department of the Environment (DoE) influences the framework within which the NRA and LPAs interact. This has included meetings and consultation on Planning Policy Guidance (PPGs), Regional Policy Guidance (RPGs), Mineral Planning Guidance (MPGs) and input to Government Circulars, e.g. DoE 30/92.

Catchment management plans (CMPs) have been issued for consultation to local authorities, which to some extent portray the NRA's vision of development in the catchment and should subsequently influence LPAs. The Thames Region have also produced *Thames 21 - A Planning Perspective and a Sustainable Strategy for the Thames Region*, a strategic examination of the entire Region, with a view to promoting sustainable development. The Region has also held a meeting (entitled "Water and the Water Environment) with the regional branch of the Royal Town Planning Institute (RTPI) with speakers from both the NRA and LPAs.

Other than commenting on individual planning applications, a variety of other *ad hoc*-contact occurs. For instance LPAs may ask the NRA for advice on sustainability, the LPAs, like many people, being unsure as to how to incorporate the concept into policies and actions. Survey data to assess flood risk, as collected under Section 24(5) of the Water Act 1973, have been issued as they have become available.

The NRA request various feedback from LPAs, including early notification of development proposals, consultation on relevant planning applications and decision notices on applications.

Where LA boundaries cross more than Region (e.g. Gloucestershire includes parts of four Regions), one Region takes the lead in dealing with the LPA.

The NRA has recently produced the first ten groundwater vulnerability maps intended to enable planners, developers and consultants to identify the vulnerability of groundwater to contamination. The areas covered are East Kent, Humber Estuary, West London, West Cheshire, North Essex, North West Hants, North East Yorkshire, West Norfolk, North Northants and Nottinghamshire.

5.2.2 Conveyance of NRA interest to developers

A general leaflet "*Safeguard the Environment - A guide to developers*" is available for issue to developers (either directly or via LPAs). It outlines the general responsibilities of the NRA and principal concerns with respect to development. The leaflet generally encourages developers to contact the NRA with respect to development.

More detailed information on NRA concerns with respect to specific development types exists in R&D Note 76 and this has been used to a limited extent (see Section 5.5). Guidance notes had been passed on both in response to specific planning proposals from developers and as a general briefing to consulting engineers and county councils.

Severn-Trent Region has produced guidance notes for some development types (details expected). The Region issues its Regional Guidelines for Environmental Assessment - these are designed for internal use, but are circulated to developers as an example of what the NRA would do themselves. As such, they incorporate considerations beyond NRA concerns, because the NRA as a developer, has to conduct EA in compliance with EA Regulations. (The EC Directive on Environment Assessment with respect to land drainage works was implemented by *The Land Drainage Improvement Works (Assessment of Environmental Effects) Regulations 1988*, SI 1217). Severn-Trent Region also distribute an EA/ES review questionnaire which differs from that of R&D Note 76.

Other information that was reported to have been sent to developers included the Riverside Owners Guide and Groundwater Protection Policy document in the Thames Region. The Welsh Region issued specific conservation guidance relating to pond construction, bridges etc. and copied relevant pages from the *Rivers and Wildlife Handbook* (Lewis and Williams 1984). (A 1994 edition of the Handbook is now available; RSPB/NRA/RSNC 1994). Also issued were guidelines on survey methodologies, e.g. for River Corridor Surveys, and NRA Special Requirements.

Catchment management plans (CMPs) may be relevant to developers, particularly in identifying sensitive areas. Similarly, documents such as *Thames 21* are useful in indicating sensitive areas and pressure points on a Regional basis. The Region specifically mentioned that verbal guidance may be given.

5.3 Responses to planning applications and applications for licences/consents

Planning applications are generally received by Area Planning Liaison or development control/flood defence departments. Increasing pre-submission enquiries were being received from developers; developers are generally learning that contacting the NRA early is ultimately beneficial.

Most applications were routinely processed by the NRA. However in some cases the NRA have identified the need for a formal EA, where the LPA has not requested one (e.g. hydro schemes in both Severn Trent and Welsh Regions, a project involving a large mixed development, and a project involving the redevelopment of contaminated land. In one instance, the LPA had invited the NRA to request an EA to strengthen LPA's demands for more environmental information in association with a quarry development). For a variety of applications the NRA may request environmental information, including instances where an adequate ES has been presented. In general, proposed schemes involving formal EA occurred infrequently.

Larger planning applications (including those with an associated formal ES) were generally dealt with by Planning Liaison. Planning Liaison seek comments from relevant functional staff and issue a co-ordinated response to the LPA. Planning applications for smaller schemes where the LPA assess that flood defence is the main issue are often received and processed directly by development control/flood defence staff. This was often done with support of conservation staff. This particularly occurred in the Thames Region where there seemed to be some reliance on conservation staff by area planning engineers, particularly after the relatively recent loss of area environment officers and Regional support with restructuring.

Generally, planning applications were dealt with at Area level although the Regional EA contact or other Regional staff may offer advice, when required. South Western Region reported that there were named Regional EA specialists from each discipline who could be called upon.

Standard comments and letters were generally used to respond to planning applications (and pre-submission enquiries, where appropriate). In addition, documents considered above, NRA functional leaflets, DoE guidance and text copied or extracted from R&D Note 76 were used. Internal guidance was used in formulating responses, e.g. standard comments, manuals and Policy Implementation Notes (PINs).

Although contact with LPAs and developers was generally through planning liaison or development control/flood defence staff, functional staff also would be in direct contact in detailed discussions, e.g. if NRA requirements were thought unreasonable or if the NRA request an ES to be rewritten or clarified.

The NRA could affect the outcome of development proposals via a number of routes:

(i) by influencing planning conditions set by the LPA;

(ii) by instigating or consulting on Section 106 agreements set by the LPA;

(iii) through powers as a licensing authority under the WRA 1991 and

(iv) (rarely) through legal agreements established between the developer.

In general, it was felt that the NRA would achieve most within the planning system by negotiating improvements to schemes (although these must be within the legitimate planning framework). Ideally, the need for environmental improvements should be raised early so that the costs of these improvements could be taken into account at the original sale of land to the developer. Thus, the NRA require input wherever possible to a pre-development brief.

Applications for licences/consents alone may be dealt with directly by relevant functional staff (i.e. land drainage consents by flood defence, discharge consents by water quality/pollution control, abstraction licences by water resources and fish stocking. consents by fisheries). The views of other functional staff may be sought where applications are considered to affect those other functions. Severn-Trent Region reported that all consent applications were passed to the Conservation and Recreation Section and generally dealt with by Assistant Area Conservation and Recreation Officers who would utilise a site database of maps to identify important/vulnerable sites. It was stated, however, that there was not direct input into decision for conditions of licences.

In general, NRA staff reported that LPA's varied greatly in their degree of interaction with and responsiveness to the NRA. Regions reported that occasionally some planning applications had been approved by LPAs without any NRA consultation, despite their relevance to the NRA. The NRA would usually learn about such instances from decision notices or from subsequent licence applications. It was more difficult to refuse licence applications if planning permission has been granted. Fortunately, instances of significant development beginning without any prior NRA knowledge were rare.

The experience of the NRA with planning authorities/developers varied with development type, reflecting the differing planning authorities or developers responsible. For instance, South Western Region reported that for schemes not covered by T&CP procedures, the experience with roads and water company schemes was generally good, but was poor with forestry, ports and other schemes covered by specific SIs.

5.4 Review criteria

Review criteria of Environmental Statements were rarely applied, due to the infrequency of ES receipt and extent of use of R&D Note 76. However, criteria were applied in some instances to environmental information supplied with planning applications or to applications for water abstraction licences. Review criteria used included those in Section 4 of R&D Note 76 and those developed by Severn-Trent Region. The use of matrices was also reported in one Area. One Region commented that recent training has raised staff awareness on what to expect in EAs.

Review criteria were thought useful as there is often a tendency to judge only the information supplied, and not that lacking. However, there is the opposing risk of being too prescriptive and local knowledge of NRA staff not being taken into account. In some instances, term consultants (consulting engineers - roads) were the recipients of some ESs and these took an overview.

On Region commented that few people had time to read ESs sent out for comment.

A simple checklist had also been developed by strategic planners in Thames Region to review structure plans and identify outstanding issues (Table 5.3).

Table 5.3 Checklist to review structure plans in the Thames Region

NRA Functions	Legislation, Guidance, Advice etc.				Policies in Guidance Notes	Policies CMPs	Policies in Devt. Plans
	European	National Legislation	PPGs	Regional (RPG9)			
General Issues	*	*	*	*			
Water Quality/ Pollution Control	*	*	*	*			
Flood Defence	*	*	*	*			
Fisheries	*	*	*	*			
Navigation	*	*	*	*			
Ecology/ Conservation	*	*	*	*			
Amenity & Recreation	*	*	*	*			
Water Resources	*	*	*	*			

*** Cross referenced to the index**

5.5 Use of R&D Note 76

Some of the uses of the R&D Note 76 Environmental Assessments Undertaken by External Developers - An Interim Handbook for Staff are discussed above, i.e. to convey NRA concerns to developers and for ES review. These and the wider use of the handbook are discussed below.

In the Anglian Region the handbook it frequently used, principally by Planning Liaison and Fisheries, Recreation, Conservation and Navigation (FRCN) staff. It was felt that wider dissemination, e.g. to pollution control staff would be useful, particularly with respect to assessing applications for discharge consents.

Main uses included:

- to respond to pre-submission enquiries staff may copy general guidance on EA and the NRA (Section 1A), the sample checklist to identify impacts (Section 1B), the sample layout for a scoping brief (Section 3A), and relevant guidance notes (from Section 3);

- for scoping EAs (pre-submission) and formal environmental reports;

- for assessing the need for formal statements, assessing ES quality and coverage of impacts or issues;

- for assess applications for licences and consents; and

- as a general reference document.

In Severn-Trent Region the handbook was used only by Assistant Area Conservation and Recreation Officers (Asnt. ACRO) and Area Planning Liaison officers and not by other functional staff. There was a deliberate desire to limit the dissemination of the handbook such that responsibilities were not confused and to base responses on a core of experience/expertise. It was felt that the handbook should not be used more widely as a "paper-based expert system". Not all those in possession of the handbook used it, in one case this was because the occasions had not arisen. In another case experienced staff members had not generally used the handbook but it has proved useful for a new member of staff and as a checklist for the main issues of concern where these were unclear.

In the Thames North East Area the handbook was generally not used, even though staff in this Area had been specifically trained in its use.

The South East (London) Area used the introduction for background information. Other parts of the handbook were photocopied to applicants including checklists. The guidance notes were generally not relevant to the Area and too rural in outlook.

In the West Area of Thames Region the handbook was used by development control, mainly as a quick checklist/*aide memoir* for scoping. Other uses included screening and guidance notes, where relevant.

In the Welsh Region the manual had been disseminated to Area offices but had been little used, although one consultee admitted this was essentially due to oversight. Some staff felt that they are familiar with the development types already and did not require guidance. The handbook was regarded, at worst, a safety net to be used if needed, and potentially a useful guide for reference and information.

Guidance notes were generally thought useful to raise internal staff awareness. But some consultees expressed concern that awareness should not dilute responsibilities, the project case officer being in authority. Some staff also commented that they preferred to comment specifically on each application.

Most thought that the current guidance notes were satisfactory with respect to technical detail, identification of key impacts, ease of reading. There was some criticism of a lack of cross-referencing and that the notes were too rural in outlook for metropolitan areas.

The need for further guidance notes was a factor raised by many consultees, thus making the handbook more relevant to a wider variety of development proposals.

Development types activities or issues suggested as warranting guidance included:

> marinas, new boreholes for large abstractions, gravel pits (may or may not be joined to rivers), large-scale rearing of trout (in waters connected to rivers), enrichment of still waters, housing developments, industrial developments, business parks, roads (new and widening), service stations, golf courses, mineral extraction, airports, railways, fish

farms, reservoirs, (tidal) barrages, development on flood plains, holiday parks or homes, run-of-river hydroelectric schemes, coastal development (affecting coastal processes), slate quarrying, redevelopment of industrial sites/contaminated land (e.g. coal mines), bank repairs, bridges, culverts, river diversions, lake creation (for fishing, recreation or irrigation), pipelines, cemeteries, canal restoration and landscape (particularly in urban environments).

There was also felt to be a need for standard guidance on structures such as outfalls and bankworks for use in response to land drainage consent applications.

Another request was for guidance on how to take strategic factors into account, such as how to respond to another in a series of related proposals (e.g. barrages around the coast)

5.6 Use of other guidance

Regions in which R&D Note 76 had not been officially launched reported use of the normal regulations and flood defence related guidance produced by Thames Region.

5.7 Training

Training in EA generally or specifically on EA and the handbook had occurred in varying manner in the four Regions in which the handbook had been launched.

(i) Anglian Region had not carried out any formal training; there have been small sessions at conservation officer meetings and planning workshops at which case studies were done.

(ii) In the Severn-Trent Region the Regional EA Co-ordinator had given briefings to relevant staff. A Regionally-produced video on EA had also been shown to staff.

(iii) In the Thames Region EA seminars had been held in each area, attendees including development control and planning liaison staff. Some staff in the past had also been on relevant external courses such as on EA and on land drainage, conservation and amenity.

(iv) In the Welsh Region approximately 30 staff Regionally were briefed and asked to pass the handbook on to relevant staff. It was unclear to what extent this had actually occurred. A local university had also given T&CP and EA training to about 60 staff members.

In general, whilst staff who had been trained felt they had received a good overview, there was some desire expressed for regular (e.g. annual) updates. Some other staff felt that sufficient training was received "on the job". Anglian and South Western Region commented that they were looking to the launch of the national EA training manual for more formal training. There had been no general EA training in Regions in which R&D Note 76 had not been launched. However, in South Western Region, the EA contact reported that he himself had attended relevant courses, seminars and conferences. The EA contact in North West Region had provided training to NRA flood defence, conservation staff and project managers, principally with respect to NRA capital schemes.

Thames Region reported on other planning initiatives in the pipeline, such as a general planning course, which was thought to be useful as many Planning Liaison staff were not necessarily planning conscious. The course would also discuss the workings of Government functions which were thought to be little understood by some staff. A specialist courses on planning agreements has also been proposed.

6. CONSULTATION WITH LPAs

Consultation with a number of representatives were carried on a limited scale to investigate the relationship between LPAs and the NRA from the viewpoint of the LPAs. The findings, based on a relatively small sample of LPAs and LPA staff may not be representative of LPAs as a whole. The relationship between planning authorities and regulatory bodies with respect to strategic environmental assessment is discussed by Wilson (1994).

6.1 Experience with the NRA

The framework within which LPAs operate is largely that of the T&CP system; although they may be consultees for developments under separate regulations. Under the T&CP system, council officers make recommendations on the outcome of planning applications received. Planning decisions are actually determined by elected council members sitting on planning committees. The committees generally follow officers' recommendations. Decisions on planning applications are normally required within 8 weeks. In general, a LPA should grant planning permission unless it can cite a planning-based reason or reasons for refusal. Decisions and policies within the T&CP framework, are guided by government advice including various policy guidance notes, such as Planning Policy Guidance (PPGs), Mineral Planning Guidance (MPGs) and Regional Planning Guidance (RPGs) which, although principally aimed at structure plans, may be material to decisions in individual planning applications. Government Circulars are also relevant, and in the NRA/EA context particularly those on *Environmental Assessment* (DoE 15/88, WO 23/88), *Environmental Assessment: Amendment of Regulations* (DoE 7/94) and *Development and Flood Risk* (DoE 30/92, WO 68/92). The latter is particularly relevant in certain boroughs within the Thames Region, where the presumption against development in the floodplain severely inhibits any further large scale development. (Following DoE 30/92 there was established a *Memorandum of Understanding - Development and Flood Risk* between the NRA, Association of County Councils, Association of District Councils and Association of Metropolitan Authorities (NRA/ACC/ADC/AMA 1994)). (Guidance on coastal floodplains exists in PPG20 *Coastal Planning*).

One LPA consultee had been much involved in open discussions with the NRA. A recurrent problem had been the speed of response (which several consultees commented on). Although there was some sympathy for the need for the NRA to consult internally, comments from the NRA had often come too late. Also, prior to more established planning liaison arrangements, comments had been received from different functions at different times. The planning authorities have a duty to respond to applications within an allotted time, and if comments from consultees are not received by then they generally make decisions without the NRA's input. By making comments too late, NRA staff had not only been wasting their own time, but also the NRA's view would not have been taken into account in decisions. The situation had generally improved, with comments usually being received within an acceptable timeframe. Also, the NRA were now better at emergency responses, e.g. enquiries are faxed between LPAs and NRA when the opinion of the NRA is clearly required.

In addition, the quality of NRA comments had generally improved, partly due a better appreciation of planning law. Planning authorities are bound to make decisions on planning grounds only, because, if not, decisions are indefensible on appeal. Although many aspects of NRA comments are relevant to planning, such as those on development in the floodplain, other aspects may be irrelevant and can reduce the value of more relevant comments if the latter are not clearly highlighted. An example is where conservation improvements were suggested. Whilst it is a fundamental duty for the NRA to seek opportunities to enhance the aquatic environment, the powers of local planning authorities largely limits them to protect areas with statutory designations. There may also be some difficulty for LPAs to ensure that conservation measures are successful in the longer term, e.g. obtaining guarantees that conservation management will be regularly carried out. However, where there is scope for negotiating around plans, such as the inclusion of essential work required to prevent flooding from the planned development, environmental improvements may be incorporated as a condition of planning permission or as a voluntary agreement (Section 106). A further example of inappropriate commenting were those comments made to LPAs with respect to pollution control and other aspects of the NRA's role as a regulatory body. These comments should be reserved for responses to licence/consent applications made direct to the NRA. By making these comments to the LPA, there had been occasions where there seemed to have been the assumption within the NRA that pollution control issues had been addressed (although the LPA could not implement such suggestions themselves), resulting in confusion and ultimately a lack of NRA control.

One LPA (a district council) commented that it used the NRA's planning liaison document to identify which development types should be referred to the NRA, although was aware that the document went further than statutory requirements; the LPA accepted this as a preventative approach despite the added burden of work (and delays) in contacting the NRA, receiving and incorporating their comments. Another (county) LPA stated that it used the GDO as a basis to identify NRA interest. A further (borough) council consulted the NRA on the basis of the size of the development and floodplain location. Another stated it consulted the NRA as standard procedure.

The NRA are asked to comment on most applications for new development in one borough, where most of the borough is dominated by floodplain. Applications for house extensions were generally not referred to the NRA as would be difficult to refuse on the grounds of flood risk. Where, following initial NRA comments, LPA officers recommended to a planning application on flooding grounds alone, a check was made with the NRA that they would stand by the recommendation in a planning appeal.

It was felt by one borough that floodplain information supplied by the NRA was inaccurate and out of date.

One borough stated that problems arose because the NRA's comments were copied to applicants. The problems arose when NRA comments recommended refusal but suggested conditions should permission be granted. This weakened the case for outright refusal by the LPA. The LPA concerned now preferred the NRA to suggest suitable conditions in a secondary consultation. However, this does assume a level of trust that secondary consultation will occur.

One consultee felt that NRA comments were often too purist and unrealistic. Another commented that NRA responses to planning applications were often akin to general policy statements rather than a specific response to a particular application; however, it was also felt that this was understandable in that the NRA staff did not have time to make site visits.

A (county) planning authority commented that contact with the NRA on water-related issues consisted of both formal consultation and the seeking of technical support due to the combined role of the LA in waste licensing and development control. The same consultee considered that the main interest of the NRA was the potential for pollution of water.

One consultee had had some informal input to the standard comments produced by the NRA for national use. LPAs in general supported the idea of the NRA issuing (standard) guidance to developers, but information issued to LPAs would be best restricted to that relevant to planning. There was a mixed response as to whether LPAs would generally welcome any guidance from the NRA.

The idea of catchment management plans was supported and it was felt that they would be referred to. The *Thames 21* document was welcomed and thought to be a good compilation (if only for public relations purposes) of otherwise fragmented information.

LPA comments indicated that they varied in the extent they took environmental considerations into account (also reflected in NRA experience of dealings with LPAs). Environmental guidance from various bodies was often conflicting (e.g. from English Nature, local Wildlife Trust, NRA and others with respect to wetland sites. One LPA consultee considered that his borough tended to adopt a more precautionary approach than the County Council, particularly with respect to development proposals for mineral extraction combined with waste disposal.

6.2 LPAs and EAs

LPAs tended to follow government guidance (i.e. DoE Circulars 15/88 and 7/94, and DoE/WO 1989) to identify the needs for formal EA within the planning system. Two consultees reported that their LPAs received informal environmental assessments at the developer's own initiative quite often, or following requests for limited information. These assessments were reviewed, although may only contain information on certain aspects of the environment. However, one LPA reported that developments that might have required EA may arise too rarely for development staff to be familiar with the need for it, and some could conceivably "slip the net". The infrequency of EAs was commented on by more than one consultee.

One LPA commented that they normally had informal discussions with prospective developers at the stage of the scoping study and normally advised potential applicants to contact the NRA. (Several consultees commented that they encouraged developers to contact the NRA at a presubmission stage, particularly if problems were foreseen.)A further consultee commented that contentious issues of development proposals arising in the EA process were often discussed at tripartite meetings including the LPA and developer. However, it was not usual for PLAs to directly seek NRA input to the scoping of EAs.

Planning applications are refused on the basis of environmental constraints that are of interest to the NRA.

In general, LPAs closely followed government guidance on identifying the need for an EA and on ES content. One LPA commented that despite this, cases had occurred of their request for an EA being turned down by the DoE on appeal.

Surrey County Council with the assistance of Borough Council representatives have produced draft advisory checklist and accompanying guidelines for environmental assessment. The production of these were prompted by concern over government guidance which was thought to be somewhat vague and to contain threshold criteria which were too high, given the perceived sensitivity of development in Surrey. Using these guidelines LPAs in Surrey are able to identify sensitive locations or effects and the need for further environmental information and possibly formal EA. It was expected that the guidance would be updated regularly (current draft - June 1994).

The checklist asks whether the development is likely to have a significant impact via a number of factors. Factors are categorised, including those as follows:

- **water** - "involving changes to the local drainage pattern?" and "affecting other hydrographic characteristics?";

- **pollution** - "resulting in discharge to watercourses, aquifers and Groundwater Protection Zones?" and "resulting in contamination of the site or any structure on it?"

- **ecology** - "affecting Ramsar Site, SPA, SSSI, NNR, LNR, Site of Nature Conservation Importance, Area of High Ecological Quality?" and "affecting habitats, plants and animal species?";

- **river valleys** - "affecting environmental and operational aspects of a river valley?"

- utility infrastructure - "requiring expansion or updating of infrastructure?"

Other categories are: land; landscape and townscape; archaeology, historic landscape and historic buildings; geology; energy; transport infrastructure, cumulative effects.

For each factor responses to monitoring questions are required: i.e. as to whether the item applies, whether further information has been requested, and received. Comments on the adequacy of information supplied are also requested.

The guidelines discuss the factors in the checklist in more detail, suggesting the sort of information that may be required to assess the impacts of proposed development, and provide internal and external contact points. Under the **water** category there is the following guidance:

"Appropriate information may relate to changes to the local drainage pattern which are likely to have a greater impact than can be addressed in the normal processing of individual planning applications. Other hydrographic characteristics involve effects on groundwater level and flow, watercourses, surface water flow and flooding. The impact of development on downstream areas can be significant (increased overland flows, flooding being more severe and more rapid, etc.). Often measures such as storm water retention ponds may be proposed to deal with such effects and the environmental consequences of these measures will need to be addressed.

[Contacts: District engineers, National Rivers Authority (Chris Bedford, Thames Region; 0734-535790)]

Information under **pollution** includes:

(i) "Damage to the aquatic environment is addressed by the Environmental Protection Act 1990 (EPA) and the Water Resources Act 1991 (WRA). The WRA controls pollution resulting from activities not regulated under the EPA. The National Rivers Authority is to be consulted for any development affecting surface water and groundwater. Her Majesty's Inspectorate and local authority Environmental Health Officers are responsible for authorising processes likely to result in such pollution."

(ii) "Groundwater is at risk from types of pollution. Waste disposal operations are a major potential threat to groundwater. Mineral working can affect the future availability of groundwater resources by restricting recharge and diverting flow. The NRA's recently adopted *Policy and Practice for the Protection of Groundwater* will introduce new and vigorous controls on mineral and waste sites. The NRA document describes eight activities or types of development that can have a potential impact on groundwater. The document also makes a clear distinction between aquifers, which can be very extensive as in the case of the chalk and greensand aquifer, and groundwater Protection Zones which relate to specific water abstraction points and are especially sensitive to pollution. [Contact: National Rivers Authority (NRA) (Chris Bedford; 0734-535790)]

(iii) "A PPG on Planning and Pollution Control was issued in July 1994. It seeks to clarify the relationship between planning and pollution control, stressing the need to avoid duplication and the importance of co-ordination and communication between all bodies concerned, including LPAs. Sections of the PPG are devoted to Integrated Pollution Control (with regulation being carried out by HMIP), air quality and water quality. The PPG applies particularly to industrial development, waste treatment and disposal and the redevelopment of contaminated land. The statutory involvement of HMIP in the planning process is restricted to being a consultee in environmental assessments."

(iv) Circular 28/85 on the Reclamation of Derelict Land related to the contamination of land... Also the Interdepartmental Committee on the Redevelopment of Contaminated Land has produced documents which seek to establish some control... The NRA are concerned with water contamination resulting from redevelopment of contaminated land. [Contacts: ..., NRA (Chris Bedford; 0734-535790)]

Under the **ecology/geology** category, habitats are described as:

"areas containing rare flora and fauna, a large variety of species, wet areas including ponds, rough topography or land left undisturbed for a long period, or any combination of these characteristics. Habitats include vegetation, geological and surface material."

Guidance for **river valleys** is:

> "The NRA suggests that a broad view be taken of river valleys as important features. Aspects to be considered are flooding, river banks, trees and woodland along river banks, etc. [Contact: (Chris Bedford, NRA; 0734-535790)]."

Finally guidance on **utility infrastructure** includes:

> "This involves water supply, treatment and distribution; sewage collection and treatment; ...."

Infrastructure also is considered under **cumulative effects**.

LPAs staff interviewed felt that they were as stringent with their own Local Authority (LA) schemes as they were with external schemes. This is in contradiction to some NRA experience. For example in North West Region an LPA had insisted that the NRA use local sandstone to face a Flood Defence Capital scheme and yet proposed to strengthen a riverside path (of their own) with bare concrete. Although LPAs may be unlikely to confess to double standards if these do occur, it may also be a reflection of recent legislative changes.

The County Council consulted stated that it now tended to conduct EAs for its own highway schemes as a matter of course (albeit a largely internal process), regardless of the threshold criteria indicated in Government guidance. This had been prompted by raised environmental awareness within the electorate, reflected in Government guidance (e.g. PPGs). The quality of EA and/or ES produced influenced the extent to which environmental considerations would be included in final plans.

The Blackwater Valley Route, described in Appendix E, provides an illustrative case study of the use of EA by a LPA for a highway scheme and also of LPA/NRA interaction. The initial environmental statement for the scheme, the outcome of EA without consultation with the NRA, was found to be inadequate by the NRA (and EN) when the organisations did become involved. subsequent EA work led to a well designed and environmentally acceptable scheme.

7. GUIDANCE NOTES

Guidance notes for the two levels are presented as Appendices F (brief guidance notes/checklists) and G (more detailed notes). The results of literature searches on each development type are presented as Appendix H. The notes in Appendix F have since been amended by the NRA in the production of the NRA scoping manual. The notes in Appendix G however have taken into account comments received from NRA staff.

It is important to note that the notes are limited to addressing NRA concerns and should not be used in isolation by developers conducting a formal EA. They should be used alongside other guidance (e.g. DoE/WO 1989) which sets out the wider issues to be addressed and the statutory requirements of EA. Within the NRA context these notes are potentially appropriate for consultations with developers, their consultants and LPAs on all relevant planning applications and not just those requiring formal EA. However, their use may best be targeted to more significant developments in terms of scale or potential impact, as the uptake of the notes may be lessened if they are found to be largely irrelevant or overly demanding, e.g. for small scale schemes.

8. DEVELOPMENT OF REVIEW CRITERIA

8.1 Introduction

An objective of the research was to develop and apply a procedure to review the quality and contents of Environmental Statements (ESs) and other documentation.

The EC Directive (85/337/EEC) placed minimum requirements for the content of an ES as indicated by Table 8.1. The resulting UK Regulations on EA, such as SI 1988 No. 1199, set these out as statutory requirements for ESs, although their wording is altered (see Table 8.2). Local Planning Authorities have the responsibility for checking that ES meet this minimum standard.

Table 8.1 Information required in Environmental Statements as specified by the EC Directive (85/337/EEC)

1.	Description of the project, including in particular: - a description of the physical characteristics of the whole project and the land-use requirements during the construction and operational phases, - a description of the main characteristics of the production processes, for instance, nature and quantity of the materials used, - an estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, etc.) resulting from the operation of the proposed project.
2.	Where appropriate, an outline of the main alternatives studied by the developer and an indication of the main reasons for his choice, taking into account the environmental effects.
3.	A description of the aspects of the environment likely to be significantly affected by the proposed project, including, in particular, population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape and the inter-relationship between the above factors.
4.	A description (1) of the likely significant effects of the proposed project on the environment resulting from: - the existence of the project - the use of natural resources - the emission of pollutants, the creation of the forecasting methods used to assess the effects on the environment. and the description of the measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment.

5.	A description of the measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment.
6.	A non-technical summary of the information provided under the above headings.
7.	An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information.

Note

1 This description should cover the direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the project.

Table 8.2 Information required in an Environmental Statement as specified by SI 1988 No. 1199.

A description of the development proposed, comprising information about the site and the design and size or scale of the project;

The data necessary to identify and assess the main effects which the project is likely to have on the environment;

A description of the likely significant effects, direct or indirect on the environment of the development, explained by reference to its possible impact on:

- human beings;
- flora;
- soil;
- water;
- air;
- climate;
- the landscape;
- the inter-action between any of the foregoing;
- material assets; and
- the cultural heritage.

Where significant adverse effects are identified with respect to any of the foregoing, a description of the measures envisaged in order to avoid, reduce or remedy those effects;

A summary in non-technical language of the information specified above.

In addition to the minimum requirements of ES content, the EA Regulations (SI 1988 No. 1199) require that certain procedures are followed to facilitate the preparation of ESs. Further to the statutory requirement, guidance on best practice for ES production (DoE 1994) suggests further procedures, such as the developer having "early consultation with the relevant pollution control body". This recommendation is more specific than that recommended in earlier Circulars (e.g. DoE 15/88 and the Guide to the Procedures (DoE/WO 1989).

As a result of the above the review of ESs has two aspects:

- procedural; and
- material.

8.2 Existing criteria

A number of review criteria have produced. To some extent the usefulness of some of the criteria to the NRA is reduced as they are intended to address whether the minimum requirements have been met and not necessarily whether issues of particular NRA concern are addressed. For example, flora may generally be given good coverage in an ES but aquatic flora may be largely overlooked.

Lee and Colley (1990) produced widely used procedural review criteria which have been modified by the Institute of Environmental Assessment (IEA) (Table 8.3). To facilitate the review procedure, the Institute produced a system of review grades.

A Excellent, no tasks left incomplete

B Good, only minor omissions and inadequacies

C Satisfactory despite omissions and inadequacies

D Parts are well attempted, but must as a whole be considered just unsatisfactory because of omissions and/or inadequacies

E Poor, significant omissions or inadequacies

F Very poor, important tasks poorly done or not attempted

N/A Not applicable. The review topic is not applicable or relevant in the context of this statement.

Table 8.3 Institute Review Criteria

1. Description of the development, the local environment and the baseline conditions

1.1 Description of the development

The purpose and objectives of the development should be explained. The description of the development should include the physical characteristics, scale and design as well as quantities of material needed during construction and operation.

1.2 Site description

The area of land affected by the development should be clearly shown on a map and the different land uses of this area clearly demarcated. The affected site should be defined broadly enough to include any potential effects occurring away from the construction site (e.g. dispersal of pollutants, traffic, changes in channel capacity of water courses as a result of increased surface run off etc.).

1.3 Residuals

The types and quantities of waste matter, energy and residual materials and the rate at which these will be produced should be estimated. The methods used to make these estimations should be clearly described, and the proposed methods of treatment for the waste and residual materials should be identified. Waste should be quantified wherever possible.

1.4 Baseline conditions

A description of the environment as it is currently and as it could be expected to develop if the project were not to proceed. Some baseline data can be gathered from existing data sources, but some will need gathering and the methods used to obtain the information should be clearly identified. Baseline data should be gathered in such a way that the importance of the particular area to be affected can be placed into the context of the region or surroundings and that the effect of the proposed changes can be predicted.

2. Identification and evaluation of key impacts

2.1 Identification of impacts

The methodology used to define the project specification should be clearly outlined, including details of consultation with expert bodies (e.g. Planning Authority, HMIP, NRA, NCC, Countryside Commission etc.) and the public, and reference to panels of experts, guidelines, checklists, matrices, previous best practice examples of environmental assessments on similar projects (whichever are appropriate). Consideration should be given to impacts which may be positive or negative, cumulative, short or long term, permanent or temporary, direct or indirect.

The logic used to identify the key impacts for investigation and for the rejection of others should be clearly explained. The impacts of the development on human beings, flora and fauna, soil, water, air, climate, landscape, material assets, cultural heritage, or their interaction, should be considered.

2.2 Prediction of impact magnitude

The size of each impact should be determined as the predicted deviation from the baseline conditions, during the construction phase and during normal operating conditions and in the event of an accident when the proposed development involves materials that could be harmful to the environment (including people). The data used to estimate the magnitude of the main impacts should be clearly described and any gaps in the required data identified. The methods used to predict impact magnitude should be described and should be appropriate to the size and importance of the projected disturbance. Where possible, estimates of impacts should be recorded in measurable quantities with ranges and/or confidence limits as appropriate. Qualitative descriptions where necessary should be as fully defined as possible (e.g. `insignificant means not perceptible from more than 100 m distance').

2.3 Assessment of impact significance

The significance of all those impacts which remain after migration should be assessed using the appropriate national and international quality standards where available. Where no such standards exist, the assumptions and value systems used to assess significance should be justified and the existence of opposing or contrary opinions acknowledged.

3. Alternatives and mitigation

3.1 Alternatives

Alternative sites should have been considered where these are practicable and available to be developed. The main environmental advantages and disadvantages of these should be discussed in outline, and the reasons for the final choice given. Where available, alternative processes, designs and operating conditions should have been considered at an early stage of project planning and the environmental implications of these outlined.

3.2 Mitigation

All significant adverse impacts should be considered for mitigation and specific mitigation measures put forward where practicable. Mitigation methods considered should include modification of the project, compensation and the provision of alternative facilities as well as pollution control. It should be clear to what extent the mitigation methods will be effective. Where the effectiveness is uncertain or depends on assumptions about operating procedures, climatic conditions etc., data should be introduced to justify the acceptance of these assumptions.

3.3 Commitment to mitigation

Clear details of when and how the mitigation measures will be carried out should be given. When uncertainty over impact magnitude and/or effectiveness of mitigation over time exists, monitoring programmes should be proposed to enable subsequent adjustment of mitigation measures as necessary.

4. Communication of results

4.1 Presentation

The report should be laid out clearly with the minimum amount of technical terms. An index, glossary and full references should be given and the information presented so as to be comprehensible to the non specialist.

4.2 Balance

The environmental statement should be an independent objective assessment of environmental impacts not a best case statement for the development. Negative impacts should be given equal prominence with positive impacts and adverse impacts should not be disguised by euphemisms or platitudes. Prominence and emphasis should be given to predict large negative or positive impacts.

4.3 Non technical summary

There should be a non technical summary outlining the main conclusions and how they were reached. The summary should be comprehensive, containing at least a brief description of the project and the environment, an account of the main mitigating measures to be undertaken by the developer, and a description of any remaining or residual impacts. A brief explanation of the methods by which these data were obtained and an indication of the confidence which can be placed in them should also be included.

Procedural review criteria were also produced by King and Wathern (1992b), i.e. those appearing in R&D Note 76. These are reproduced as Table 8.4.

Table 8.4 Procedural review criteria for environmental statements recommended by King and Wathern (1992b)

These review criteria consider the ES with respect to 8 attributes:

1. Information of the EA process (Method Statement)
2. The description of the proposed project
3. Alternatives
4. Site and local environment
5. Predicted environmental impacts
6. Mitigation and enhancements
7. Monitoring and maintenance
8. Presentation and non-technical summary.

Each attribute is then divided into questions indicating tasks which should have been performed within that section. These should be circled `Yes' or `No' as appropriate. The reviewer then grades each section from A-F indicating how well the tasks have been performed where:

A - Excellent, all tasks performed well

B - Good, no important missions or inadequacies

C - Satisfactory, despite some omissions or inadequacies

D - Unsatisfactory, some important omissions, but parts well attempted

E - Poor, important omissions and inadequacies

F - Very poor, important tasks poorly done or not attempted

N/A - the category is not applicable for the project

Based upon these, a grade is obtained for each of the 8 sections and for the whole report. Where category boundaries lie will be a matter for judgement. It is recommended that more than one person reviews the ES, in order to reduce the subjectivity of an individual reviewer. Whilst a grade of C is satisfactory, a good ES should score A or B.

Section 1. Information on the EA process (Method Statement)

1. Does the ES clearly explain how the EA process has taken place, who has been consulted and what methods have been used? [ ] Score A-F

Indicate Yes or No

1.1	Is there a full list of who has been consulted?	Y/N
1.2	Is there a summary of responses, highlighting areas of concern?	Y/N
1.3	Did consultations take place openly at an early stage in the project planning?	Y/N
1.4	Are any survey or predictive techniques explained?	Y/N
1.5	Does the ES indicate why these methods or techniques have been used?	Y/N
1.6	Are any gaps in information and uncertainties outlined?	Y/N
1.7	Has the assessment been carried out in a logical and rational manner?	Y/N

Section 2. The description of the proposed project

2. How adequate is the description of the project? [ ] Score A-F

Indicate Yes or No

2.1	Is the design, size and scale of the project clearly shown?	Y/N
2.2	Are the main characteristics of production processes described in sufficient detail?	Y/N
2.3	Are the type and quantity of any residues, emissions or other waste described in sufficient detail?	Y/N
2.4	Are any associated activities or developments shown, for instance off-site implications?	Y/N
2.5	Is the timing and phasing of construction activities indicated?	Y/N
2.6	Are strategies for operation and decommissioning included?	Y/N

Section 3. Alternatives

3. Are the main alternatives to the project identified and is their rejection justified? [ ] Score A-F

Indicate Yes or No

3.1	Are alternative designs or developments considered?	Y/N
3.2	Are alternative locations considered?	Y/N

3.3 Is there a more environmentally sensitive alternative to the project? Y/N

3.4 Are valid reasons given for its rejection in favour of the proposed project? Y/N

Section 4. Site and local environment

4. How adequate is the description of the site and local environment [ ] Score A-F

Indicate Yes or No

4.1 Are maps of the area directly affected included? Y/N

4.2 Is the area which is broadly affected indicated? Y/N

4.3 Is there an outline of land use, e.g. recreation? Y/N

4.4 Is reference made to the relevant site designations, local plans, EC Directives and other legislative requirements? Y/N

4.5 Is use made of photographic and other illustrative material? Y/N

4.6 Are any physical characteristics quantified? Y/N

Section 5. Predicted environmental impacts

5. Are all impacts likely to affect NRA interests identified, evaluated and clearly presented? [] Score A-F

Indicate Yes or No

5.1 Are there any important impacts which have not been mentioned? Y/N

5.2 Does the ES highlight the key impacts? Y/N

5.3 Are construction impacts indicated as well as those associated with the operation of the project? Y/N

5.4 Does the ES indicate if the impacts are:

- strategic or local? Y/N
- temporary or permanent? Y/N
- short or long term Y/N
- adverse or beneficial? Y/N
- direct or indirect? Y/N

5.5 Are impacts quantified where possible and an indication of their magnitude and significance given? Y/N

Section 6. Mitigation and enhancements

6. Are all significant adverse impacts mitigated to the NRA's satisfaction and is the opportunity taken to incorporate appropriate enhancements? [ ] Score A-F

Indicate Yes or No

6.1 Have all reasonable mitigation measures been proposed? Y/N

6.2 Does the ES indicate how the mitigation is to be implemented? Y/N

6.3 Is the likely success of mitigation measures indicated? Y/N

6.4 Does the ES clearly identify any residual impacts, which cannot be mitigated? Y/N

6.5 Has any opportunity been taken to incorporate enhancements appropriate to the local environment? Y/N

6.6 Are there any `enhancements' which are not in keeping with the local environment? Y/N

Section 7. Monitoring and maintenance

7. Are there appropriate provisions for future monitoring and maintenance based upon predicted impacts and areas of uncertainty? [ ] Score A-F

Indicate Yes or No

7.1 Are there adequate provisions for monitoring impacts during:

- construction? Y/N
- operation? Y/N

7.2 Is there a suitable plan for:

- maintenance? Y/N
- restoration and aftercare? Y/N
- disposal of wastes? Y/N

7.3 Is there a suitable strategy to deal with emergencies, such as spillages or accidents? Y/N

Section 8. Presentation and non-technical summary

8. Is the layout of the ES clear and logical with an adequate non-technical summary and no obvious bias? [ ] Score A-F

Indicate Yes or No

8.1 Does the ES have:

- a list of contents?	Y/N
- a glossary?	Y/N
- a reference list?	Y/N
- appendices?	Y/N
- non-technical summary?	Y/N

8.2 Does the non-technical summary present the main findings?	Y/N
8.3 Is the ES presented as an integrated whole?	Y/N
8.4 Is the language clear and concise?	Y/N
8.5 Are adverse impacts outlined without bias?	Y/N
8.6 Does the ES make unsubstantiated claims?	Y/N

OVERALL QUALITY OF THE ENVIRONMENTAL STATEMENT [ ]

COMMENTS:

King and Wathern (1992b) emphasised that these criteria covered were only for procedural review and commented that criteria for the review of material factors were difficult to standardise, with the review being best done on a case-by-case basis by technical experts. However, they outlined what the NRA requirements should be for material review (Table 8.5) and also recommended the use of cross-referencing to the original scoping brief.

Table 8.5 NRA requirements for material review (after King and Wathern 1992b)

NRA require:

1. Full and detailed information on:

   - methods of data collection
   - survey and sampling techniques
   - the timing of the baseline data collection

   These should be preferably comparable to its own methods. The results should be clearly presented for scrutiny.

2. A clear description of:

   - the full extent of the development
   - associated activities

3. The rationale underlying the development including:

   - alternatives of either process or location
   - justification for their rejection

4. Key questions to be answered as to:

   - whether its interests will be affected
   - to what extent

Quantifications should be made where possible and sources of references quoted.

5. Rationale behind choice of mitigations and enhancements such as:

   - what other mitigations are likely?
   - how effective are they likely to be?
   - how appropriate are they?

6. Whether an appropriate monitoring and maintenance strategy is proposed.

NRA would NOT require:

1. Superficial answers and bland reassurances where there may be potential impacts

2. Poorly indexed documents

3. Excessively bulky or glossy documents.

The ES can be a succinct document as long as the correct issues are addressed.

More recently, the DoE has produced a good practice guide for the evaluation of environmental information for planning projects (1994c). Whilst providing explanation of a detailed process for review, the mechanism is geared to local authorities, rather than NRA needs. However, the guide is a useful supporting document.

8.3 Development of criteria

Although the difficulties in producing standardised criteria for the material review of ESs are acknowledged, the criteria presented in Table 8.6 are suggested for the purposes of the combined material/procedural review of both ESs and environmental information by the NRA. These criteria are based on those of King and Wathern (1992b), but utilise the expected format of criteria currently being produced for the European Commission.

Initially, for each criterion options of positive or negative responses are given on the applicability or relevance of the criterion. Given the difficulty in devising a universal review system and the fact that environmental information produced may have a far more limited scope than a full ES, many criteria may not be applicable in each case for environmental information. However, the 'not relevant' response should only be used where the subject is genuinely not applicable and should not be used as a "not sure" option.

For relevant criteria a judgement is made as to whether the ES or information supplied is either 'complete', 'acceptable' or 'inadequate'. On the basis of these judgements each of nine sections is graded (A-D) and an overall grade produced on the basis of these. The grading system will be more applicable for an ES, it may be less workable on rather more limited environmental information produced for less significant developments.

It is recommended that the review criteria presented in Table 8.6 are adopted for general use to assess the quality of the ES or environmental information supplied to the NRA. These criteria should be used in association with scoping guidance that may be applicable to a development type.

Table 8.6 Recommended criteria for the review of environmental information or environmental statements provided by developers in association with planning application, licence applications etc.

The following review criteria may usefully be applied to Environmental Statements (ESs) and may also be applicable to environmental information supplied in connection with larger, more significant schemes that do not warrant formal EA. The criteria should be applied primarily by planning liaison (or equivalent) staff, although support may also be required from technical specialist for some areas (see 'Reviewers'). Such support may best be sought at the same time as the ES or relevant sections is/are circulated for comment. The criteria are arranged into nine main sections:

1. General ES content - overview
2. The EA process - consultation
3. The description of the proposed project

4. Alternatives
5. Site and local environment
6. Predicted environmental impacts
7. Mitigation and enhancements
8. Monitoring and maintenance
.9. Presentation and non-technical summary

Relevance

Each section is then divided into questions indicating tasks or issues which may or may not be relevant. Responses under the 'Relevant' column should indicate whether the issue is (Y) or is not applicable (N). Note that for environmental information that is not in the form of an ES, a large number of the attributes or questions may not be applicable. Also, the 'not applicable' response should only be used where the subject is genuinely not applicable and should not be used as a 'not sure' option.

Adequacy of information

For each relevant criterion, the reviewer should express a judgement of C, A or I based on the following:

Complete - The information presented is complete in consideration of the issues in question.

Acceptable - The information presented is not complete, but omissions are generally minor.

Inadequate - The information presented contains major omissions; additional information is required before the NRA can fully assess the proposal.

Where category boundaries lie will be a matter for judgement. Comments may be added to support any judgements made.

Summation of grades

Based on the judgements made within each of the nine sections, on completion of each section the reviewer should then grade each section from A-E indicating how well the tasks have been performed where:

A - Excellent, all tasks performed well
B - Good, no important omissions or inadequacies
C - Satisfactory, despite some omissions and inadequacies
D - Inadequate, some important omissions, but parts well attempted
E - Poor, important omissions and inadequacies
N/A - the category is not applicable for the project.

Again, where category boundaries lie will be a matter for judgement. The grades attributed to each of the nine sections may be compiled in the table at the end and single grade attributed to the whole report. No detailed weightings are recommended, but it is suggested that a reduced weighting be given to Section 1, as it is repeated elsewhere in more detail, and Section 9 as the presentation of the ES is not critical to the protection of the environment. Section 6 should be given added weighting due to its length, although should be borne in mind that some of the features in 6.1, e.g. air, are not of direct interest to the NRA.

Whilst a grade of C is satisfactory, a good ES should score A or B.

Reviewers

Ideally and where resources allow, more than one person (generally from planning liaison) would review an ES as a whole, in order to reduce the subjectivity of an individual reviewer. Upon circulating the ES for comment, specialists may be asked to provide judgements on specific criteria relevant to the responsibilities/background of the reviewer. As a guide specialists may be particularly required in the following areas:

Technical Area/Function	Relevant Criteria
Fisheries	5.10, 6.2 (h)-(j)
Recreation	5.11, 6.2 (j), (l)-(p)
Conservation	5.7, 5.9, 5.11, 5.17, 5.18, 6.2(a)-(g), (k), (s), (x)
Navigation	6.2(p)
Water quality	5.7 5.15, 5.16, (y), (z)
Water resources	5.12, 5.14, 5.16, 6.2 (t)-(w), (z)
Flood defence	5.12, 5.13, 5.18, 6.2(q)-(t)

Reviewers should bear in mind that the adequacy of the extent of coverage of an issue and the appropriateness of methods of data collection and treatment will vary according to thesize and complexity of the developmeny shceme involved.

THE REVIEW CRITERIA

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
1.	**General ES content - overview**			
1.1	To what extent does the ES contain a clear description of the full extent of: a) the development? b) associated activities?			
1.2	To what extent does the ES discuss alternatives of either process or location?			
1.3	To what extent does the ES contain full and detailed information on the site and local environment with information on: a) site location? b) land use, ecological interest etc.?			
1.4	To what extent are potential impacts thoroughly discussed and examined?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
1.5	To what extent is a variety of mitigation and enhancement options considered?			
1.6	To what extent is an appropriate monitoring and maintenance strategy proposed?			

Does the ES clearly explain who has been consulated and at what time? Score | | A-E

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
2.	**The EA Process - Consultations etc.**			
2.1	To what extent is there a full list of who has been consulted?			
2.2	To what extent was the NRA consulted at an early stage?			
2.3	To what extent was the public consulted at an early stage?			
2.4	To what extent is there a summary of responses, highlighting areas of concern?			
2.5	To what extent was the consultation process continuous throughout the project life?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
2.6	To what extent have the concerns of the NRA raised in consultation been taken into account?			

Does the ES clearly explain who has been consulted and at what time? Score [ ] A-E

3.	**The description of the proposed project**			
3.1	To what extent is the design, size and scale of the project (in construction) shown?			
3.2	To what extent is the timing and phasing of construction activities shown?			
3.3	To what extent is the design, size and scale of the project (in operation) shown?			
3.4	To what extent are the water supply and/or abstraction requirements, if any, of the project indicated?			
3.5	To what extent are the type and quantity of any materials used during construction and operation described?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
3.6	To what extent are the type and quantity of any residues, emissions or other waste described?			
3.7	In particular, to what extent is the volume, frequency and quality of discharges to surface and ground waters described?			
3.8	To what extent are the strategic implications of the project indicated:			
	a) on a local scale?			
	b) on a regional/national scale?			
3.9	To what extent are strategies for operation and decommissioning included?			
How adequate is the description of the proposed project?			Score [ ] A-E	
4.	**Alternatives**			
4.1	To what extent are alternative designs or developments considered?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
4.2	To what extent are alternative locations considered?			
4.3	To what extent is the "do-nothing" approach considered?			
4.4	To what extent is there consideration of a more environmentally sensitive alternative to the project than that proposed			
4.5	To what extent are valid reasons given for its rejection in favour of the proposed project			

Are the main alternatives to the project identified and is their rejection justified? Score [ ] A-E

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
5.	**Site and local environment**			
5.1	To what extent are maps of the area directly affected included? (including associated access roads, compounds etc.)			
5.2	To what extent is the area more broadly affected indicated? (e.g. downstream areas, wetlands etc.)			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
5.3	To what extent is there an outline of land use, e.g. recreation?			
5.4	To what extent is reference made to the relevant site designations, sensitive areas, local plans, EC Directives and other legislative requirements?			
5.5	To what extent is use made of photographic and other illustrative material?			
5.6	To what extent are any physical characteristics quantified?			
5.7	To what extent is information on aquatic ecology supplied? And with relevant:			
	a) methods of data collection?			
	b) survey and sampling techniques?			
	c) the timing of the baseline data collection?			
5.8	To what extent are rare and/or protected species highlighted?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
5.9	To what extent is information on habitats presented for:			
	a) adjacent land (to watercourses) and wetlands?			
	b) bank?			
	c) foreshore?			
	d) channel and water?			
5.10	To what extent is information on fisheries supplied? And with relevant:			
	a) methods of data collection?			
	b) survey and sampling techniques?			
	c) the timing of the baseline data collection?			
5.11	To what extent is information on recreation, amenity and landscape supplied? And with relevant:			
	a) methods of data collection?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
	b) survey and sampling techniques?			
	c) the timing of the baseline data collection?			
5.12	To what extent is information on hydrology supplied? And with relevant:			
	a) methods of data collection?			
	b) survey and sampling techniques?			
	c) the timing of the baseline data collection?			
5.13	To what extent is information on flood defence supplied?			
	And with relevant methods of data collection and survey techniques?			
5.14	To what extent is information on water resources supplied?			
	And with relevant methods of data collection and survey techniques?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
5.15	To what extent is information on surface water quality supplied? And with relevant:			
	a) methods of data collection?			
	b) survey and sampling techniques?			
	c) the timing of the baseline data collection?			
5.16	To what extent is information on groundwater quality supplied? And with relevant:			
	a) methods of data collection?			
	b) survey and sampling techniques?			
	c) the timing of the baseline data collection?			
5.17	To what extent is information on archaeology supplied?			
	And with relevant methods of data collection and survey techniques			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
5.18	To what extent is information on river geomorphology supplied?			
	And with relevant methods of data collection and survey techniques?			
5.19	To what extent have data known to be supplied by the NRA been usefully incorporated?			

How adequate is the description of the site and local environment? Score [ ] A-E

6.	**Predicted environmental impacts**			
6.1	To what extent are impacts on the following generally considered:			
	a) human beings?			
	b) flora?			
	c) soil?			
	d) water?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
	e) air?			
	f) climate?			
	g) the landscape?			
	h) the interaction between any of the foregoing?			
	i) material assets?			
	j) the cultural heritage?			
6.2	To what extent are impacts suitably assessed for:			
	a) aquatic mammals?			
	b) aquatic birds?			
	c) aquatic amphibians?			
	d) aquatic invertebrates?			
	e) aquatic flora (bankside)?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
	f) aquatic flora (instream)?			
	g) aquatic and riparian habitats?			
	h) aquatic fish and fish habitat?			
	i) commercial fisheries?			
	j) recreational fisheries?			
	k) rare or valued flora and fauna as identified?			
	l) recreational use for water sports?			
	m) recreational use by bird watchers and ramblers?			
	n) access?			
	o) visual intrusion and landscape?			
	p) navigation			
	q) flood defence and drainage of site of development?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
	r) flood risk to other sites (e.g. downstream)?			
	s) river geomorphology?			
	t) surface water hydrology?			
	u) groundwater hydrology?			
	v) (surface) water resources?			
	w) (ground) water resources?			
	x) archaeology?			
	y) surface water quality:			
	from discharges in construction?			
	from discharges in operation?			
	from surface runoff in construction?			
	from surface runoff in operation?			
	z) ground water quality?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
6.3	To what extent has the assessment addressed impacts likely to affect NRA interests?			
6.4	To what extent has the assessment addressed any other important impacts.			
6.5	To what extent does the ES highlight the key impacts?			
6.6	To what extent are construction impacts indicated as well as those associated with the operation of the project?			
6.7	To what extent are the potential impacts of non-standard operating conditions considered? For example, those arising from equipment failure, flooding etc.			
6.8	To what extent are the effects of decommissioning the project considered?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
6.9	To what extent does the ES indicate if the impacts are: - strategic or local? - temporary or permanent? - short or long term? - adverse or beneficial? - direct or indirect?			
6.10	To what extent are impacts quantified where possible and an indication of their magnitude and significance given?			
6.11	To what extent are the models used for impact prediction suitable?			
6.12	To what extent are quantitative predictions accompanied by associated levels of uncertainty?			
6.13	To what extent does the ES indicate if the proposal and associated schemes are part of a sustainable development strategy?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments

Are both general impacts and those specifically affecting NRA interests identified, evaluated and clearly presented?
Score | | A-E

7.	**Mitigation and enhancements**			
7.1	To what extent have reasonable mitigation measures been proposed?			
7.2	To what extent does the ES indicate how the mitigation is to be implemented?			
7.3	To what extent is the likely success of mitigation measures indicated?			
7.4	To what extent are the proposed mitigation methods acceptable?			
7.5	To what extent does the ES clearly identify any residual impacts, which cannot be mitigated against?			
7.6	To what extent has the opportunity been taken to incorporate enhancements appropriate to the local environment?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
7.7	To what extent are 'enhancements' in keeping with the local environment?			

Are all significant adverse impacts mitigated to the NRA's satisfaction and is the opportunity taken to incorporate appropriate enhancements? Score | | A-F

8.	**Monitoring and maintenance**			
8.1	To what extent are there adequate provisions for monitoring impacts during:			
	- construction?			
	- operation?			
8.2	To what extent is there a suitable plan for:			
	- maintenance?			
	- restoration and aftercare?			
	- disposal of wastes?			
8.3	To what extent is there a suitable strategy to deal with emergencies, such as spillages or accidents?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
8.4	To what extent is there a suitable strategy to deal with unexpected impacts? (e.g. those detected by monitoring)			
9.	**Presentation and non-technical summary**			
9.1	To what extent does the ES have:			
	- a list of contents?			
	- a glossary?			
	- a reference list?			
	- non-technical summary?			
9.2	To what extent does the non-technical summary present the main findings?			
9.3	To what extent is the ES presented as an integrated whole?			
9.4	To what extent is the language clear and concise?			
9.5	To what extent has the assessment been carried out in a logical and rational manner?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments
9.6	To what extent are quantifications supported by an indication of the level of confidence?			
9.7	To what extent are survey or predictive techniques explained?			
9.8	To what extent does the ES indicate why these methods or techniques have been used?			
9.9	To what extent are difficulties in compiling information for the ES indicated?			
9.10	To what extent are adverse impacts outlined without bias?			
9.11	To what extent are claims made in the ES substantiated?			

No.	Criterion	Relevant? (Y/N)	Judgment (C/A/I)	Comments

SUMMARY AND OVERALL APPRAISAL

No.	Criterion	Relevant? (Y/N)	Grade (A-E)	Comments
1.	General ES content - overview			
2.	The EA process - consultation			
3.	The description of the proposed project			
4.	Alternatives			
5.	Site and local environment			
6.	Predicted environmental impacts			
7.	Mitigation and enhancements			
8.	Monitoring and maintenance			
9.	Presentation and non-technical summary			

OVERALL ASSESSMENT (A-E) Excellent/ Good/ Satisfactory/ Inadequate/ Poor

8.4 Notification of ES quality

A sheet similar to this should be sent to the developer, those involved in the production of the Environmental Statement (ES) and the local planning authority to inform them of the quality of an ES. Such notifications should contribute to the quality of future ESs. A further copy should be retained with the ES as a permanent NRA record. The sheet may also be appropriate for environmental information, where it covers a variety of subject areas.

ENVIRONMENTAL STATEMENT QUALITY

....Region of the National Rivers Authority (NRA) has a policy of issuing a brief report on the quality of Environmental Statements received. The aim of this is to help developers produce more satisfactory Statements in the future or to know that the standard that they have achieved is adequate. The opinion given is entirely independent of the project itself.

The Environmental Statement accompanying Planning Application.......................................
....was determined, after thorough review, to be:

Excellent, all tasks performed well

Good, no important omissions or inadequacies

Satisfactory, despite some omissions and inadequacies

Inadequate, some important omissions, but parts well attempted

Poor, important omissions and inadequacies

The following aspects were considered to be well executed:

....
....
....

The following aspects were considered to be poorly executed and important information was lacking:

....
....
....

It is noted that consultation did/did not take place with the NRA prior to submission of the Statement.

Statement reviewed by: ....

9. BROCHURE MATERIAL

9.1 Existing material

Existing brochure material exist in the form of the published NRA leaflet *Safeguard the environment - a guide to developers* and the section *Environmental assessment guides for developers* in R&D Note 76.

9.2 Development of brochure material

Development and the NRA

The National Rivers Authority (NRA) has responsibilities under the Water Resources Act 1991 for the following:

- pollution control
- flood defence/land drainage
- fisheries
- water resources
- conservation and recreation
- navigation

The NRA's responsibilities apply not only to rivers, but also to groundwaters, coastal waters, estuaries, lakes, ponds, brooks and ditches. With such a wide range of responsibilities, the NRA has an interest in the potential impacts of most development proposals. The NRA encourages developers, their consultants and planning authorities to contact the NRA at an early stage of development proposals such that the NRA can contribute to the planning process. This will be at an earlier stage and for a wider range of development activity than contact with the NRA as a statutory consultee or as a licensing authority for abstraction licences etc. There are a number of benefits to developers from such contact, most notably that the NRA can identify sensitive aspects of a scheme and suggest alternatives, thus avoiding costly modifications to plans at a later stage. The appropriate initial point of contact with the NRA is the Area office relevant to the proposed development. A list of Area offices appears at the end of this leaflet, together with a map showing Area boundaries.

The NRA have an internal procedure of environmental appraisal or assessment which may be applied to relatively small-scale "developments", such as applications for abstraction licences or land drainage consents, through to large-scale developments requiring formal environmental assessment (otherwise known as environmental impact assessment) under planning regulations.

To assist developers in the considering the environmental implications of development schemes guidance notes have been produced for a wide variety of development types, including:

- General construction
- Redevelopment of contaminated land
- Marinas
- Golf courses
- Fish farms
- Pipelines
- Long sea outfalls
- Sewage treatment works
- Large residential developments
- Large industrial developments
- Power stations
- Wind farms
- Hydropower
- Oil refineries
- Forestry
- Waste disposal facilities
- Mines and quarries
- Roads and road widening
- Railways
- Airports

These notes are available from Area NRA contacts. The notes are of designed as scoping briefs to determine the likely impacts of a particular scheme and the issues to be addressed in the environmental assessment. The notes are of particular use at the early stages of the environmental assessment associated with the formulation of development proposals. The notes are not intended to substitute detailed discussions on a specific development that may arise as more detailed design plans are produced. Nor are the notes intended to cover all environmental issues, as a variety of potential environmental impacts, such as traffic generation and air pollution; are not within the NRA's range of responsibilities.

NRA Contact Points

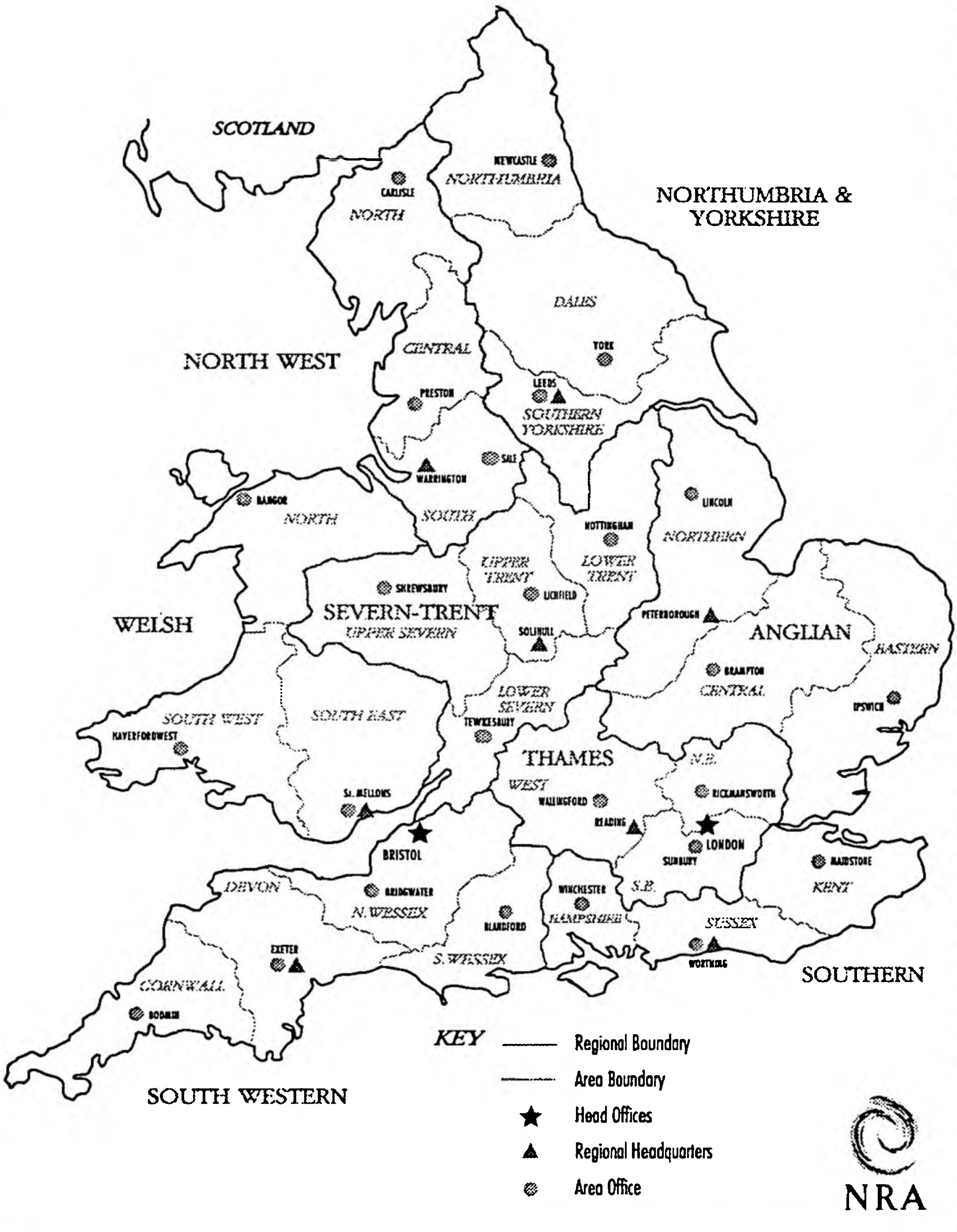
Region/Area	Contact Address	Tel. No.	Fax No.
Anglian			
Northern Area	Area Planning Manager NRA Anglian Aqua House Harvey Street LINCOLN LN1 1TF	01522 513100	01522 512927
Central Area	Area Planning Manager NRA Anglian Bromholme Lane Brampton Huntingdon CAMBS PE18 8NE	01480 414581	01480 413381
Eastern Area	Area Planning Manager NRA Anglian Cobham Road IPSWICH IP3 PJE	01473 727712	01473 724205

Region/Area	Contact Address	Tel. No.	Fax No.
Northumbria & Yorkshire			
Northumbria Area	Planning Liaison Officer NRA Northumbria &Yorkshire Tyneside House Skinnerburn Newcastle Business Park NEWCASTLE UPON TYNE NE4 7AR	0191 2034000	0191 2034004
Dales Area	Planning Liaison Officer NRA Northumbria &Yorkshire Coverdale House Aviator Court Amy Johnson Way Clifton Moor YORK	01904 692296	01904 693748
Southern Yorkshire	Planning Liaison Officer NRA Northumbria & Yorkshire Olympia House Gelderd Lane Gelderd Road LEEDS LS12 6DD	01132 440191	01132 312116
North West			
Northern Area	Planning and Services Manager NRA North West Chertsey Hill London Road CARLISLE CA1 2QX	01228 25151	01228 49734
Central Area	Planning and Services Manager NRA North West Lutra House Dodd Way Walton Summitt Bamber Bridge PRESTON PR5 8BX	01772 39882	\01772 627730
Southern Area	Planning and Services Manager NRA North West Mirwell Carrington Lane SALE M33 5NL	0161 973 2237	0161 973 4601
Severn-Trent			
Upper Severn Area	Senior Planning Liaison Officer NRA Severn-Trent Hafren House Welshpool Road Shelton SHREWSBURY SY3 8BB	01217 112324	01217 115824

Region/Area	Contact Address	Tel. No.	Fax No.
Lower Severn Area	Senior Planning Liaison Officer NRA Severn-Trent Riversmeet House Northway Lane TEWKESBURY GL20 8JG	01684 850951	01684 293599
Upper Trent Area	Senior Planning Liaison Officer NRA Severn-Trent Sentinel House 9 Wellington Crescent Fradley Park Lichfield STAFFS SW13 8RR	01543 444141	01543 444161
Lower Trent Area	Senior Planning Liaison Officer NRA Severn-Trent Trenside Office Scarrington Road West Bridgford NOTTINGHAM NG2 5FA	01159 455722	01159 817743
Southern			
Hampshire & Isle of Wight	Planning Liaison Manager NRA Southern Sarum Court Sarum Road WINCHESTER HANTS	01962 713267	01962 841573
Kent Area	Planning Liaison Manager NRA Southern Millbrook House 114 Mill Street East Malling, Maidstone KENT ME19 6BU	01732 875587	01732 875057
Sussex Area	Planning Liaison Manager NRA Southern 3 Liverpool Gardens Worthing WEST SUSSEX BN11 1TF	01903 215835	01903 215884
South Western Cornwall Area	Regulation Officer NRA South Western Sir John Moore House Victoria Square Bodmin CORNWALL PL31 1EB	01208 78301	01208 78825
Devon Area	Regulation Officer NRA South Western Manley House Kestrel Way EXETER EX2 7LQ	01392 444000	01392 444238
North Wessex Area	Regulation Officer	01278 457333	01278 452985

Region/Area	Contact Address	Tel. No.	Fax No.
	NRA South Western Rivers House East Quay SOMERSET TA6 4YS		
South Wessex Area	Regulation Officer NRA South Western Rivers House Sunrise Business Park High Shaftesbury Road BLANDFORD DT11 8ST	01258 456080	01258 455998
Thames			
North East	Senior Planning Liaison Officer NRA Thames Gade House London Road Rickmansworth HERTS WD3 1RS	01992 635566	01992 645451
South East	Senior Planning Liaison Officer NRA Thames Sunbury Yard Riverside Works Fordbridge Road Sunbury on Thames TW16 6AP	01932 789833	01932 786463
West Area	Senior Planning Liaison Officer NRA Thames Isis House Howberry Park Wallingford OXON OX10 8BD	01734 535000	01734 535900
Welsh			
Northern	Development Liaison Officer NRA Welsh Bryn Menai Holyhead Road Bangor GWYNEDD LL57 2EF	01248 370970	01248 370747
South Eastern Area	Development Liaison Officer NRA Welsh c/o Rivers House St Mellons Busoness Park St Mellons CARDIFF CF3 0LT	01222 770088	01222 798555
South Western Area	Development Liaison Officer NRA Welsh Lys Afon Hawthorn Rise, Haverfordwest DYFED SA61 2BH	01437 760081	01437 760881

NATIONAL RIVERS AUTHORITY
Office Location Plan



10. IDENTIFICATION OF TRENDS

The main developments in EA during Phase 2 of the project have been steps towards strategic environmental assessment (SEA) and increasing incorporation of the concept of sustainability into the planing process. There have also been some minor legislative changes and the production of improved guidance on EA. More subtle changes have probably occurred, such as increasing awareness of EA as an interactive process rather than just the production of an ES. The introduction of IPC following the EPA 1990 has also installed a statutory system for environmental considerations in industrial processes, i.e. use f BATNEEC, BPEO etc. In addition, PPG 23 has raised the profile of pollution as a factor that may be material to planning decisions.

10.1 Strategic environmental assessment and sustainability

SEA is a strategic approach to environmental assessment based on a more general assessment of the environmental effects of development, i.e. examining the effects of plans and policies resulting in a whole series of developments, rather than assessing the impacts of individual development proposals in EA. The need for SEA has been recognised for some time, but historically EA within the EC has been founded on the project-based level. It can be argued that decisions on individual projects should be made within a strategic framework. Therivel *et al.* (1992), Sheate (1994) and Wilson (1994) discuss SEA at some length.

Although the UK Government has demonstrated some resistance to changes in EA legislation on the basis of deregulation initiatives and calls for subsidiarity, there have been some moves towards SEA. The DoE has produced a number of relevant reports, such as *Policy Appraisal in the Environment*, which encourage the practice of the appraisal, rather than EA, of policies. PPG 12 on development plans and regional planning cites the latter as appropriate guidance for use in the formulation of plans. One of the shortcomings of the policy appraisal approach is the lack of statutory provision for public participation. However, the NRA would generally be consulted, being statutory consultees. Also, guidance to local authorities on how to carry out policy appraisal on development plans *Development Plans: A good practice guide* (DoE 1992a) advises an approach more akin to SEA (Sheate 1994).

The need for SEA is linked to the international acceptance of the concept of sustainability. Commitments made at the Earth Summit in Rio de Janeiro in 1992 led to the Council of the European Communities passing a resolution accepting the Fifth Action Programme on the Environment and Sustainable Development, also known as *Towards Sustainability*. This has resulted in the UK Government developing its own strategy, published as *Sustainable Development: the UK Strategy*. Although current institutional arrangements and policies prevent a dramatic shift towards more sustainable approaches to planning across the board, considerations of sustainability will become a more important factor in planning , if only gradually. Sustainability appears as a factor in more recent planning policy guidance notes. Some guidance on how to identify policies needed for sustainable development was produced by the Town and Country Planning Association (Blowers 1994), aimed chiefly at the planning establishment. The Thames Region of the NRA have already taken the opportunity to influence LPAs and others to adopt approaches incorporating sustainability considerations with the publication of *Thames 21 - A Planning Perspective and a Sustainable Strategy for the Thames Region.* Catchment management planning by the NRA should also generally encourage a sustainable approach to planning.

In order to formulate sustainable development policies, it is likely that strategic risk assessment techniques will play an increasing role.

10.2 Legislative changes

There have been some minor changes to the legislation under which schemes may require. For instance following the adoption of the Transport and Works Act 1992, requirements for the EA of a number of transport-related development types are now in accordance with the Transport and Works (Applications and Objections Procedure) Rules 1992 (SI No 2902).

Under the Planning and Compensation Act 1991 provisions were made to extend EA to projects falling outside of the Directive. As a result, EA may also be required for wind farms, coastal protection works, motorway service areas and toll roads. However, additional development types (trout farming, water treatment plants, non-motorway service areas and golf courses) proposed in a consultation paper (DoE 1992b) of legislation is not yet in force to adequately cover all development types within the Directive (Sheate 1994).

The implementation of the EC Habitats Directive (CEC 1992) by The Conservation (Natural Habitats, &c.) Regulations 1994 (SI No. 2716) has planning implications with respect to the protection of important sites. In addition, these regulations require development plans to include conservation policies encouraging the management of features of the landscape which are of major importance for wild flora and fauna. The regulations describe such features as "..those by virtue of their linear and continuous structure (such as rivers with their banks.....) or their function as stepping stones (such as ponds or small woods), are essential for the migration, dispersal and genetic exchange of wild species."

The recent production of the Town and Country Planning (General Permitted Development) Order 1995 (SI 1995 No. 418) and The Town and Country Planning (Environmental Assessment and Permitted Development) Regulations 1995 (SI 1995 No. 417) has had the effect of consolidating the General Development Order and also means that Schedule 1 and Schedule 2 projects previously benefiting from permitted development rights will now have to go through the normal planning process if they are judged to require EA. The new arrangements are explained in DoE Circular 3/95 *Permitted Development and Environmental Assessment* and a related guide (DoE/WO 1995). In the circular indicative thresholds criteria are given for when EA may be required for the following (permitted) development types:

- field drainage works;
- reclamation of land from the sea;
- surface storage of fossil fuels and natural gas;
- storage of petroleum, petro-chemical and chemical products;
- local authority roads;

- harbours and marinas;
- long-distance aqueducts (including water pipelines);
- wastewater treatment plants;
- sewage sludge lagoons.

The Environment Agency Bill, under debate at the time of writing, will have fundamental implications for the NRA and EA. The Agency will have a wider range of responsibilities. Key issues in the progress of the Bill have been the extent of a duty to further conservation, contaminated land and cost-benefit analysis.

At an EC level, proposed amendments to the EA Directive may bring about some changes to EA, such as the formal addition of screening and scoping to EA procedures. The proposals also suggest a more accountable decision-making system with respect to the consideration of environmental information arising from EAs. The proposals also include additions of further development types to Annex II and the implementation in part of the 1991 Espoo Convention on environmental impact assessment in a transboundary context. Earlier proposals to include post-project monitoring have not come to fruition. There are also proposals to introduce a separate directive on SEA.

10.3 Improve guidance

The amount of guidance available has steadily increased (see Chapter 4) and should generally continue to improve the quality of EAs.

10.4 Other factors

Moves towards life cycle analysis (LCA) may have implications for EA, LCA on processes and products providing detailed information on what may be alternatives to consider as part of an EA.

The increasing adoption of Environment Management Systems BS 7750 will result in more voluntary assessments of the environmental effects of individual company or site practices, and should result in more environmentally-sympathetic approach to development.

11. CONCLUSIONS

11.1 Issues identified in the consultation process

11.1.1 General planning system

Although Planning Policy Guidance notes (PPGs) are part of the framework that Local Planning Authorities (LPAs) operate, their implementation is often weak, thus environmental considerations may be overlooked. Besides, monitoring for uptake was difficult because of a lack of detailed guidance on certain aspects, e.g. sustainability.

11.1.2 LPA/NRA interaction

Guidance such as the Circular 30/92 and subsequent agreements has raised the expectations of LPAs as to what information they might expect from NRA (i.e. flood survey data) but these have not yet been forthcoming.

There was some indication that LPAs may have a rather limited appreciation of NRA duties and interests. Also, LPAs varied greatly in their responsiveness to NRA efforts on both strategic and planning application levels. As such, annual meetings were too frequent for the more enlightened LPAs, but too distant for those that did not welcome NRA involvement in the planning process. Metropolitan authorities often seemed to be the most problematic. There are significant resource implications to increase the frequency of meetings with the seemingly less-responsive LPAs, or to actually review how well LPAs were consulting the NRA on relevant planning application and taking on board NRA comments (e.g. by auditing decision notices).

Often NRA staff had insufficient time to respond to pre-submission enquiries. Being able to respond to planning applications in time was a recurrent problem for NRA staff. This was largely due to insufficient time in the process of receipt, internal circulation and co-ordination of response. The problem was increased when single copies of lengthy documentation, such as an ES, were received and had to be either copied or circulated.

Standard (NRA) comments that have been used in the past had often been too general to be really useful and had fallen into disrepute (with LPAs) to some extent. There was concern (within the NRA) that the current standard comments did not have enough conservation input.

In some of the ESs received by the NRA, there appeared to still be some confusion in developer's minds between the NRA's current role and the responsibilities of former water authorities.

Some developments continue to occur without any prior NRA knowledge. When the NRA have been consulted, they do not always receive decision notices when requested or relevant.

There are some inconsistencies between Regional Planning Liaison documents on the type of developments the NRA would like to be consulted on, and this could become an issue were Regional lists compared by an LPA or LPA association, or in any judicial review. Also the legal foundation for seeking consultation could, in theory, be challenged, the NRA only being statutory consultees for a more limited range of development types. However, co-operative LPAs should welcome early NRA involvement, if only because as a licencing body the NRA will become involved at a later stage in many developments.

There was some element of bluff in consultation, e.g. the desire to be consulted on non-statutory development types and the proposal of conditions in response to planning applications. This may be a precarious course without further statutory backing. Some authorities felt that the NRA did indeed make demands beyond their powers. In contrast, some LPAs often ignored NRA suggestion because they were too woolly, e.g. "It would be a good idea to request an EA".

The Housebuilders Federation had apparently expressed annoyance some at the NRA in that the Authority was not are statutory concern and was thus felt to be over presumptive. The term "presumption against" in NRA literature is now discouraged.

On some issues, the NRA may provide advice to LPAs that conflicts with that of other related organisations.

There was inconsistency is the use of the visitor system and the alternative, reliance on LPAs to consult with the NRA on relevant schemes. Although the NRA would find out about all planning applications, relevant or not, through the visitor system, the system was quite demanding on staff time and was limited by the information provided - often only a one line description of some planning applications. Another potential drawback of the visitor system was also thought to result from bias in the applications sought by the NRA due to the background of the staff visiting, who are often from a flood defence background.

There was some experience within the NRA of LPAs being less stringent in applying environmental considerations to their own LA schemes. It seemed there had been a certain amount of an attitude, particularly in the past, that they considered EAs are largely for their own purposes in assessing planning applications and hence were not required if they are the developer themselves. However, the situation seemed to have improved.

11.1.3 NRA internal

There seemed to be some confusion as to when the environmental appraisal (ea) process stopped, e.g. with respect to applications for licences or consents. There also appeared to some confusion in EA roles above a Regional level.

Internal consultees often do not distinguish between pre-submission enquiries and actual planning applications, due to misunderstanding of the form of the information supplied. Sometimes licence applications were not linked to planning applications leading to a risk of inconsistent responses and the loss of credibility. This was probably a problem with smaller schemes only, as larger schemes would be well known, co-ordinated by planning liaison and might even involve the formation of multi-functional teams.

There had been instances of responses to licence/consent applications not being linked to responses to consultation on planning applications.

Informal verbal guidance given on both planning and licence/consent applications may go unrecorded and potentially conflict with a subsequent more formal response.

Functional staff acting on their own sometime had caused some problems. Often cited were examples of discharge consents being agreed by Environmental Quality staff without consideration of impacts beyond water quality, e.g. flow-related flood defence implications.

There was a need for a greater understanding of planning among some staff (i.e. by those with an environmental background) and of conservation/environmental issues (i.e. by those with a planning/engineering background). There were instances of inadequate responses and also reliance of some staff on others to deal with areas outside of their expertise. The shortfall of knowledge is more significant with planning staff as these are the staff who interact directly with LPAs and developers and are empowered to speak on behalf of conservation (rather than *vice versa*). In particular, further conservation input to scoping suggestions was often needed in response to pre-submission enquiries.

11.2 R&D Note 76

The handbook was not in widespread use in all of the four Regions in which it was launched. Reasons for the lack of use included: no receipt of the handbook at all, oversight, the small quantity of guidance notes on relevant development types, and a lack of need due to good prior knowledge of the relevant issues. The latter point raises the question of personal experience vs guidance. Although staff may feel they know a subject, they may repeatedly overlook issues that might feature in a checklist or guidance. However, guidance notes may also be lacking in areas and cannot substitute for local knowledge.

Despite the release of the documentation to the Regions, it was uncertain as to how well distributed the handbook had been within offices. Usually staff training positively encouraged dissemination but it was difficult to ensure that it did actually happen. There were contrasting views as to how well disseminated the handbook should be.

Some were unaware of the status of the handbook, whether it was subject to national distribution and whether it could be copied to developers.

Although initially useful, background material in the handbook was thought to be a little repetitive in one Region and not necessary for everyday use.

In some Areas it was felt there had been insufficient training in the use of the manual, particularly by non-conservation staff.

Concern was expressed that in some cases there was not enough detail in guidance notes for internal use and there was a need to highlight key impacts and expand on these. Cross referencing was also insufficient, particularly for non-experienced EA professionals involved. In predominantly metropolitan areas the guidance notes were thought to be too rural in outlook. The handbook lacked guidance on landscape issues in urban environments.

There was fear expressed in one Area that guidance notes might add to, rather than relieve, the workload on staff. Any requirement to use checklists routinely would add to such workloads.

There was some reluctance to use guidance notes as they were, particularly in formal responses, for reasons of presentation. The guidance notes, checklists and other relevant parts of the manual were not stand alone documents and as such information was often extracted rather than copied *in toto*.

There appeared to be some overlap with PINs (e.g. PIN SC/CC/014 on highways), which were used alongside or instead of guidance notes. This may result from inadequate cross-referencing.

A minor error cited in the manual was the 48 days to approve land drainage consents (p13 para 3) - it is in fact 2 months.

Due to local bylaws and Regional procedures etc., some national guidance may contain information not agreed or practised nationally. For example, the national leaflet *Safeguard the Environment - A guide to developers* was considered inaccurate with respect to Thames bylaws.

11.3 Identification of Trends

There has been a number of changes to the EA system, including the addition of some development types warranting EA where significant impacts are expected. Further changes to the EA system may arise from proposed amendments to the Directive.

EA is beginning to be applied more widely to policies and plans as a strategic approach. The concept of SEA and need for sustainability will play an increasing role in the EA framework.

The coming of the Environment Agency will have fundamental implications for EA and the NRA. The scope of the NRA guidance will need to be broadened to incorporate the other areas of the Agency, such as air pollution. The Environment Agency Bill was before Parliament at the time of writing.

12. RECOMMENDATIONS

12.1 General planning

The NRA should welcome any moves by the Government to broaden the range of development types requiring statutory consultation with the NRA and continue to influence government planning policy guidance at a strategic level.

12.2 Interaction with external bodies

The NRA should continue to seek to influence structure plans.

The NRA should promote their role to LPAs, developers (and their consultants) by dissemination of brochures, publications, articles etc.

Model policies (as issued to LPAs) should be disseminated more widely.

Involvement of LPAs and developers in the formulation and adoption of CMPs should be positively encouraged to help sell NRA visions for catchments.

An advice sheet on sustainability and on the integration of CMP and EA/SEA within NRA should be prepared in order to provide consistent and helpful guidance.

The value of more consistency of approach to LPAs should be considered, with respect to Planning Liaison documents, visitor/receipt systems and frequency of meetings with LPAs.

Memoranda of agreements may be required to firm up agreed liaison , e.g. the LPA intention of secondary consultations following initial NRA comments recommending refusal of planning permission.

The NRA should continue to develop and maintain a good rapport in the planning liaison process, with training of staff in negotiating/business relations skills if appropriate.

The NRA should encourage pre-submission enquiries from developers and LPAs on individual planning proposals. Requesting inclusion of a question "Have you consulted the NRA?" on planning application forms may further this aim.

The NRA should seek involvement in pre-development briefs so that environmental improvements written in at early stage.

Closer liaison with other bodies, e.g. English Nature on certain conservation issues, may provide a stronger case for the adoption of suggested environmental measures by LPAs and developers.

12.3 Response to planning applications

The need for timely responses to planning applications should be emphasised to NRA staff.

The NRA should ensure the encouragement of pre-submission enquiries (to the NRA) is supported by an efficient response. This along with the previous recommendation may have staffing implications.

The planning liaison system should be maintained and developed with single contact points and consistent multi-functional responses.

NRA staff should be prepared to receive applications by having supporting information upon which to base comments. Particularly where time does not allow for site visits, the use of aerial photos of sufficient detail may be invaluable. These should be at hand.

The NRA should provide realistic, relevant comments in response to planning applications (and ESs) highlighting key points of NRA concern.

There should be a good database or cross referencing system to reduce possible anomalies between responses to pre-submission enquiries, planning applications and licence/consent applications for the same development (and also possibly for different applications for similar developers/development types). Alternatively, staff or responsibilities could be centralised into the same department.

Published lists of planning applications and/or decision notices could be incorporated into the above database and also could be audited for degree of consultation and uptake of NRA comments.

Consistencies between Regions should be maintained, particularly with respect to responses to developers. The use of standard guidance notes will aid this process. Consistency is desirable with LPAs, although in some respect this is less important as LPAs only deal with a single Region, whereas developers may propose developments in several Regions.

There may be a need for a formal review system of responses to planning applications (ESs) to assess for consistency and general quality control.

Targeted levels of service should be reflected by adequate staffing levels.

LPA expectations may be reduced if the NRA were to set a timetable for the provision of flood survey data, where possible.

12.4 EA Review Criteria

Review criteria could be used more extensively. However, their use as part of a more prescriptive system may not be welcomed by Area staff. The feedback of ES quality to developers may be useful. The outcome of reviews may also be instructive as research tools and identify any areas in which the NRA should develop further guidance.

Ticklists for each development type could be developed but any added value will probably be offset by the dilution of other material (and costs of production). However, scoping guidance notes may be used to serve this purpose.

12.5 Guidance Notes

Wide use of the scoping guidance notes contained in manuals replacing R&D Note 76 should be encouraged, including through training.

Guidance notes for a broader range of development types should be introduced (as achieved in this project). Suggested additional topics include water treatment works and motorway service areas.

The production of detailed guidance on certain specific development types by internal expert groups may still be required. At least experts should be identified to advise on appropriate methodologies, modelling techniques etc.

The format of guidance notes could be arranged by function (for ease of use by NRA staff) and by issue/stage (for ease of use by developers or their consultants). Again, added value will probably be offset by the dilution of other material, costs of production, and also the risk of inconsistencies between guidelines.

There is a need to be able to format scoping guidance material into presentable standalone documents (i.e. with corporate logo etc.).

There is a need for internal guidance as to what information can be sent to developers.

There may be a need to look at links and consistency between standard comments and guidance notes.

More detail is required in internal guidance with key impacts highlighted and expanded upon. This may be achieved by the production internally and in this project of some more detailed guidance.

More cross referencing in guidance notes is required.

Manuals of scoping guidance should be user friendly, widely disseminated and well publicised internally.

Feedback on the use of the manuals should continue to be encouraged, and the manuals periodically updated to reflect changes in legislation etc.

The EA process should perhaps not be too prescriptive - experienced staff may need to temper national guidance with local experience.

The formation of the Environment Agency will require a widening of scope of the handbook and guidance notes to incorporate the concerns of HMIP etc.

12.6 Training

Training on EA, including the use of the handbook and with updates as appropriate, should be carried out with relevant staff. Follow-up multi-functional workshops may be useful.

There should be more training in project scoping for those involved in pre-submission enquiries.

There is a need for more training of planning staff with respect to environmental issues, and training of environmental staff with respect to planning. Staff should be familiar with the legal footing for NRA demands.

There may be a need for training on the integration of CMP with EA within the NRA.

Training on the NRA's interpretation of sustainability may be required.

Planning Liaison and other staff in regular contact with local authorities should be considered for training in negotiating/business relations skills.

12.7 Further research

1. Further guidance notes

Further guidance notes could be produced on relevant topics as they arise. At present there may be some need for notes on:

- water treatment works;
- motorway service areas ;
- coastal protection works; and
- development types for which (as yet) only brief scoping guidance notes have been produced.

2. Environment Agency

The role of EA and use of guidance notes in the Agency should be assessed. The notes should be amended to take the wider responsibilities of the Agency into account.

3. Monitoring/auditing of impacts

Auditing to assess whether predicted impacts actually occur and to what extent rarely happens, particularly as there is no legal requirement to do so.

A review of existing monitoring studies could be combined with a programme of targeted post-project monitoring studies for a number of schemes to assess the accuracy of impact predictions. Attempts could be made to identify, where possible, the sources of failure of impact predictions with a view to avoiding such failure in the future. Further key objectives could be to identify successful monitoring protocols and the need for method development where existing environmental monitoring techniques are inadequate for impact assessment.

The study could incorporate assessments of impacts not predicted at all in the environmental assessment process, where baseline information is available. Reasons for such effects being overlooked would be examined.

4. Efficacy of mitigation measures

Not unrelated to the above, a programme of review/monitoring could be undertaken to examine the success of mitigation measures. As such, methods of best practice can be maintained.

5. Development of methods

There may be scope for method development where existing environmental monitoring techniques are inadequate for impact assessment. The need for such methods may be identified in studies above (see Monitoring/auditing of impacts)

6. Risk assessment

Risk assessment may not be considered adequately in EA. That is, there are not enough "what if" scenarios, with consideration of resultant water quality impacts. The combined risks also need to be assessed. It may also be of value for the combined "pollution risk" associated with a catchment to be part of a Catchment Management Plan.

Methods of risk assessment with respect to pollution events could be developed for use in Environmental Appraisal and the techniques could be extended for use in Catchment Management Planning.

7. Economic appraisal

The arguments put forward by the NRA about proposed developments usually relate to the quality of the environment. Techniques have recently been developed on the economic value of changes to water quality. Such methods could be developed to add an economic element to such responses, including a valuation of the existing situation and the economic loss of uses precluded by a development.

8. Other

Practicable options to apply sustainability in EA should be explored.

The closer integration of CMP and EA within the NRA should be explored.

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APPENDIX A QUESTIONNAIRE USED AS A BASIS FOR DISCUSSION IN NRA CONSULTATION

ENVIRONMENTAL ASSESSMENT BY EXTERNAL DEVELOPERS

CONSULTATION QUESTIONNAIRE

BACKGROUND INFORMATION

1a	Name	
1b	Region	
1c	Job Title/description	
1d	Date when questionnaire completed	

1e Could you please outline below the structure and process of Environmental Assessment and Appraisal in your Region, and how this relates to Head Office? (For Environmental Appraisal read assessment of all planning applications or licence/consent applications, i.e including those that are not necessarily part of schemes requiring a formal ES under the Town and Country Planning (Assessment of Environmental Effects) or related regulations).

1f Does this structure and process work adequately?

Yes ☐ No ☐

1g If NO, how could it be improved?

USAGE OF GUIDANCE NOTES

2. Are the guidance notes provided in the manual (R&D 76) used by you or your staff (for environmental assessment/appraisal)?

Yes ☐ No ☐

2a If, **YES**, how is the manual used? For example:

Which NRA staff use it?

For what purposes is it used?

How often has it been used?

Other comments

2c If **NO**, why is the manual not used?

3. Is the guidance provided in the notes appropriate?

Yes ☐ No ☐

3a If **NO**, what were the major shortcomings, (ranked in terms of importance).

3b If **YES** in what ways could the notes be improved? For example:

Was the degree and level of information, detail and scope adequate:

Format (e.g. issue-related compared to function-related)	Yes	☐	No	☐
Background information	Yes	☐	No	☐

Scoping of potential impacts	Yes	☐	No	☐
Technical detail	Yes	☐	No	☐
Identification of key impacts	Yes	☐	No	☐
Cross referencing for further information/help	Yes	☐	No	☐
Was the text easy to read?	Yes	☐	No	☐
Was the text easy to follow?	Yes	☐	No	☐
Was the text too repetitive?	Yes	☐	No	☐

3c Have you any specific comments on any of the notes produced to date?

3d In your opinion what other development types would need to be covered?

3e Any other comments?

4. Should the notes be made available to other NRA staff (e.g. environmental specialists)?

Yes ☐ No ☐

If **YES**, who?

If **NO**, why not?

5. What is the level of integration between Planning, Environmental Quality, and Conservation (and other FRCN) staff? That is, are the wider impacts of some applications, such as discharge consents or land drainage applications, not fully realised?

6 What other guidance notes are used?

TRAINING

7a What training in Environmental Assessment (background, purposes, techniques and procedures) have you (and your staff) been given?

7b Who provided it?

7c Was it sufficient for you (and your staff) to fulfil your duties?

7d If it wasn't sufficient how could it be improved?

RELATIONSHIPS WITH EXTERNAL BODIES
(developers, LPAs, LPAs as developers)

8. To what extent do developers liaise with the NRA? (i.e. at what stage of the planning process do the NRA generally get involved with a developer?)

9. Are relevant sections of the manual being copied to developers?

Yes ☐ No ☐

If **YES**, which sections, and what has been the effect and response?

If NO, why not?

10. What other guidance is currently sent?

11. Do your local planning authorities (LPAs) understand the NRA's and your needs in terms of Environmental Appraisal and Assessment of development projects?

Yes ☐ No ☐

If **NO** why not?

If **YES,** how has this been accomplished?

12. At what stage of the planning process do you become involved with the LPA and developers?

12a Is this soon enough? Yes ☐ No ☐

12b If **NOT,** at what stage should you be consulted and how could this be achieved?

13. Do you get involved with the formulation of local and regional planning issues and policies e.g. local and structure plans?

Yes ☐ No ☐

13a If **YES** what is the mechanism?

13b and, are the NRA's needs taken into account?

Yes ☐ No ☐

14. Do you consult with LPAs with regard to catchment management plans?

Yes ☐ No ☐

14a If not, why not.

15. Can you suggest any approachable LPA contacts with whom we could discuss the potentially sensitive topic of NRA/LPA interaction?

16. Have you had any difficulties with the LPA as the developer?

Yes ☐ No ☐

16a If **YES** please provide examples/reasons

17. Has the NRA in this Area/Region insisted that a formal EA be requested by an LPA (or carried out by the LPA as a developer) where the LPA would not otherwise have required one?

Yes ☐ No ☐

17a If **YES** please provide examples/reasons

18. What is the mechanism/procedure for reviewing Environmental Statements (or other environmental reports) submitted to you?

18a Are these effective?

Yes ☐ No ☐

18b If **YES**, why?

18c If **NO**, why not?

18d Are the designated consultation periods too short?

Yes ☐ No ☐

18e. If **YES** how much time do you think you require?

19. Can you suggest any case studies that we could use to demonstrate the use of R&D 76 and interaction with an LPA (and developer)?

APPENDIX B NRA CONSULTEES

Anglian

Claire Redmond - Conservation Officer
Andrea Meachan* - Conservation Officer
Brian Elsdon* - Planning Manager

Northumbria and Yorkshire

Simon Keys* - FRCN Officer (Conservation)

North West

Peter Fox* - EA contact

Southern

Robin Crawshaw* - CRN Co-ordinator

South Western

Peter Nicholson* - Conservation Officer

Severn-Trent

David Hickie - Regional EA Co-ordinator
Andrew Taylor* - Planning Liaison Officer (Lower Trent)
Kate Cox/L. Hogarth* - Assistant Area Conservation and Recreation Officer
Paul Green* - Assistant Area Conservation and Recreation Officer
C L Ward* - Planning Liaison Officer (Lower Severn)

Thames

Andrew Brookes - Regional EA Manager, R&D Project Leader
Hugh Howes - Principal Strategic Planning (and member of NPLG)
John Meekings - Planning Manager
Trevor Brawn - Planning Engineer
George Campbell - Planning Engineer
James Burstow - Senior Planning Engineer
Amanda Montague - Planning Liaison Officer
Stuart Reilly* - Forward Planning Officer
Kevin Reid* - Planning Liaison Officer (now Catchment Management Officer)
Sandra Clarke* - Senior Planning Liaison Officer
Ian Tiller - Senior Planning Engineer (West)
Barry Winter - Planning Manager (West)

Welsh

Richard Howell - Conservation and Recreation Officer
Ken Jones* - Area Planning & Support Services Co-ordinator
John Lambert* - Technical Planning Officer (and member of NPLG)
Liz Roblin* - Resources Officer FRCN

Head Office

Sue Slack - Head of Operations(and member of NPLG)

Notes:

* indicates postal response only (direct or via Regional EA contact)

NPLG National Planning Liaison Group

APPENDIX C QUESTIONNAIRE USED AS A BASIS FOR DISCUSSION IN LPA CONSULTATION

QUESTIONNAIRE - PLANNING APPLICATIONS, ENVIRONMENTAL ASSESSMENT, THE NRA AND LPAS

What criteria and/or guidelines are used to assess whether planning applications require formal Environmental Assessment (EA) under the Town and Country Planning (Assessment of Environmental Effects) 1988 and associated Regulations?

Has there been problems interpreting DOE guidance or otherwise deciding on the need for EA?

In order to process a planning application, do you often request specific further environmental information for applications not deemed to require a formal EA?

How often are informal assessments received for projects not deemed to require a formal EA?

Are such assessments examined by the LPA?

Do you issue guidelines to developers with respect to the scope of EAs when formal EAs are required or when informal EAs are offered?

Or do you refer developers to external sources of guidelines? If so, what are these?

What checklists or procedures are used to assess the adequacy of Environmental Statements?

Have planning applications been refused on the basis of environmental constraints?

What do you see as the key issues in most EAs?

(e.g. aids/hinders development, provides environmental protection, socio-economic concerns, land-take, landscape, conservation, air quality, water quality, water resources)

Which external bodies do you consult during the EA process?

What criteria do you use to judge whether the NRA should be consulted?

Do you know who to contact in the NRA for formal or informal consultations? (Who/what is your point of contact?)

At what stage(s) of a development proposal how do you liaise with the NRA? For example, do you alert them to relevant proposals at a presubmission stage?

Is contact with the NRA for formal/informal consultation only or for technical support on water-related issues?

Do you ask for NRA input to the scoping of EAs?

Do you encourage developers to contact the NRA at a pre-submission stage?

What issues do you consider concern the NRA?

Have you had any difficulties in dealing with the NRA? (Please give details).

Would you welcome further guidance from the NRA?

Have you used the NRA document *Guidance notes for Local Planning Authorities on the Methods of Protecting the Water Environment through development plans?*

Are developments proposed by the local authority itself treated in the same manner as external applications?

APPENDIX D LPA CONSULTEES

Peter Sims - Development Control Officer, Runnymede B.C.

Paul Saunderson - Surrey CC

Steve Laurenson* - Surrey CC

Chris Tyson - Planning Manager (Southern Area) SODC

Dave Baldwin - Public Services Division, Babtie Shaw and Morton (@SODC)

Gillian Hein* - London Borough of Merton

Julie Goves* - Borough of East Staffordshire

* indicates postal response only

APPENDIX E CASE STUDY - BLACKWATER VALLEY ROUTE

The Blackwater Valley Route (BVR) provides a useful case study of a development and the interaction between an LPA (Surrey County Council) and the NRA.

The scheme had been proposed for some time and Structure Plans had restricted other development in the valley. Formal plans were drawn up for the road and a public consultation exercise initiated in 1989. An ES was produced in 1992. However, the ES was lacking in some areas, partly a reflection of a lack of consultation during scoping and time allowed for the EA. Environmental sensitive aspects of the scheme included the Basingstoke Canal, areas of wetland of high ecological quality, contaminated land and the Blackwater River itself. The detailed importance of some of these areas was not realised until the ES stage. Criticism of the ES included a limited consideration of alternatives, other than whether to go over or under at the canal crossing, and its poor information content and organisation.

The NRA initially raised severe objections to the whole scheme, then principally confined their objection to the proposed realignment of the River Blackwater. Many of the reasons for NRA's objections were also stated by English Nature. At one point, it was felt within the LPA that the road may have needed to be totally re-routed at considerable cost in both financial terms and the delay in road construction. None of the alternative routes considered at this stage were without environmental impacts, not least to housing. However, further negotiations and environmental studies enabled the formulation of river realignment and mitigation proposals that were satisfactory to both the NRA and SCC. The altered proposals are documented in a supplementary ES which the NRA had insisted upon.

The scheme is now underway. Significantly, SCC consider that the use of a suitably experienced landscape ecologist on site has been of great value to the scheme in construction. In addition, consultation with the NRA on the scheme still occurs on a regular basis through a conservation/landscape working party. Monitoring is already under way.

SCC felt that the case of the BVR had demonstrated the value of EA, although was not a good example of how it should be carried out from the start. It was expected that such problems would be reduced in the future following reorganisation of the Highways and Transportation Department and the early involvement of the Planning Department in highway schemes subject to EA.

APPENDIX F BRIEF GUIDANCE NOTES/TICKLISTS

N.B. These notes were produced as the basis for the NRA Scoping guidance manual and have since been revised.

GENERIC IMPACTS OF CONSTRUCTION WORK

Issues	Sources of Impact	Potential Impact	Other Guidance
Surface Water Hydrology/ Hydraulics	Soil excavation, removal, storage	Increased surface runoff Decreased surface runoff	
	Soil compaction	Increased surface runoff Increased flooding	
	Laying of impervious surfaces (incl. roads)	Increased surface runoff Increased river flow & velocities Increased flooding	
	Culverting/ drainage	Increased flow velocities	
	In-channel works/channel diversion	Changed flow velocities	
Channel Morphology	Riparian soil excavation/ movement	Decreased stability Erosion of banks Change of planform/pattern Downstream deposition/siltation Increased suspended sediment load Increased bed load	
	In-channel works - piling, piers, bridges, vehicle movements	Erosion of bed and banks Disturbance to bed forms (pools, riffles) Downstream erosion Downstream deposition/siltation Reduced channel size Upstream deposition/siltation Increased suspended sediment load Increased bed load	
	Channel realignment/ diversion	Increased/decreased stability Erosion of bed and/or banks Upstream/downstream deposition/ siltation Change of slope Change of planform/pattern Disturbance to bed forms (pools, riffles) Reduced/increased channel size	

Issues	Sources of Impact	Potential Impact	Other Guidance
Estuarine/ Coastal Morphology	Structures and groynes	Altered erosion/sedimentation patterns	
Groundwater Hydraulics	Excavation	Altered flow	
	Dewatering	Altered flow Loss of infiltration Fall in water-table	
	Laying of impervious surfaces	Loss of infiltration Fall in water table	
	Structure	Altered flow Changed direction	
Surface Water Quality	Storage and use of chemicals, fuel/oil, cement etc., accidental spillage, site management including sanitation and sewerage	Chemical pollution Oil/fuel pollution Chemical pollution Rubbish/trash Organic pollution Deoxygenation Microbial contamination Increased turbidity	
	Earthworks	Increased turbidity Increased suspended solids Re-suspension of contaminated sediments	
	Disturbance of contaminated land	Chemical pollution Oil/fuel pollution Rubbish/trash	
	Tree removal	Thermal pollution Algal blooms	
	In-channel works	Increased turbidity Increased suspended solids Oil/fuel pollution	
	Dewatering	Decreased dilution capacity Increased suspended solids Increased turbidity	
	Balancing ponds	Improved water quality Decreased suspended solids	

Issues	Sources of Impact	Potential Impact	Other Guidance
Groundwater Quality	Storage and use of chemicals, fuel/oil, etc.	Chemical pollution Oil/fuel pollution	
	Pumping	Chemical pollution Movement of contaminated water	
	Disturbance of contaminated land	Chemical pollution Oil/fuel pollution	
Aquatic Ecology	Construction (including in-channel works) and associated works	Degraded habitat Disturbed habitat Habitat removal Decreased fish biomass Loss of invertebrates Reduced species diversity Loss of plants Obstacle to fish migration Disturbance of sensitive species Effect on fish behaviour Change in fish community Effects on fish spawning Fish kill Decreased fish biomass Loss of other vertebrates	
	Channel realignment	Disturbed habitat Habitat removal Loss of invertebrates Loss of plants Effects on fish spawning Disturbance of sensitive species	
	Balancing pond	Improved habitat	
Terrestrial Ecology	Site preparation and land take (including access roads, car parks and other associated works)	Disturbed habitat Degraded habitat Habitat loss Destruction of flora Tree removal Loss of bird habitat Loss of bat habitat Disturbance of sensitive species Decreased number of species Wetland change Severance of river corridor	

Issues	Sources of Impact	Potential Impact	Other Guidance
Human-Related	In-channel structures	Increased flood risk Disruption to Commercial Navigation	
	Channel re-alignment	Reduced/increased flood risk	
Land Use Change	Land take	Loss of riparian land	
	Construction of buildings, car parks etc.	Increased urban area Restriction to future developments/allow development of floodplain	
	Tree clearance	Deforestation	
Visual Amenity	Earthworks, construction	Aesthetic deterioration (e.g. river discoloration)	
Recreation-related	Site security and safety restrictions	Disrupted access Disruption to anglers Disruption to navigation	
	In-channel works and structures	Disruption to anglers Disruption to navigation	

Development Type: Reservoirs

Issue	Source of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Impoundment	Decreased river velocities (upstream) Riparian drainage affected Increase in (direct) surface runoff	
	Release structure	Regulated flow Decreased/increased flooding Changed flow velocities (downstream)	
Channel Morphology/ Sediments	Impoundment	Increased stability Change of slope Change of planform/pattern Increased channel size Decreased suspended sediment load Increased bed load Erosion of banks	
	Release structure	Altered sedimentation patterns downstream Downstream erosion Decreased suspended sediment load	
Groundwater Hydraulics	Impoundment	Altered flow patterns Rise/fall in water table	
Surface Water Quality	Impoundment	Deoxygenation Algal bloom Oil/fuel pollution Eutrophication Microbial contamination (roosting birds) Decreased turbidity (suspended solids) Increased turbidity (algae) Stratification Re-suspension of contaminated sediments Increased dilution capacity (upstream) Improve quality	

Issues	Sources of Impact	Potential Impact	Other Guidance
	Release structure	Decreased dilution capacity (downstream) Decreased suspended solids Thermal pollution Chemical pollution Eutrophication	
	Associated afforestation (conifers)	Acidification Chemical pollution Eutrophication	
Aquatic Ecology	Impoundment	Gross habitat change/ creation of new aquatic habitat Increased fish biomass Increase of invertebrates (plankton and midges) Loss of sensitive species Loss of fauna and flora of running waters Disturbance of sensitive species Effect on fish behaviour Change in fish community Effects on fish spawning	
	Dam wall	Barrier to fish migration Barrier to corridor species (e.g. mammals)	
	Release structure	Loss of sensitive species Effect on fish behaviour Disturbed habitat Change in fish community Change in invertebrate community Change in plant community	
Terrestrial Ecology	Impoundment	Habitat loss (riparian areas) Wetland changes	
	Associated pipelines	Various impacts	

Issues	Sources of Impact	Potential Impact	Other Guidance
Human-Related	Impoundment	Reduced/Increased flood risk Increased water resource Protected water resource Adverse odour Health risk Nuisances	
Land Use Change	Impoundment	Restriction to future developments	
Visual Amenity	Impoundment	Altered landscape	
Recreation -Related	Impoundment	Improved facilities Restricted access for water users	Change
in angling quality		Restricted access for water users	
Heritage & Archaeology	Impoundment	Change to historic landscape	

Development Type: Barrages

Issues	Source of Impacts	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Impoundment	Decreased flow velocities (upstream) Regulated flow Decreased/increased flooding Riparian drainage affected	
	Impounding structure	Reduced tidal flow/flushing/ mixing Wave generation	
Channel Morphology/ Sediments	Impoundment	Increased stability Change of slope Change of planform/pattern Increased channel size Decreased suspended sediment load Increased bed load	
	Dredging	Decreased stability Disturbance of bed forms Increased suspended sediment load Decreased bed load	
Groundwater Hydraulics	Impoundment	Altered flow Rise in water table	
Surface Water Quality	Impoundment	Chemical pollution Oil/fuel pollution Organic pollution Eutrophication Algal bloom Increased turbidity Microbial contamination Rubbish/trash Salinity change Deoxygenation Decreased turbidity (suspended solids) Stratification Re-suspension of contaminated sediments Increased dilution capacity (upstream) Decreased dilution capacity (downstream)	

Issues	Sources of Impact	Potential Impact	Other Guidance
	Dredging	Increased suspended solids Re-suspension of contaminated sediments	
Groundwater Quality	Impoundment	Movement of contaminated water Saline intrusion	
Aquatic Ecology	Impoundment	Gross habitat change Increased fish biomass Change in benthic community Increase of invertebrates (plankton and midges) Loss of flowing-water species Effect on fish behaviour Change in fish community Effect on fish spawning Fish kill Disturbance of sensitive species Loss of sensitive species Effects on fish spawning	
	Impounding structure	Barrier to fish migration Barrier to other species (e.g. mammals)	
Terrestrial habitat	Impoundment	Habitat loss (intertidal and other riparian areas) Wetland changes	
Human-Related	Impoundment	Reduced/Increased flood risk Increased water resource Adverse odour Health risk Nuisances	
	Impounding structure	Disruption to Commercial Navigation	
Land Use Change	Impoundment	Increased urban area Associated development	
Visual Amenity	Impoundment	Altered landscape Aesthetic improvement Aesthetic deterioration	

Issues	Sources of Impact	Potential Impact	Other Guidance
Recreation-Relate	Impoundment	Improved facilities Increased boat use Change in angling quality Restricted access for water users	
	Impounding structure	Disruption to navigation	
Heritage & Archaeology	Impoundment	Change to historic landscape	

Development Type: Sea Outfalls

Issues	Sources of Impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Outfall structure	Change in local tidal currents	
Estuary/ Sea Bed Morphology/ Sediments	Outfall structure and discharge	Change in sediment deposition/resuspension characteristics	
Groundwater Hydraulics	No significant effects		
Surface Water Quality	Discharge	Microbial contamination Organic pollution Eutrophication Algal blooms Sewage derived rubbish/trash on beach/shore Increased turbidity Chemical pollution Deoxygenation Improved quality (inshore)	
Groundwater Quality	No significant effects		
Aquatic Ecology	Outfall structure	Altered habitat Change in invertebrate community Change in fish community	
	Discharge	Degraded habitat Change in invertebrate community Decrease in direct and secondary food-supply inshore Increase in "food" supply offshore Change in trophic structure Reduced bird abundance Increased bird diversity Change in fish community Effects on fish spawning Fish disease Loss of sensitive species Organic enrichment of sediments	

Issues	Sources of Impact	Potential Impact	Other Guidance
Terrestrial Ecology	Headworks	Loss of habitats and species Human-Related	
	Outfall structure	Severance of beaches Hazard to Commercial Navigation and fisheries	
	Discharge	Health risks Nuisances Adverse odour Contamination of shell fisheries	
Land Use Change	Outfall structure	Restriction to future developments	
	Discharge	Derestriction/Restriction to future developments	
Visual Amenity	Outfall structure	Aesthetic deterioration	
	Discharge	Aesthetic deterioration	
Recreation-Relate	Outfall structure	Restricted access Disruption to navigation Disruption to walkers	
	Discharge	Degraded facilities for water users (offshore) Improved facilities (inshore)	
Heritage & Archaeology	Outfall structure	Visual disturbance Loss of historical landscape	

Development Type: **Roads and Road Widening**

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Drainage/runoff	Increased surface runoff Increased river flow & velocity Increased magnitude of flooding	
	Bridges/culverts	Changed flow velocities Increased flooding	
	Reed beds	Increased hydraulic roughness	
Channel Morphology/ Sediments	Drainage/runoff	Deposition/siltation Increased suspended sediment load Increased bed load	
	Bridges/culverts	Altered channel	
	Road routing	River diversion Decreased stability	
Groundwater Hydraulics	Soakaways	Change in water-table Altered flow patterns	
Surface Water Quality	Drainage/runoff/ spillage	Acute chemical pollution Chronic chemical pollution Oil/fuel pollution Altered salinity Deoxygenation Increased turbidity Decreased turbidity Rubbish/trash	
	Verge maintenance	Chemical pollution	
	Traffic	Acidification Chemical pollution Accidental spills	
Groundwater Quality	Runoff/soakaways	Chemical pollution Oil/fuel pollution	
Aquatic Quality	Runoff/spillage	Degraded habitat Decreased fish biomass Loss of invertebrates Loss of plants Reduced species diversity Change in the fish community Fish kill (and loss of other aquatic life) Loss of sensitive species Reduced bird/mammal populations	

Issues	Sources of Impact	Potential Impact	Other Guidance
	Culverts	Obstacle to fish migration Barrier to mammals	
	Balancing ponds/reed beds	Creation of new aquatic habitat	
Terrestrial Ecology	Road	Barrier to amphibian/mammal migration/movement Severance of river corridor	
	Traffic	Disturbed habitat Degraded habitat Loss of sensitive species Reduced amphibian/bird/mammal populations	
	Surface water spray/ rubbish/trash	Degraded habitats	
	Runoff/soakaways/ balancing ponds	Wetland change	
Human-Related	Runoff	Increased flood risk Decreased water resource	
	Bridges/culverts	Increased flood risk	
Land Use Change	Associated development	Increased urban area Development of floodplain	
Recreation-Related	Bridges/culverts	Disrupted navigation	

Notes:

Associated developments, e.g. motorway surface areas, can magnify the local impact of a road. Similarly, link roads and extensions can have further impacts.

Development Type: **Fish Farms**

Issues	**Sources of Impact**	**Potential Impacts**	**Other Guidance**
Surface Water Hydrology/ Hydraulics	Abstraction	Decreased river velocity Low flows	
	Discharge	Increased river flow & velocity	
Channel Morphology/ Sediments	Construction of fish ponds	Change of planform/pattern	
	Abstraction	Reduced channel size Deposition/siltation	
	Discharge	Downstream deposition/siltation Increased suspended sediment load Increased bed load	
	Fish cage	Deposition/siltation Increased bed load	
Groundwater Hydraulics	Groundwater abstraction	Fall in water-table	
Surface Water Quality	Discharge	Chemical pollution Deoxygenation Thermal pollution Eutrophication Algal growths/blooms Increased turbidity Microbial contamination (incl. disease/parasitic/antibiotic resistant organisms) Decreased dilution capacity	
	Accidental releases	Chemical pollution Deoxygenation	
	Fish cage	Chemical pollution Deoxygenation Eutrophication Algal bloom Increased turbidity Microbial contamination (incl. disease/parasitic/antibiotic resistant organisms) Oil/fuel pollution	

Issues	Sources of Impact	Potential Impact	Other Guidance
	Shellfish ropes/ bags	Oil/fuel pollution Introduction of alien fish species/stocks	
Groundwater Quality	Burial of fish carcasses	Microbial contamination Organic pollution Chemical pollution	
Aquatic Ecology	Construction of fish/crayfish ponds	Altered habitat	
	Discharge	Disturbed habitat Increased fish biomass Change in fish community Change in invertebrate community Increased plant biomass Loss of plants Loss of invertebrates Effects on fish spawning Disturbance of sensitive species Disease/parasitic infection	
	Fish escapes	Introduction of alien fish species/stocks Increased fish biomass Change in fish community Disease/parasitic infection	
	Abstraction/low river flow/weirs/flow diversion	Obstacle to fish migration Effects on fish spawning Fish kill	
	Predator control	Reduced bird/mammal populations	
Land Use Change	Abstraction/discharge	Restriction to future developments	
Visual Amenity	Cages, turbidity, eutrophication	Aesthetic deterioration	
Recreation-Related	Creation and operation of angling lakes & shop	Improved facilities Change in angling quality	
	Fish escapes	Change in angling quality	
	Fish cages	Restricted access Disruption to navigation	

Development Type: Restoration of mineral extraction sites (landfill, recreation)

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Landfill capping	Increased surface runoff Increased flooding	
	Flooded pit	Change in flow and drainage patterns	
Channel Morphology/ Sediments		Downstream deposition/siltation Increased suspended sediment load Increased bed load	
Groundwater Hydraulics	Landfill lining	Loss of infiltration Fall in water-table Barrier to flow Altered flow patterns	
Surface Water Quality	Landfill leachate	Chemical pollution Deoxygenation Increased turbidity Microbial contamination Organic pollution Rubbish/trash	
	Leachate treatment (e.g. reed beds, ponds)	Improved water quality	
	Flooded pit - recreation	Oil/fuel pollution Litter trash	
	Flooded pit - birds	Microbial contamination Eutrophication	
Groundwater Quality	Leachate	Chemical pollution Deoxygenation Increased turbidity Microbial contamination Organic pollution	
Aquatic Ecology	Landfill/ recreational activity	Disturbed habitat Disturbance of sensitive species	

Issues	Sources of Impact	Potential Impact	Other Guidance
	Leachate	Degraded habitat Sewage fungus Loss of invertebrates Loss of plants Reduced species diversity Fish kill (& loss of other aquatic life) Effects on fish spawning Loss of sensitive species	
	Leachate treatment (ponds, reed beds etc.)	Creation of new aquatic habitat	
	Flooded pit	Creation of new aquatic habitat	
Terrestrial Ecology	Landfill/water fill	Gross habitat change Loss of rare/sensitive species	
	Landfill/ recreational activity	Disturbed habitat Disturbance of sensitive species	
	Leachate treatment (reed beds, ponds etc.)	Wetland changes Improved riparian habitat	
	Site restoration (soil importation/ sowing/planting)	Introduction of alien species	
	Conservation management	Improved habitat	
	Flooded pit	Wetland changes New riparian habitat	
Human-Related	Landfill operation	Decreased water resource	
	Water body	Increased water resource	
	Water recreation	Increased noise	
	Creation of nature reserve/public area	Improved access	

Issues	Sources of Impact	Potential Impact	Other Guidance
Visual Amenity	Flooded pit	Altered landscape	
Recreation-Related	Landfill	Restricted access	
	Creation of nature reserve	Improved access Improved facilities	
	Flooded pit	Improved facilities for water users	

Notes: "Landraise" is taken to be synonymous with "landfill"

Development Type: **Large Residential Developments**

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Runoff	Increased surface runoff Increased river flow & velocity Increased frequency of flooding Increased magnitude of flooding Low flows	
	Balancing/ornamental ponds	Riparian drainage affected Regulated/controlled flow	
Channel Morphology/ Sediments	Runoff	Deposition/siltation	
	Landscaping	Modified channel	
Groundwater Hydraulics	Impervious surfaces	Loss of infiltration Fall in water-table Barrier to flow Altered flow patterns	
Surface Water Quality	Runoff/storm drains	Oil/fuel pollution Chemical pollution Deoxygenation Eutrophication Algal bloom Increased suspended solids & turbidity Microbial contamination Rubbish/trash Decreased dilution capacity	
	Balancing/ornamental ponds	Decreased turbidity Increased dilution capacity Improved general water quality	
	Garden/vehicle maintenance	Chemical pollution Oil/fuel pollution	
Groundwater Quality	Garden/vehicle maintenance	Chemical pollution Oil/fuel pollution	
Aquatic Ecology	Runoff/storm drains	Degraded habitat Decreased fish biomass Loss of invertebrates Loss of plants Reduced species diversity Fish kill (& loss of other aquatic life) Effects on fish spawning Loss of sensitive species	

Issues	Sources of Impact	Potential Impact	Other Guidance
	Balancing/ornamental ponds	Improved habitat Increased fish biomass Increase of invertebrates Increased plant biomass Change in the fish community Increased species diversity	
	Culverts	Obstacle to fish migration Barrier to mammals	
Terrestrial Ecology	Traffic	Disturbance of sensitive species Reduced mammal populations	
	Balancing/ornamental Ecology	Wetland changes	
Human-Related	Runoff	Adverse odour Increased flood risk	
	Balancing/ornamental lakes	Adverse odour Health risk Safety risk Nuisance Reduced flood risk	
Land Use Change	Development	Increased urban area Deforestation Loss of riparian land Development of floodplain	
	Landscaping	Afforestation	
Visual Amenity	Runoff/culverts	Aesthetic deterioration	
	Balancing/ornamental lakes	Aesthetic improvement	
Recreation-Related	Balancing/ornamental lakes	Improved facilities for anglers	

Development Type: **Afforestation**

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Site preparation and ploughing	Increased surface runoff Increased flooding Increased river flow and velocity Increased magnitude of flooding	
	Tree maturation	Decreased surface runoff Decreased flooding Decreased flow velocities	
	Felling	Increased surface runoff Increased flooding Increased flow velocities	
Channel Morphology/ Sediments	Site preparation/ ploughing/planting/ felling	Decreased stability Erosion of bed and/or banks Deposition/siltation Increased suspended sediment load Increased bed load	
Groundwater Hydraulics	Tree maturation	Loss of infiltration Fall in water-table	
Surface Water Quality	Site preparation/ ploughing	Acidification Oil/fuel pollution Increased turbidity Rubbish/trash	
	Tree maturation	Acidification Decreased dilution capacity	
	Felling	Acidification Eutrophication Oil/fuel pollution Thermal pollution (loss of shade) Algal bloom Increased turbidity Rubbish/trash	
	Application of fertilisers/ pesticides	Chemical pollution Eutrophication Rubbish/trash	
Groundwater Quality	Application of pesticides	Chemical pollution	

Issues	Sources of Impact	Potential Impact	Other Guidance
Aquatic Ecology	Afforestation	Disturbed habitat Degraded habitat Decreased fish biomass Loss of invertebrates Loss of plants Reduced species diversity Obstacle to fish migration Fish kill (& loss of other aquatic life) Effects on fish spawning Loss of sensitive species Reduced bird/mammal populations Reduced productivity	
Terrestrial Ecology	Afforestation	Changed habitat Destruction of flora Loss of bird habitat Wetland changes Altered riparian habitat Disturbance of sensitive species	
	Felling	Tree removal Changed habitat	
Human-Related	Site preparation/ ploughing/felling	Increased flood risk	
	Tree maturation	Decreased water resource	
Recreation-Related	Site preparation/ ploughing/felling	Restricted access	
	Forest	Change in angling quality and access to anglers	

Notes:

Site preparation includes road construction
Ploughing includes other forms of ground preparation and drainage

Development Type: **Windfarms**

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Construction & use of haul & access roads	Increased surface runoff	
	Construction & operation of substations & transformers	Increased surface runoff	
	Cable laying	Increased surface runoff	
Channel Morphology/ Sediments	Construction & use of haul & access roads	Downstream deposition/siltation Increased suspended sediment load Increased bed load	
	Cable laying	Downstream deposition/siltation Increased suspended sediment load Increased bed load	
Surface Water Quality	Construction, cable laying and road use	Chemical pollution Oil/fuel pollution Increased turbidity Microbial contamination Rubbish/trash Organic pollution	
	Operations and site maintenance	Oil/fuel pollution Chemical pollution	
Aquatic Ecology	Construction, cable laying and road use	Disturbed habitat Loss of sensitive species	
Terrestrial Ecology	Construction, cable laying	Degraded habitat Destruction of flora Wetland changes Disturbance of sensitive species Habitat loss	

Development Type: **Mineral Extraction/Quarrying**

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Buildings, plant, roads	Increased surface runoff Increased frequency of flooding Increased river flow & velocity	
	Dewatering	Changed river velocities Riparian drainage affected	
Channel Morphology/ Sediments	Runoff	Increased suspended sediment load Downstream deposition/siltation Increased bed load	
Groundwater Hydraulics	Removal of aquifer material/dewatering	Altered flow Loss of infiltration Changed direction Fall in water-table	
Surface Water Quality	Site runoff	Oil/fuel pollution Chemical pollution Increased turbidity & suspended solids Rubbish/trash	
	Removal of aquifer material/dewatering	Decreased dilution capacity	
Groundwater Quality	Site runoff	Chemical pollution Oil/fuel pollution	
Aquatic Ecology	Site runoff, dewatering	Disturbed habitat Degraded habitat Effects on fish spawning	
	Catchment lagoons	Creation of new aquatic habitat	
Terrestrial Ecology	Site investigating/ prospecting	Disturbance of sensitive species	
	Construction and operation of roads/ buildings/process plant, blasting, overburden disposal	Habitat loss Disturbance of sensitive species	
	Dewatering	Wetland changes	
	Catchment lagoons	Wetland changes Creation of riparian habitat	

Development Type: **Marinas**

Issues	**Sources of impact Guidance**	**Potential Impacts**	**Other**
Surface Water Hydrology/ Hydraulics	Marina	Decreased flow velocities (upstream)	
	Lockage	Changed flow velocities Reduced tidal flow/flushing/mixing	
	Boat movements	Wave generation	
Channel Morphology/ Sediments	Marina	Increased stability Increased channel size Decreased suspended sediment load Increased bed load	
	Lockage	Change of slope	
	Boat movements	Bank erosion	
	Dredging	Decreased stability Disturbance of bed forms Increased suspended sediment load Decreased bed load	
Groundwater Hydraulics	Marina/lockage	Rise in water table	
Surface Water Quality	Boats	Chemical pollution Oil/fuel pollution Organic pollution Eutrophication Re-suspension of contaminated sediments Increased turbidity Microbial contamination Rubbish/trash	
	Marina/lockage	Salinity change Deoxygenation Decreased turbidity (suspended solids) Stratification Algal bloom Rubbish/trash	
	Dredging	Eutrophication Re-suspension of contaminated sediments Increased turbidity	
Groundwater Hydraulics	Marina/lockage	Movement of contaminated water Saline intrusion	

Aquatic Ecology	Marina	Gross habitat change Increased fish biomass Increase of invertebrates (plankton and midges) Loss of flowing-water species Effect on fish behaviour Change in fish community Effect on fish spawning Fish kill Loss of sensitive species Loss of intertidal/riparian habitat Creation of artificial "reef" habitat
	Boat/pedestrian/ vehicle movements	Disturbance of sensitive species
	Lockage	Barrier to fish migration
Terrestrial	Marina	Habitat loss (intertidal and Ecology other riparian areas) Wetland changes
Human-Related	Marina	Increased water resource Health risk Nuisances
	Boats/lockage	Disruption to Commercial Navigation
Land Use Change	Marina & associated development	Increased urban area
Visual Amenity	Marina & associated development	Altered landscape
Recreation-Related	Marina	Improved facilities Increased boat use Change in angling quality
	Lockage	Disruption to navigation Disruption to anglers
Heritage & Archaeology	Marina	Change to historic landscape

Development Type: **Hydropower**

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Impounding structure/ weir	Decreased river velocities Increased flooding Increased hydraulic roughness Decreased flooding Riparian drainage affected	
	Release regime	Increased flow velocities Decreased flow velocities Increased flooding Decreased flooding Regulated flow Low flows Wave - generation Reduce tidal flow/flushing/mixing	
Channel Morphology/ Sediments	Impounding structure/ weir	Increased stability Change of slope Upstream deposition/siltation Decreased suspended sediment load Increased bed load	
	Release regime	Increased stability Decreased stability Bank degradation/erosion Erosion of bed and/or banks Deposition/siltation Downstream deposition/siltation Reduced channel size Increased channel size Increased suspended sediment load Increased bed load	
Groundwater Hydraulics	Impounding structure/ weir	Rise in water-table	
Surface Water Quality	Impounding structure/ weir	Deoxygenation Eutrophication Algal bloom Decreased turbidity Stratification Re-suspension of contaminated sediments Increased dilution capacity	
	Release regime	Oxygenation Thermal pollution Increased turbidity Increased dilution capacity Decreased dilution capacity	

Issues	Sources of Impact	Potential Impact	Other Guidance
Groundwater Quality	-	-	
Aquatic Ecology	Impounding structure/ weir	Gross habitat change Increased fish biomass Increased plant biomass Change in the fish community Barrier to fish migration Obstacle to fish migration Effects on fish spawning Loss of flora and fauna of flowing waters Barrier to mammals Loss of sensitive species	
	Release regime	Disturbed habitat Increased fish biomass Decreased fish biomass Increase of invertebrates Loss of invertebrates Increased plant biomass Loss of plants Effect on fish behaviour Change in the fish community Obstacle to fish migration Effects on fish spawning Disturbance of sensitive species	
Terrestrial Ecology	Maintenance and operational activity/ turbines/pumps	Disturbed habitat Disturbance of sensitive species	
	Impounding structure	Habitat loss Wetland changes	
	Release regime	Destruction of flora Wetland changes Disturbance of sensitive species	
	Pipelines/cables	Habitat loss	
Human-Related	Turbines/pumps	Increased noise Increased vibration	

	Impounding structure	Disrupted access Health risks Nuisances Reduced flood risk Increased flood risk Increased water resource Decreased water resource Disruption to Commercial Navigation
	Release regime	Disrupted access Health risks Reduced flood risk Increased flood risk Increased water resource Decreased water resource Disruption to Commercial Navigation
Land Use Change	Impounding structure	Loss of riparian land
Visual Amenity	Impounding structure	Change in aesthetic value Altered landscape
Recreation-Related	Impounding structure	Restricted access Improved access Improved facilities Degraded facilities for water users Disruption to navigation Change in angling quality Disruption to walkers Restricted access for water users
	Release regime	Disrupted access Improved facilities Degraded facilities for water users Disruption to navigation Disruption to anglers Change in angling quality Restricted access for water users
Heritage & Archaeology	Impounding structure	Destruction and damage of known/unknown features Loss of historical landscape Change to historic landscape
	Release regime	Visual disturbance

Development Type: Sewage treatment works (extension and installation)

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Buildings/tanks/car parks	Increased surface runoff Increased river flow & velocity Increased flooding Riparian drainage affected	
	Discharge	Increased river flow & velocity	
Channel Morphology/ Sediments	Discharge/storm overflow	Bank degradation/erosion Deposition/siltation Increased channel size Increased suspended sediment load Increased bed load	
Groundwater Hydraulics	Buildings/tanks/car parks	Loss of infiltration Changed direction Fall in water-table Barrier to flow	
	Sludge disposal/ tertiary treatment in unlined ponds	Rise in water-table	
Surface Water Quality	Construction	Chemical pollution Re-suspension of contaminated sediments Oil/fuel pollution	
	Discharge	Chemical pollution Deoxygenation Eutrophication Algal bloom Increased turbidity Microbial contamination Stratification Rubbish/trash Organic pollution	
	Treatment upgraded	Improved quality Increased dilution capacity Decreased turbidity	
	Maintenance/spills	Chemical pollution Oil/fuel pollution	
	Sludge disposal to land (runoff)	Organic pollution Eutrophication Microbial contamination	

Issues	Sources of Impact	Potential Impact	Other Guidance
	Sludge incineration	Acidification	
	Sludge disposal to sea	Organic pollution Eutrophication Microbial contamination Chemical pollution Increased suspended solids	
Groundwater Quality	Spills	Chemical pollution Oil/fuel pollution	
	Sludge disposal to land	Chemical pollution Microbial contamination Organic pollution	
Aquatic Ecology	Construction and discharge	Degraded habitat Increased fish biomass Decreased fish biomass Increased plant biomass Loss of plants Reduced species diversity Change in the fish community Obstacle to fish migration Fish kill Effects on fish spawning Disturbance of sensitive species Loss of sensitive species Disease/parasitic infection	
	Upgrade to works/ tertiary reed bed or pond treatment	Improved habitat	
Terrestrial Ecology	Operations	Disturbed habitat Degraded habitat Disturbance of sensitive species	
	Reed beds	Improved habitat Wetland changes Improved riparian habitat	
	Percolating filters	Improved habitat	
	Sludge to land	Changed habitat	
Human-Related	Discharge	Decreased water resource Adverse odour Nuisances Health risks	

Issues	Sources of Impact	Potential Impact	Other Guidance
Land Use Change	Buildings and works	Increased urban area Loss of riparian land Restriction to future developments	
	Sludge disposal to land	Change in grade of agricultural land	
Visual Amenity	Discharge	Aesthetic deterioration	
Recreation-Related	Buildings and works	Restricted access Change in angling quality Restricted access for water users	
	Discharge	Degraded facilities for water users	

Development Type: Redevelopment of Contaminated Land

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	-	-	
Channel Morphology/ Sediments	Earthworks	Downstream deposition/siltation Increased suspended sediment load Increased bed load	
Groundwater Hydraulics	Boreholes, earthworks, piling, site demolition & construction	Change in infiltration rate Change in water-table Altered flow	
Surface Water Quality	Runoff, leachate	Chemical pollution Oil/fuel pollution Deoxygenation Increased turbidity & suspended solids Microbial contamination Re-suspension of contaminated sediments Rubbish/trash Organic pollution	
Groundwater Quality	Boreholes, earthworks, piling, site demolition & construction, disposal of contaminated soil	Movement of contaminated water Chemical pollution Oil/fuel pollution	
Aquatic Ecology	Runoff, leachate	Degraded habitat Decreased fish biomass Loss of invertebrates Reduced species diversity Fish kill Loss of sensitive species	
Terrestrial Ecology	Earthworks, site demolition, construction	Disturbed habitat Improved habitat Habitat loss Loss of sensitive species	
Human-Related	Contaminants	Health risks Nuisances Decreased water resource	

Issues	Sources of Impact	Potential Impact	Other Guidance
Land Use Change	Development	Increased urban area	
Visual Amenity	Runoff, leachate	Aesthetic deterioration	
Recreation-Related	Earthworks, construction, contaminants	Restricted access Disrupted access	
	Removal/capping of contamination	Improved access	

Development Type: Railways

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Drainage/runoff	Increased surface runoff Increased river flow & velocity Increased magnitude of flooding	
	Bridges/culverts	Changed flow velocities Increased flooding	
Channel Morphology/ Sediments	Drainage/runoff	Deposition/siltation Increased suspended sediment load Increased bed load	
	Bridges/culverts	Altered channel	
	Rail routing - river diversion	Decreased stability Erosion of bed and/or banks Change in slope	
Groundwater Hydraulics	Drainage/infiltration	Change in water-table Altered flow	
	Tunnelling	Altered flow	
Surface Water Quality	Drainage/runoff/ spillage	Oil/fuel pollution Chemical pollution Deoxygenation Increased turbidity Rubbish/trash	
	Vegetation management	Chemical pollution	
	Emissions	Acidification	
Groundwater Quality	Drainage/infiltration/ spillage	Chemical pollution Oil/fuel pollution	
	Vegetation management	Chemical pollution	
Aquatic Ecology	Drainage/runoff/ spillage	Degraded habitat Decreased fish biomass Loss of invertebrates Loss of plants Reduced species diversity Change in the fish community Fish kill Loss of sensitive species Reduced bird/mammal populations	

Issues	Sources of Impact	Potential Impact	Other Guidance
	Culverts	Obstacle to fish migration Barrier to mammals	
Terrestrial Ecology	Track	Barrier to amphibian/mammal migration/movement Severance of river corridors	
	Rail traffic	Disturbed habitat Degraded habitat Loss of sensitive species Reduced amphibian/bird/mammal populations Rubbish/trash	
	Vegetation management	Loss of plants Loss of trees Degraded habitats	
	Tunnelling	Disturbed habitat	
Human-Related	Drainage	Increased flood risk Decreased water resource	
	Bridges/culverts	Increased flood risk	
Land Use Change	Associated development	Increased urban area Development of floodplain	
Visual Amenity	Track/traffic	Aesthetic deterioration Altered landscape	
Recreation-Related	Track	Restricted access	
	Bridges/culverts	Disruption to navigation	

Development Type: **Waste Management (incinerators, digesters, composting plants, treatment works, disposal to sacrificial land, waste separation/transfer stations)**

Issues	**Sources of impact**	**Potential Impacts**	**Other Guidance**
Surface Water Hydrology/ Hydraulics	Buildings, site, roads	Increased surface runoff Increased flooding	
Channel Morphology/ Sediments	Runoff	Downstream deposition/siltation Increased suspended sediment load Increased bed load	
Groundwater Hydraulics	Buildings, site, roads	Loss of infiltration Fall in water-table	
	Disposal of liquid waste to land	Rise in water-table	
Surface Water Quality	Runoff/discharge/ spills	Acute chemical pollution Chronic chemical pollution Oil/fuel pollution Deoxygenation Eutrophication Algal bloom Increased turbidity Microbial contamination Rubbish/trash Organic pollution	
	Emissions (incin- erators)	Acidification	
Groundwater Quality	Site	Chemical pollution Oil/fuel pollution	
	Disposal to land	Chemical pollution Organic pollution Microbial contamination	
Aquatic Ecology	Site activity	Disturbed habitat	
	Emissions/discharges/ leachate/spills/runoff	Degraded habitat Loss of species	
Terrestrial Ecology	Site activity	Disturbed habitat Habitat loss	

Issues	Sources of Impact	Potential Impact	Other Guidance
	Disposal to land	Degraded habitat Destruction of flora Loss of sensitive species Habitat loss	
Land Use Change	Building, site, roads	Increased urban area	
	Disposal to land	Restriction to future developments	
Visual Amenity	Leachate/runoff	Aesthetic deterioration	
Recreation-Related	Site and operations	Restricted access for water users	

Notes:

For disposal of incinerator and other solid residues, e.g. fly ash, and landfill see relevant (restoration of mineral extraction sites) guidance notes.

Development Type: **Large industrial/manufacturing development and operations**

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Buildings/car parks	Increased surface runoff Increased river flow and velocity Increased flooding Riparian drainage affected	
	Abstraction	Decreased river velocity Low flows Reduce tidal flow/flushing/mixing	
Channel Morphology/ Sediments	Runoff	Decreased stability Erosion of bed and/or banks Downstream deposition/siltation	
	Abstraction	Reduced channel size Increased suspended sediment load Increased bed load	
Groundwater Hydraulics	Buildings/car parks	Loss of infiltration Fall in water-table Barrier to flow	
	Abstraction	Fall in water-table	
Surface Water Quality	Runoff/spills/leaks/ discharges/development of contaminated land	Chemical pollution Oil/fuel pollution Altered salinity Deoxygenation Thermal pollution Eutrophication Algal bloom Increased turbidity & suspended solids Stratification Re-suspension of contaminated sediments Rubbish/trash Decreased dilution capacity Organic pollution	
	Abstraction	Decreased dilution capacity	
Groundwater Quality	Spills/leaks/development of contaminated land	Movement of contaminated water Chemical pollution Oil/fuel pollution	
	Abstraction	Saline intrusion	

Issues	Sources of Impact	Potential Impact	Other Guidance
Aquatic Ecology	Runoff/spills/ discharge	Degraded habitat Decreased fish biomass Loss of invertebrates Loss of plants Reduced species diversity Change in the fish community Obstacle to fish migration Fish kill (& other aquatic life) Effects on fish spawning Loss of sensitive species Disease/parasitic infection	
	Emissions	Acidification	
	Abstraction	Degraded habitat	
Terrestrial Ecology	Buildings/car parks and associated development	Habitat loss Changed habitat	
	Operations	Disturbed habitat Degraded habitat Disturbance of sensitive species	
	Emissions	Acidification	
Human-Related	Buildings/roads/car parks	Increased flood risk	
	Discharges	Adverse odour Health risks	
	Abstraction/runoff/ discharge	Decreased water resource	
Land Use Change	Buildings/roads/car parks and associated development	Increased urban area Loss of riparian land Development of floodplain	
Visual Amenity	Discharge	Aesthetic deterioration	
Recreation-Related	Buildings	Restricted access for water users	
	Discharges	Degraded facilities for water users Disruption to anglers Change in angling quality	

Development Type: **Golf courses**

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Club hut, car park drainage & landscaping	Increased surface runoff Increased flow velocities Increased flooding	
	Off stream lakes	Decreased surface runoff Decreased flow velocities Decreased flooding	
	Abstraction	Low flows	
	Drainage/lakes	Riparian drainage affected	
Channel Morphology/ Sediments	Construction, landscaping	Decreased stability Bank degradation/erosion Deposition/siltation Change of slope Disturbance to bed forms (pools, riffles) Increased suspended sediment load Increased bed load	
	Instream lakes	Increased channel size Decreased suspended sediment load Sedimentation	
Groundwater Hydraulics	Drainage	Loss of infiltration Fall in water-table	
	Abstraction	Fall in water-table	
Surface Water Quality	Construction, landscaping	Oil/fuel pollution Increased turbidity & suspended solids Thermal pollution Chemical pollution	
	Car park	Oil/fuel pollution	
	Maintenance	Oil/fuel pollution Chemical pollution Eutrophication Algal bloom Organic pollution	
	Instream lakes	Eutrophication Algal bloom Deoxygenation	

Issues	Sources of Impact	Potential Impact	Other Guidance
	Abstraction/ Offstream lakes	Decreased dilution capacity	
Groundwater Quality	Construction	Oil/fuel pollution	
	Maintenance	Chemical pollution Oil/fuel pollution Organic pollution	
	Car park	Oil/fuel pollution	
Aquatic Ecology	Construction	Degraded habitat Habitat removal Improved habitat Effects on fish spawning	
	Maintenance	Disturbed habitat Plant removal Increased plant biomass Fish kill Disturbance/loss of sensitive species	
	Instream lakes/ structures	Change in the fish community Obstacle to fish migration	
	Offstream lakes	Creation of new aquatic habitat	
Terrestrial Ecology	Construction	Degraded habitat Severance of river corridor Loss of bird habitat Loss of bat habitat Tree removal Habitat removal Changed habitat Improved habitat	
	Golf play	Disturbed habitat	
	Drainage/lakes	Wetland changes	
	Maintenance/sowing	Change in plant community Reduced earthworm/mole populations	
Human-Related	Drainage	Increased flood risk	
	Abstraction	Decreased water resource	

Issues	Sources of Impact	Potential Impact	Other Guidance
Land Use Change	Construction	Loss of riparian land	
	Club huts and associated development	Increased urban area Development of floodplain	
Recreation-Related	Golf course	Restricted access for water users Disruption to anglers	
	Landscaping/lakes/ drainage	Change in angling quality	

Development Type: **Airports**

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Runways/terminals/car parks/associated development/drainage network	Increased surface runoff Increased river flow and velocity Increased flooding Riparian drainage affected	
Channel Morphology/ Sediments	Runoff	Decreased stability Erosion of bed and/or banks Downstream deposition/siltation Increased suspended sediment load Increased bed load	
	Drainage network	Culverting	
Groundwater Hydraulics	Runways/terminals/car parks underground stores	Loss of infiltration Barrier to flow	
Surface Water Quality	Runoff/spillages/de-icing/fire fighting	Chemical pollution Oil/fuel pollution Altered salinity Increased turbidity and suspended solids Decreased dilution capacity	
	Runway maintenance	Chemical pollution Organic pollution	
	Emissions	Acidification	
Groundwater Quality	Spillages/leaks/runoff	Chemical pollution Oil/fuel pollution	
Aquatic Quality	Runoff	Degraded habitat Reduced species diversity Effect on fish behaviour Fish kill (&other aquatic life) Effects on fish spawning Loss of sensitive species	
	Culverting	Degraded habitat Habitat removal Reduced species diversity Obstacle to fish migration Barrier to mammals Reduced bird/mammal populations Loss of sensitive species	

Issues	Sources of Impact	Potential Impact	Other Guidance
	Balancing ponds	Creation of new aquatic habitat	
Terrestrial Ecology	Terminal/runways	Habitat loss Changed habitat Degraded habitat Destruction of flora Tree removal Loss of bird habitat	
	Runway maintenance	Destruction of flora	
	Airplane movements & operations	Disturbed habitat Disturbance of sensitive species	
	Drainage	Wetland changes	
Human-Related	Impervious surfaces	Decreased water resource	
	Runoff	Increased flood risk Decreased water resource	
Land Use Change	Runways/terminals/ associated developments	Increased urban area Restriction to future developments	
Recreation-Related	Terminals/runways	Restricted access for water users	
	Culverting/runoff	Degraded facilities for water users Restricted access for water users	

Development Type: Pipelines

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Earthworks/trench digging/dewatering	Increased surface runoff Increased river flow & velocity Increased flooding Riparian drainage affected	
	Pipeline crossing river bed	Increased hydraulic roughness	
Channel Morphology/ Sediments	Trench digging/runoff	Bank degradation/erosion Downstream deposition/siltation Increased bed load Increased suspended sediment load	
	Pipeline crossing river bed	Disturbance to bed forms (pools, riffles) Upstream deposition/siltation Increased bed load	
Groundwater Hydraulics	Earthworks/trench digging/dewatering	Loss of infiltration Fall in water-table Resuspension of contaminated sediments	
	Water main/sewer leakage	Rise in water table	
	Pipeline	Barrier to flow	
Surface Water Quality	Earthworks/dewatering/ trench digging	Oil/fuel pollution Increased turbidity	
	Pipe leakage	Oil/fuel pollution Chemical pollution Organic pollution Microbial contamination Deoxygenation Increased turbidity & suspended solids	
	Pipe lining/ rehabilitation	Chemical pollution Increased turbidity Decreased turbidity Rubbish/trash	

Issues	Sources of Impact	Potential Impact	Other Guidance
Groundwater Quality	Earthworks/trench digging	Movement of contaminated water Chemical pollution Oil/fuel pollution	
	Pipe leakage	Oil/fuel pollution Chemical pollution Organic pollution Microbial contamination	
Aquatic Ecology	Earthworks/trench digging	Disturbed habitat Habitat removal	
	Runoff/leakage	Degraded habitat Decreased fish biomass Loss of invertebrates Loss of plants Reduced species diversity Fish kill (& other aquatic life) Loss of sensitive species	
Terrestrial Ecology	Earthworks/trench digging	Disturbed habitat Destruction of flora Tree loss Wetland changes Disturbance of sensitive species	
Human-Related	Leaks	Adverse odour Disrupted access Health risks Nuisances Decreased water resource	
Land Use Change	-	-	
Recreation-Related	Pipelines over rivers	Disruption to navigation	

Development Type: **Cemeteries**

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Buildings, roads	Increased surface runoff	
Channel Morphology/ Sediments	Runoff, soil disturbance	Increased suspended sediment load Downstream deposition/siltation Increased bed load	
Groundwater Hydraulics	-	-	
Surface Water Quality	Use of herbicides	Chemical pollution	
	Use of mechanical excavators, strimmers	Oil/fuel pollution	
	Leachate	Microbial contamination Organic pollution	
Groundwater Quality	Leachate	Microbial contamination Organic pollution	
	Use of herbicides	Chemical pollution	
	Use of mechanical excavators, strimmers	Oil/fuel pollution	
Aquatic Ecology	Runoff, leachate	Degraded habitat Loss of sensitive species	
Land Use Change	Site	Restriction to future developments	

Development Type: **Points of large abstraction**

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Reduction in river flow	Decreased river velocity Low flow Decreased flooding Reduce tidal flow/flushing/mixing Riparian drainage affected	
Channel Morphology/ Sediments	Reduction in river flow	Deposition/siltation Reduced channel size Disturbance to bed forms (pools, riffles) Decreased bed load	
Groundwater Hydraulics	Reduction in river flow	Fall in water-table	
Surface Water Quality	Reduction in river flow	Eutrophication Algal bloom Deoxygenation Decreased dilution capacity	
Groundwater Quality	-	-	
Aquatic Ecology	Reduction in river flow	Degraded habitat Decreased fish biomass Loss of invertebrates Reduced species diversity Effect on fish behaviour Change in the fish community Obstacle to fish migration Effects on fish spawning	
Terrestrial Ecology	Pumping	Disturbed habitat	
	Reduction in river flow	Wetland changes Habitat loss	
Human-Related	Reduction in river flow	Reduced flood risk Decreased water resource Disruption to Commercial Navigation	
Land Use Change	Reduction in river Change	Restriction to future developments	
Visual Amenity	Reduction in river flow	Aesthetic deterioration	

Issues	Sources of Impact	Potential Impact	Other Guidance
Recreation-Related	Reduction in river flow	Degraded facilities for water users Disruption to navigation Disruption to anglers Change in angling quality	
Heritage & flow	Reduction in river flow	Visual disturbance	

Development Type: **Points of large discharge**

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Discharge	Increased river flow & velocity Increased flooding	
Channel Morphology/ Sediments	Discharge	Erosion of bed and/or banks Downstream deposition/siltation Increased suspended sediment load Increased bed load	
Groundwater Hydraulics	-	-	
Surface Water Quality	Discharge	Acute chemical pollution Chronic chemical pollution Oil/fuel pollution Altered salinity Improved quality Deoxygenation Oxygenation Thermal pollution Eutrophication Algal bloom Increased turbidity & suspended solids Microbial contamination Re-suspension of contaminated sediments Rubbish/trash Organic pollution Radioactive pollution	
Groundwater Quality	Discharge/river	Movement of contaminated water	
Aquatic Ecology	Discharge	Disturbed habitat Degraded habitat Increased fish biomass Decreased fish biomass Increase of invertebrates Loss of invertebrates Increased plant biomass Loss of plants Reduced species diversity Effect on fish behaviour Change in the fish community	

Issues	Sources of Impact	Potential Impact	Other Guidance
		Obstacle to fish migration Fish kill (& other aquatic life) Introduction/encouragement of alien eggs, larvae, fry Effects on fish spawning Disturbance of sensitive species Loss of sensitive species Disease/parasitic infection Reduced bird/mammal populations	
Terrestrial Ecology	Discharge	Wetland changes Loss of sensitive species	
Human-Related	Discharge	Adverse odour Health risks Nuisances Increased flood risk Increased water resource Decreased water resource	
Land Use Change	Discharge	Restriction to future developments	
Visual Amenity	Discharge	Aesthetic deterioration	
Recreation-Related	Discharge	Degraded facilities for water users Disruption to anglers Change in angling quality Restricted access for water users	
Heritage & Archaeology	Discharge	Visual disturbance	

Development Type: **Navigation issues**

Issues Guidance	Sources of impact	Potential Impacts	Other
Surface Water Hydrology/ limit)	Boat wash (speed limit)	Increased flow velocities Wave generation	
	Lockage	Changed flow velocities Regulated flow Low flows Reduce tidal flow/flushing/mixing	
	Canoeing (artificial freshets)	Regulated flow Increased flow velocities Low flows	
Channel Morphology/ Sediments	Piling	Increased stability	
	Boat wash	Decreased stability Erosion of bed and/or banks Deposition/siltation Increased channel size Increased suspended sediment load	
	Installation of locks	Change of slope Disturbance to bed forms (pools, riffles) Downstream erosion Altered channel size Upstream deposition/siltation Increased suspended sediment load Increased bed load	
	Canoeing (artificial freshets)	Erosion of bed and/or banks	
Groundwater Hydraulics	Installation of lockage	Rise in water-table	
	Canoeing/rafting	Rise in water-table	
Surface Water Quality	Boats	Oil/fuel pollution Chemical pollution Increased turbidity & suspended solids Organic pollution Rubbish/trash Re-suspension of contaminated sediments	
	Lockage/canoeing (freshets)	Decreased dilution capacity	

Issues	Sources of Impact	Potential Impact	Other Guidance
Groundwater Quality	-	-	
Aquatic Ecology	Boats/boat wash	Disturbed habitat Degraded habitat Loss of plants Disturbance of sensitive species	
	Lockage/canoeing (freshets)	Effect on fish behaviour Obstacle to fish migration Effects on fish spawning Disturbance of sensitive species	
Terrestrial Ecology	Boat use	Disturbed habitat Disturbance of sensitive species	
Human-Related	Boat use	Increased noise Increased vibration Health risks	
	Lockage	Health risks Reduced flood risk Decreased water resource	
	Canoeing (freshets)	Health risks Decreased water resource Disrupted access Noise	
Land Use Change	Marinas/land based facilities	Loss of riparian land	
Visual Amenity	Boat use/freshets/ lock installation	Change in aesthetic value Altered landscape	
Recreation-Related	Canoeing	Disruption to anglers Degraded facilities for (other) water users	
	Freshets	Disruption to navigation Disruption to anglers	
	Boating	Disruption to anglers	

Issues	Sources of Impact	Potential Impact	Other Guidance
	Lock construction/ widening	Restricted access Improved facilities (boats) Disrupted access Disruption to navigation Disruption to anglers Change in angling quality Disruption to walkers Improved access	
	Lock operation	Improved access (boats) Disruption to anglers Disruption to cyclists Disruption to walkers	
Heritage & Archaeology	Lock installation	Destruction and damage of known/unknown features Change to historic landscape	
	Freshets/canoeing	Visual disturbance	

Development Type: **Power stations (excl. hydroelectric and wind generation)**

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Buildings and roads	Increased surface runoff Increased river flow & velocity Increased flooding	
	Fuel/waste storage/ disposal	Altered surface runoff	
	Abstraction	Decreased river velocity Low flows Reduce tidal flow/flushing/mixing	
	Discharge	Increased flow velocities	
Channel Morphology/ Sediments	Buildings and roads, fuel/waste storage/ disposal	Increased suspended sediment load Downstream deposition/siltation Increased bed load	
Groundwater Hydraulics	Buildings and roads, fuel/waste storage/ disposal	Loss of infiltration Fall in water-table	
Surface Water Quality	Discharge and runoff	Oil/fuel pollution Altered salinity Chemical pollution Radioactive contamination Deoxygenation Oxygenation Thermal pollution Increased turbidity Microbial contamination Stratification Re-suspension of contaminated sediments Rubbish/trash	
	Fuel/waste transport	Oil/fuel pollution Chemical pollution Radioactive contamination	
Groundwater Quality	Operation, fuel/waste transport/disposal	Oil/fuel pollution Chemical pollution Radioactive contamination	

Aquatic Ecology	Discharge	Disturbed habitat Degraded habitat Loss of invertebrates Loss of plants Reduced species diversity Effect on fish behaviour Change in the fish community Barrier to fish migration Obstacle to fish migration Fish kill Encouragement of alien eggs, larvae, fry Effects on fish spawning Disturbance of sensitive species Loss of sensitive species Disease/parasitic infection
	Abstraction	Fish kill Loss of invertebrates
	Emissions	Acidification
	Waste storage/ disposal	Habitat loss Disturbed habitat
	Creation of balancing/ cooling lagoons	Creation of new aquatic habitat
Terrestrial Ecology	Buildings, operation, fuel/waste storage/ transport, pipelines, cables, lighting	Disturbed habitat Degraded habitat Destruction of flora Habitat loss Disturbance of sensitive species
	Emissions	Loss of sensitive species Tree loss
	Balancing/cooling lagoons	Wetland changes
Human-Related	Abstraction	Decreased water resource
	Balancing/cooling lagoons	Nuisances
Land Use Change	Buildings, roads/ railways, lagoons storage/disposal areas	Development of floodplain Increased urban area
Recreation-Related	Site and operations	Restricted access Disrupted access
	Thermal discharge/ balancing ponds	Change in angling quality

Notes:

Further impacts may occur in the decommission of power stations

Development Type: **Oil Refineries/Oil Exploration**

Issues	Sources of impact	Potential Impacts	Other Guidance
Surface Water Hydrology/ Hydraulics	Buildings, roads	Increased surface runoff Increased flooding	
Channel Morphology/ Sediments	Runoff	Increased suspended sediment load Downstream deposition/siltation Increased bed load	
	Shipping, drilling	Increased suspended sediment load Increased bed load Decreased stability	
Groundwater Hydraulics	Buildings, roads, storage tanks	Loss of infiltration Fall in water-table Barrier to flow Altered flow	
Surface Water Quality	Runoff/discharge	Oil/fuel pollution Altered salinity Chemical pollution Deoxygenation Increased turbidity	
	Shipping/drilling	Oil/fuel pollution Chemical pollution Increased turbidity Rubbish/trash Organic pollution	
	Spillage	Oil/fuel pollution Chemical pollution	
Groundwater Quality	Runoff/spillage	Oil/fuel pollution Chemical pollution	
Aquatic Quality	Runoff/spillage/ discharge	Degraded habitat Decreased fish biomass Loss of invertebrates Loss of plants Reduced species diversity Effect on fish behaviour Fish kill (& other aquatic life) Loss of sensitive species Reduced bird/mammal populations	
	Shipping ballast water	Introduction of alien species Disease/parasitic infection	

Issues	Sources of Impact	Potential Impact	Other Guidance
Terrestrial Ecology	Refinery/drilling operations	Disturbed habitat Disturbance of sensitive species	
	Buildings, roads, storage tanks, dock facilities, pipelines	Habitat loss	
Human-Related	Refinery/drilling operations	Disruption to commercial fishing/navigation	
	Spillage/runoff	Decreased water resource	
Land Use Change	Buildings, roads etc.	Increased urban area	
Visual Amenity	Spillage, runoff	Aesthetic deterioration	
Recreation-Related	Refinery	Restricted access	
	Oil rigs	Disruption to navigation Disruption to anglers	

APPENDIX G DETAILED GUIDANCE NOTES

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF GENERAL CONSTRUCTION

1. Introduction

This guidance note seeks to identify the potential impacts of general construction activity upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) with respect to the Environmental Assessment (EA) of general construction schemes. Notes at two levels of detail have also been produced for various specific development types (see Appendix 1), including infrastructure works, such as roads and pipelines, and the redevelopment of contaminated land. This guidance note should be used to accompany such notes, where appropriate, as for most development types there will be general construction issues which are not considered in such depth in the specific notes. In each case the guidance notes concentrate on issues specifically of concern to the NRA.

The NRA has an interest in construction activities due to their potential impacts on water quality, water resources, flood defence, fisheries, conservation, recreation and navigation. In most instances, the NRA will require, as a minimum, supporting environmental information when considering development proposals before issuing various consents and/or licences. For certain more significant development projects a formal environmental assessment is required by law. The responsibility for obtaining information and/or an environmental assessment lies with the developer. There are distinct advantages for developers in contacting the NRA (see Appendix 2 for contacts) and conducting environmental studies well in advance of any proposed development. This should enable environmental constraints to be identified and avoided, where possible, and also enable the design of appropriate mitigation into the planned development. The developer should be able to demonstrate reasonable consideration of alternatives for the proposed scheme. There should also be the consideration of strategic issues such as the availability of water resources to meet the particular development's needs. Such issues may be on a catchment, regional or national level.

2. Development control

The local planning authority will provide advice on the development controls applicable to a particular development proposal and the need for environmental assessment. Typically, development will be covered by the Town and Country Planning framework. The NRA are statutory consultees for a variety of development types as set out in the (recently consolidated) General Development Order, but in practice are consulted on all types of development which affect the water environment or associated land.

3. Environmental Assessment

Certain development types require formal environmental assessment under SI 1988 No 1199 The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 and related regulations. These regulations together implement the European Community Directive on the assessment of the effects of certain public and private projects on the environment (85/337/EEC). Guidance on the regulations may be found in *Environmental Assessment - A guide to the procedures* (DoE/WO 1989) and, more formally, in DoE Circular 15/88 (WO 23/88). Guidance on the content of Environmental

Statements (ESs) may be found in the former. The DoE is currently preparing more detailed guidance on the general preparation of ESs.

Involvement of the NRA and other relevant bodies at an early stage will identify specific areas of concern (scoping) to be addressed in the environmental assessment. Guidance notes are available from the NRA for the scoping of specific development types (see Appendix 1). Detailed guidance may also be available on specific aspects of development, such as NRA Pollution Prevention Guidelines on the design of above ground oil storage tanks. (A full list of Pollution Prevention Guidelines is given as Appendix 3). The NRA has also published its *Policy and practice for the protection of groundwater* (NRA 1992a) and a variety of other reports (see Further guidance and references) that may be relevant for particular development types.

Other guidance that may be relevant includes that produced by the Construction Industry Research and Information Association (CIRIA), which includes *Environmental Assessment* (CIRIA 1994). The latter recommends the consideration of a voluntary environmental assessment, where environmental assessment is not formally required.

4. NRA authorisations

Licences or consents may be required from the NRA to carry out certain activities. The NRA will be willing to discuss its requirements. Applications are subject to advertising; they may also be refused by the NRA. Appeals may be made against refusal. If the NRA rejects an application for consent, then other outstanding applications will not be processed until the issues surrounding the rejection are resolved.

Land drainage consents are required for any works on the bed and banks of a 'main river' watercourse or construction of any structure likely to impede the flow. Local authorities and Internal Drainage Boards have responsibility for certain smaller watercourses. Works affecting sea and tidal defences will also require consent under Regional Bylaws.

Discharge consents may be required for discharges to inland and coastal surface waters. Discharges to groundwaters, e.g. via soakaways, may also require consents. (Note that under the Environmental Protection Act 1990 the consenting authority for discharges from certain processes is Her Majesty's Inspectorate of Pollution).

Abstraction licences may be required for abstractions of groundwater and surface water (including test pumping and dewatering operations).

Impounding licence may also be required where impoundment takes place.

A navigation consent or licence to undertake works in, on or over a navigable river where the NRA is the navigation authority.

Breaches of licence or consent conditions or pollution of surface and groundwaters may result in criminal proceedings.

In addition to the above, NRA approval will be required for the application of herbicides in or near watercourses and for introductions of fish, e.g. for angling purposes. Local NRA bylaws may also exist which may need to be taken into account.

5. Major/Potential impacts

In general, the NRA will be concerned about impacts upon water quality, water resources, flood defence, hydrology, fisheries, aquatic and bankside wildlife, navigation, recreation and amenity, landscape, archaeology, and geomorphology. As a general rule, it will be necessary to demonstrate that water quality is not adversely affected. Also, river corridors may represent both important wildlife habitat and landscape features; the integrity of these should be maintained.

Site investigation such as the drilling of boreholes may have a variety of impacts including the disturbance of contaminated land with resultant pollution of groundwater or surface waters.

Land take may result in the general destruction of habitats and displacement or loss of species. Land take may also lead to a loss of access for recreation.

Stripping of topsoil and loss of surface cover may result in increased soil erosion with an associated increased sediment load in rivers. Flood risk may increase through sedimentation within rivers and from direct erosion of defences. High suspended solid loadings reduce water quality with direct impacts on wildlife, the aesthetic appearance of a watercourse and recreation quality (e.g. fishing). Sedimentation will in turn alter substrate quality for aquatic insects and plants. Fish and their spawning areas may be particularly damaged by siltation, resulting in reduced survival, particularly of their eggs. The ground surface may demonstrate altered infiltration, with associated impacts on groundwater resources. Increased runoff from the land surface will result in an altered hydrological response to rainfall, with possible adverse consequences for flood defence, fisheries, other aquatic wildlife, and water resources. (There may also be positive effects from increased river flow in some circumstances, e.g. in low/no flow watercourses.) Removal of attenuating surface layers may increase the risk of aquifer (groundwater) contamination. Archaeological sites may also be damaged. The aesthetic appearance of earthworks and general construction may be poor and the landscape affected on a temporary or permanent basis.

Soil handling and disposal may lead to high levels of suspended material in runoff, with resultant poor water quality and the smothering of important habitats. Imported or excavated materials may also be vulnerable to leaching, such that acidic, organic or toxic runoff may contaminate groundwater or surface waters. In addition, imported material may contain seeds or root fragments of invasive or otherwise unsuitable plants. (It is an offence under the Wildlife and Countryside Act 1981 to spread certain species, e.g. Japanese knotweed).

Soil mounds and embankments may damage wildlife and interrupt existing drainage patterns. Storage of soil in the flood plain will reduce flood storage.

Compaction of river banks by heavy machinery may lead to a loss in bank stability, destruction of soil structure, natural drainage and destruction of bankside vegetation.

Tree removal from banksides may result in the destruction of wildlife habitat, including bird and bat roosting sites and otter holts, and also a reduction of bank stability with subsequent erosion. Fisheries may be affected by losses of food and cover provided by trees and their roots. (Damage to the habitat of certain protected species, such as otters and bats, is an offence under the Wildlife and Countryside Act 1981). Increased water temperature may result from a loss of shading, with potential ecological consequences. Algal and other plant growth may be stimulated by increased light leading to further ecological changes and possible water quality and flood defence problems. Tree loss may also result in a loss of landscape/amenity value.

Bad practice or a lack of care in a variety of construction activities may cause pollution of watercourses and groundwater. Examples include: the improper disposal of chemicals and containers; poor oil handling procedures and unprotected storage; the pouring of cement near watercourses; careless grouting of bridges; the direct discharge of water from dewatering operations; disposal of poorly treated site sewage; and work near, or on, operational sewers. Pollution may affect aquatic wildlife by affecting the oxygen regime of the receiving water, by direct toxicity, or by limiting the amount of natural food available. Such effects can result in the loss or displacement of fish. Downstream water abstractions may be jeopardised as may other uses such as angling. The aesthetic value of the watercourse may be reduced. In addition, pollution of watercourses may constitute a health hazard for recreational users, particularly those engaged in contact watersports. Direct blockage of watercourses may arise from various debris and lead to flooding.

Noise and intrusion may cause disturbance to fauna (e.g. breeding birds) and the outward migration of sensitive species. In addition, there may be degradation of enjoyment and quality of experience of people on or near water close to the site.

Dust may add to suspended solid loads in watercourses and smother plants.

In-channel work may cause direct destruction, damage and disturbance to wildlife, present a barrier to navigation and fish, result in the loss of (recreational) access to the river, and lead to changes in the river substrate and channel geomorphology. These changes may be remote from the development site and have knock-on effects, e.g. bank erosion and bed draw down may affect building foundations, tree stability etc. Sediment resuspension may lead to reduced water quality and siltation downstream. In addition, in-channel work may increase flood risk. Bunding (and dewatering) of working areas may trap fish.

Dewatering operations may reduce surrounding water table levels, affecting existing building foundations and the ecology of adjacent areas (e.g. wetlands and ponds) and spring-fed systems. Dewatering may enhance hydraulic continuity with underlying groundwater which is particularly undesirable near public supply boreholes. Dewatering may also derogate the rights of existing users to abstract water. The criteria necessary to support existing recreational use may be affected. River flow changes may affect the dilution of effluent discharges. Dewatering from within working areas can result in silt and suspended solids being pumped from an excavation to a watercourse, causing pollution. In addition, dewatering operations may also draw in water from surrounding contaminated land.

Disturbance of contaminated land (e.g. from excavations, piling and borehole construction) may cause pollution of groundwater and surface waters, although removal of contaminated land or sediments may result in long-term water quality improvements. The issue of contaminated land is covered in more detail by another guidance note (see also NRA 1994a).

Diversion of streams will result in the loss of a section of river with its associated and long-established habitats, flora and fauna. In general, the newly created section will initially be ecologically poor and lack habitat features. It may also be unstable, leading to bank and bed erosion and flood defence problems. Diversions may also affect existing rights of abstraction and alter dilution patterns of effluent discharges.

Culverting will result in shading and the loss of natural bankside and substrate along the affected section of river. This will lead to temperature changes, a loss of plants and faunal changes. The culvert may be a significant break in habitat continuity and act as a barrier to the migration of fish, birds, mammals and other groups. Culverts will increase flood risk if they are of inadequate cross section and/or prone to blocking by debris. The water quality within longer culverts may deteriorate. Dissolved oxygen in particular may decrease due to reduced wind/air contact with the water surface, lack of plant photosynthesis and decomposition of organic matter. In some circumstances culverts may enhance public safety and amenity.

Impervious surfaces such as buildings, roads, car parks etc. will lead to increased runoff, affecting the hydrological response of the area, with subsequent effects on flood risk, bed and bank stability, and flora and flora. Low flows may occur between rainfall events, and storm runoff may be of poor water quality. Water resources and users (including wildlife) may be impacted downstream. Reduced infiltration may reduce groundwater resources.

Buildings and other structures may result in the loss of flood plain capacity, with corresponding flood risk implications. Buildings and other structures may intrude into the local landscape and alter wind flow patterns affecting recreational use (e.g. sailing, wind surfing). The foundations of buildings, roads etc. may also interfere with groundwater flows. Pilings may also create pollution pathways to sensitive aquifers. Certain building materials may cause water quality problems, e.g. runoff from some breeze blocks may be alkaline.

Access roads may lead to impacts from land take, soil compaction, noise, intrusion, dust, impervious surfaces and temporary loss of flood storage or diversion of flood flows.

Compounds, car parks and other areas associated with the site of construction may extend construction impacts. Together these may restrict public access to the area.

Pesticides and fertilisers, where stored and/or used, may cause pollution of groundwater and surface waters and destruction of established wildlife.

6. Mitigation measures

The **location, size** and **type** of development will be key factors in determining impact significance. Construction activities including access routes should avoid sensitive areas, such as:

- flood risk areas, e.g. flood plains and low lying coastal areas;

- rivers and river corridors of high ecological, landscape or amenity value;
- rivers supporting valuable fisheries, e.g. self-sustaining salmon stocks;
- wetlands and marshes;
- coastal foreshore and saltings;
- areas of conservation importance, e.g. Sites of Special Scientific Interest (SSSIs);
- vulnerable aquifers as outlined in the NRA's *Policy and practice for the protection of groundwater* (NRA 1992a);
- close proximity to important uses of water, e.g. public water intakes, groundwater abstractions and popular recreational areas; and
- upland areas of catchments with particular sensitivities.

The **timing** of activities should be such that sensitive periods, such as bird nesting and fish spawning seasons, are avoided. Where breeding/roosting/hibernating sites are inevitably going to be affected, access to these should be prevented prior to and during the relevant period, e.g. the installation of mesh to prevent house martins and swallows nesting in the eaves of a building to be demolished. Licences from English Nature (EN) or the Countryside Council for Wales (CCW) may be required to deal with protected species (e.g. bats, great crested newts, badgers, otters). Disturbance to public recreation may be greater in the summer, but wet ground conditions leading to increased soil compaction are more prevalent in the winter.

In general, the advice of relevant organisations, e.g. NRA, EN/CCW, English Heritage etc. should be sought in connection with development proposals.

Developers and their contractors should follow **building regulations, codes of good practice** and NRA Pollution Prevention Guidelines etc., where these are applicable. Staff, including supervisors, should be made aware of risks of site activity to the environment. Dealing with the environmental impact of the site should be the responsibility of a designated manager, who should establish contact with local NRA staff at the earliest possible opportunity. Ideally, an environmentally qualified and experienced site supervisor should be employed to ensure the protection and enhancement of the environment. The environment should not be compromised by taking short cuts to avoid time or other penalty clauses for contract completion. Every effort should be made to prevent pollution and other potential impacts.

Both permanent and temporary **land take** should be minimised and original habitat features maintained or enhanced.

The **storage and handling of soil** should be such that the area affected is minimised but the soil structure is maintained as much as possible (i.e. avoid mixing topsoil with underlying material). Stored and other exposed soil or spoil should be covered to minimise silt runoff. Imported material should be avoided where this may contain polluting substances or propagules of invasive plants. Seeding of landscaped areas may or may not be appropriate with suitable seed. Borrow pits should not be excavated in sites of wildlife or other value.

Opportunities to **create wetland or other habitats** should be considered.

Compaction of soils by heavy machinery should be minimised, particularly in sensitive sites, with the use of boards, matting and other temporary supporting structures and tracked or soft-tyred vehicles. Where unavoidable compaction occurs, de-compaction measures should be undertaken on completion of works.

Trees and other wildlife habitats should be retained. Opportunities should be sought to replant trees and create new habitats, as appropriate. Woodland planting should conform to relevant guidelines, e.g. Forestry Bulletin 112 *Creating New Native Woodlands*. Habitat improvements and other mitigation works may be considered at locations remote from the construction area. For instance, a fish pass could be installed to generally improve the access of fish to a watercourse.

Sites of archaeological and other interest should be preserved *in situ*, where feasible, with the provision of facilities for visitors. However, relocation may need to be considered.

Chemicals, fuel and oil should be suitably stored in areas away from watercourses and drains with adequate bunding should spillage, leakage, pipe, valve or tank failure occur. Bunds around tanks are obligatory. Drip trays should be used with pumps and other such machinery to catch leaking oil. Particular care should be taken when pouring concrete or handling cement near watercourses. The risk of pollution from vandalism and theft should be reduced by using tamper-proof valves, adequate fencing and security. Where appropriate, pollution prevention equipment should be kept on-site and employed in the case of spillage, e.g. emergency drain covers, absorbent granules etc. If pollution of any sort does occur, the NRA should be notified immediately and prompt action taken to minimise effects.

Sewerage and waste disposal arrangements should be adequately considered. It may be necessary to discharge sewage and canteen wastes to an on-site temporary storage facility prior to off-site treatment and disposal. The construction contractor should fulfil all the obligations imposed under the Environmental Protection Act 1990 Section 34 (Duty of Care) on producers of waste and ensure that waste generated from construction is managed according to good waste management practice incorporating good housekeeping. Relevant pollution prevention guidance as supplied by the NRA should be followed wherever possible (see Appendix 3).

Noise and intrusion should be minimised and avoided at sensitive times, e.g. in the evenings where birds roost in adjacent sites. Pumps/machinery should be suppressed or housed, if disturbance is likely to occur, to reduce noise impact.

Dust may be dampened down to reduce aerial transmission, but should not be washed into drains etc. (Abstraction of water for dust suppression may require an abstraction licence). Vehicle (wheel) wash facilities should be adequately constructed with containment of the effluent for proper treatment and disposal.

In-channel work should only be carried out if there is no practical alternative (e.g. thrust boring). Work should avoid disruption to relevant seasonal activities, i.e. navigation, fish spawning. Interruption to recreational access and navigation should be minimised, although public safety should not be compromised. Methods of working should be used that minimise the extent of disturbance to the banks and bed of the river. Where channels lack natural features (e.g. man-made trapezoidal channels) opportunities to improve channel form for conservation purposes should be sought in consultation with the NRA. Bunding or booms should be utilised where there is a risk of oil or other pollution. Trapped fish should be rescued from bunded/dewatered working areas.

Contaminated land. Government guidance encourages the development of contaminated land; remedial action will be required where such development is likely to lead to pollution of groundwater and surface waters (see separate guidance on the redevelopment of contaminated land). In general, opportunities should be sought to provide permanent remedies to contaminated sites; disturbance of contaminated land or sediments should be avoided unless complete removal is to occur (with disposal of spoil to registered sites). Where disturbance of contaminated material is unavoidable, care should be taken to avoid pollution of watercourses and groundwater. The use of protective linings may be required. Impervious surfaces may contain the pollution, where the main risk of pollution is from rainwater leaching.

Groundwater drawdown may be prevented by minimising the entry of water into construction works (e.g. by using diaphragm walls, well pointing, compressed air).

Diversion of streams should generally be avoided, due to the major effects on rivers and river corridors. Where diversion is unavoidable, efforts should be made to simulate the river geomorphology of the affected reach (e.g. similar gradient and number of pools, riffles and meanders). The new reach should be designed to maximise conservation opportunities, i.e. straight concrete-lined, trapezoidal channels should be avoided. Fish should be rescued from the stretch of river to be diverted. Planting of the new channel should occur with soil and plant material from the redundant stretch. Where possible, elements of the redundant stretch should be retained as ponds or wetlands. (NRA Conservation staff will be happy to advise).

Where **culverting** is unavoidable, the culvert should normally be over-wide and the invert should be set below normal bed level to enable some bed features to reform. Headroom should be maximised for light entry and to permit the passage of birds and mammals. A ledge or berm should be installed above normal water levels to aid the passage of the latter. Bat roosting and bird nesting structures should be considered in larger culverts. Adequate headroom and/or screening will also reduce flood risks. (Guidance is available from the NRA on the design of trash screens (NRA 1993a)). Stream velocities should not increase within the culvert so as to preclude the upstream migration of fish. The culvert should be designed to allow the passage of highest predicted flood flows. Agreements will be required on the future maintenance of the culvert.

The extent of **impervious surfaces** may be reduced by the use of permeable membranes, floating roads, pervious gabions, provided that there is not a high risk of contamination from throughflow. The discharge of runoff may be regulated by passage through balancing ponds/retention basins. These may also act as sediment traps and as a buffer against poor water quality from storm runoff. They may also provide useful aquatic and wetland habitats. Other drainage facilities such as oil separators (interceptors) should be considered if oil is a likely pollutant. Responsibilities for the maintenance and operation of such devices should be agreed in advance. Isolation points designed into the drainage system may be useful to prevent pollution of watercourses where there are high risks of spillage. CIRIA have produced various relevant guidance with respect to site and road drainage, e.g. CIRIA (1992) and Luker and Montague (1994).

If the construction of **buildings** in the flood plain is unavoidable, mitigating measures will be required so as not to increase flood risks to existing property. The buildings themselves will need flood protection which could take the form of construction to a specified floor level, site landscaping etc. The use of local materials may minimise landscape intrusion.

Buildings should be designed or located so as to avoid detrimental wind patterns to waters with relevant recreational use.

Access roads should be designed to take flood risk into account. The use of river fords should be considered to recreate riffles in degraded rivers/streams. Measures should be taken to reduce compaction and control drainage (see above).

Compounds, car parks and other areas associated with the site of construction should be carefully located to minimise any added impacts. The area should be fenced to provide security and to contain the area of impact. Surface drainage from these areas and associated facilities (e.g. wheel washes) should be considered with respect to pollution risk and treatment requirements. Temporary diversion of informal footpath access which cross the compound will minimise inconvenience to the public. Compounds and other temporary working areas should be reinstated following discussions with the NRA and other interested parties.

Pesticides and fertilisers should be stored and used in accordance with legislation and codes of practice. They should be used only when necessary. Only approved pesticides should be used in or near watercourses, with prior permission of the NRA. Relevant guidelines should be followed, e.g. NRA (1995). (Guidelines from the Ministry of Agriculture, Fisheries and Food are currently being revised).

Stands of invasive non-native plant species, such as Japanese knotweed and giant hogweed, should be controlled following NRA guidance (e.g. NRA 1994b) should they arise from the development (e.g. from imported soil).

7. Baseline surveys

In order to ascertain the detailed impacts of a development, baseline surveys will generally be required, although some relevant information may be available from the NRA and other bodies (for which a charge may be made). Surveys should be conducted at relevant times of year using methods recommended by relevant organisations, e.g. NRA, EN/CCW. Surveys may be required over several years to establish certain variable baseline conditions, e.g. fisheries, aquatic biology. The findings should highlight particularly sensitive sites, physical features, habitats or species.

In general, the NRA may require information on the following (from surveys or otherwise):

- flora and fauna (e.g. river corridor survey);
- fisheries;
- aquatic biology;
- water quality;
- water resources;
- hydrology and hydrogeology;
- hydraulics, bed profile and cross-sections;
- landscape/amenity;
- recreation;
- river geomorphology;
- archaeology

The actual type and nature of surveys and data required will be case specific should be relevant to assessing impacts. NRA guidance is available on recommended survey methodologies for river corridor surveys (NRA 1992b) and for landscape assessments (NRA 1993b). The NRA will be able to provide relevant any data it holds (although there may be an administrative charge)

8. Monitoring and audit

A monitoring programme relevant to assessing predicted impacts and the success of mitigation works is recommended and may be required for certain NRA consents/licences.

Audits of site management practices during construction may be desirable to ensure that the construction techniques and practices proposed in the environmental assessment do not alter without due consideration for the environment.

9. General guidance and references

Some guidance on the location of sites where development is likely to be discouraged may be found in local authority structure and development plans and also in NRA catchment management plans. Government-issued Planning Policy Guidance (PPG) may also indicate the framework within which Local Planning Authorities (LPAs) operate. Of particular relevance to NRA concerns is PPG23 *Planning and Pollution Control* published by the DoE in 1994.

There may also be local Consultation Guides as defined by discussions between staff from NRA Regions/Areas and LPAs.

Appendix 3 gives a list of NRA Pollution Prevention Guidelines. Note that, like DoE Planning Policy Guidance notes, these may also be referred to as PPGs.

English Nature (1994a) provide guidance on various types of habitat creation in connection with road schemes, although the principles are applicable for other development types. More general guidance on the inclusion of nature conservation in EA is also available (English Nature 1994b). In addition, PPG9 *Nature Conservation*, published by the DoE in 1995, provides planning guidance.

The Institute of Environmental Assessment have produced guidelines for landscape and visual impact assessment (IEA 1993a) and baseline ecological assessment (IEA 1993b).

Guidance on the environmental assessment of buildings is given by Wozniak (1994) and publications by the Building Research Establishment (BRE). There now exists the Building Research Establishment has produced Environmental Assessment Methods (BREEAM) for various categories of buildings (i.e. superstores and supermarkets, new homes, new offices, existing offices, and new industrial units; BRE 1991a, 1991b, 1993a, 1993b, 1993c).

Building Research Establishment (1991a) *An environmental assessment for new superstore and supermarket designs*. Building Research Establishment, Watford.

Building Research Establishment (1991b) *An environmental assessment for new homes*. Building Research Establishment, Watford.

Building Research Establishment (1993a) *An environmental assessment for new office designs*. Building Research Establishment, Watford.

Building Research Establishment (1993b) *An environmental assessment for existing office buildings*. Building Research Establishment, Watford.

Building Research Establishment (1993c) An environmental assessment for new industrial, warehousing and non-food retail units. Building Research Establishment, Watford.

Construction Industry Research and Information Association (1992) Scope for the control of urban runoff. Report R123/124. CIRIA, London.

Construction Industry Research and Information Association (1994) Environmental Assessment. Special Publication 96. CIRIA, London.

Department of the Environment/Welsh Office (1989) Environmental Assessment: A Guide to the Procedures. HMSO, London.

English Nature (1994a) *Roads and nature conservation. Guidance on impacts, mitigation and enhancement*. English Nature, Peterborough.

English Nature (1994b) Nature Conservation in Environmental Assessment. NRA, Bristol.

Harris, R. C. (1993) Groundwater pollution risks from underground storage tanks. Land Contamination & Reclamation, 1 № 4, 197-200.

Institute of Environmental Assessment (1993a) *Guidelines for landscape and visual impact assessment*. IEA, Lincoln.

Institute of Environmental Assessment (1993b) *Guidelines for baseline ecological assessment*. IEA, Lincoln.

Luker, M. and Montague, K. (1994) *Control of pollution from highway drainage discharges*. CIRIA Report 142. Construction Industry Research and Information Association, London.

NRA (1992a) *Policy and practice for the protection of groundwater*. HMSO, London.

NRA (1992b) *River corridor surveys: methods and procedures*. Conservation Technical Handbook Nº1. National Rivers Authority, Bristol.

NRA (1993a) *Design and operation of trash screens - interim guidance notes*. Pamphlet P-1261994b) *Guidance for the control of invasive plants near watercourses*. National Rivers Authority, Bristol.

NRA (1994c) *Abandoned mines and the water environment*. Water Quality Series Nº14. HMSO, London.

NRA (1995) *The use of herbicides in or near water*. NRA (Anglian Region), Peterborough.

Wozniak, S.J. (1993) *Environmental assessment of buildings and building development*.

Appendix 1 - other guidance

Scoping and more detailed guidance notes are available from the NRA for the following development types:

Reservoirs

Marinas

Barrages

Fish farms

Pipelines

Sea outfalls

Points of large abstraction

Points of large discharge

Sewage treatment works - extension and installation

Large residential developments

Large industry/manufacturing development

Golf courses

Power stations

Wind farms

Hydropower

Oil refineries/oil exploration

Forestry

Redevelopment of contaminated land

Waste disposal sites

Mineral extraction - mining and quarrying

Restoration of mineral extraction sites - landfill and recreation

Roads and road widening

Railways

Airports

Cemeteries

Navigation issues

At present scoping guidance alone is available for the following development types:

Navigation works

Channel works

Flood diversion channels

Fluvial dredging

Bank protection

Flood storage area

Flood embankment

Culverts and tunnels

Barriers/Bridges/Weirs

Off-line ponds and reservoirs

Coastal protection

Beach recharge

Suction dredging

Restoration and enhancement

Conservation enhancements

Water-based recreation

Off-road recreation

Vegetation management

Deliberate introduction of species

Groundwater abstraction

Interbasin transfer of flow

Agriculture

Kennels, catteries and stables

Intensive livestock/poultry units

Tipping/dumping

Camping and caravan sites

Septic tank/cesspits etc.

Vehicle parks/plant hire

Swimming pools

Chemical storage units

Petrol stations

Peat extraction

Bait digging

Vermin control

Appendix 2 - NRA contacts

Your first point of contact is your local NRA office. To identify your nearest office please refer to the map on page 1/20.

Region/Area	Contact Address	Tel. No.	Fax No.
Anglian			
Northern Area	Area Planning Manager NRA Anglian Aqua House Harvey Street LINCOLN LN1 1TF	01522 513100	01522 512927
Central Area	Area Planning Manager NRA Anglian Bromholme Lane Brampton Huntingdon CAMBS PE18 8NE	01480 414581	01480 413381
Eastern Area	Area Planning Manager NRA Anglian Cobham Road IPSWICH IP3 PJE	01473 727712	01473 724205
Northumbria & Yorkshire			
Northumbria Area	Planning Liaison Officer NRA Northumbria &Yorkshire Tyneside House Skinnerburn Newcastle Business Park NEWCASTLE UPON TYNE NE4 7AR	0191 2034000	0191 2034004
Dales Area	Planning Liaison Officer NRA Northumbria &Yorkshire Coverdale House Aviator Court Amy Johnson Way Clifton Moor YORK	01904 692296	01904 693748
Southern Yorkshire	Planning Liaison Officer NRA Northumbria & Yorkshire Olympia House Gelderd Lane Gelderd Road LEEDS LS12 6DD	01132 440191	01132 312116
North West			
Northern Area	Planning and Services Manager NRA North West Chertsey Hill London Road CARLISLE CA1 2QX	01228 25151	01228 49734

Region/Area	Contact Address	Tel. No.	Fax No.
Central Area	Planning and Services Manager NRA North West Lutra House Dodd Way Walton Summitt Bamber Bridge PRESTON PR5 8BX	01772 39882	01772 627730
Southern Area	Planning and Services Manager NRA North West Mirwell Carrington Lane SALE M33 5NL	0161 973 2237	0161 973 4601
Severn-Trent			
Upper Severn Area	Senior Planning Liaison Officer NRA Severn-Trent Hafren House Welshpool Road Shelton SHREWSBURY SY3 8BB	01217 112324	01217 115824
Lower Severn Area	Senior Planning Liaison Officer NRA Severn-Trent Riversmeet House Northway Lane TEWKESBURY GL20 8JG	01684 850951	01684 293599
Upper Trent Area	Senior Planning Liaison Officer NRA Severn-Trent Sentinel House 9 Wellington Crescent Fradley Park Lichfield STAFFS SW13 8RR	01543 444141	01543 444161
Lower Trent Area	Senior Planning Liaison Officer NRA Severn-Trent Trenside Office Scarrington Road West Bridgford NOTTINGHAM NG2 5FA	01159 455722	01159 817743
Southern			
Hampshire & Isle of Wight	Planning Liaison Manager NRA Southern Sarum Court Sarum Road WINCHESTER HANTS	01962 713267	01962 841573
Kent Area	Planning Liaison Manager NRA Southern Millbrook House 114 Mill Street East Malling, Maidstone KENT ME19 6BU	01732 875587	01732 875057

Region/Area	Contact Address	Tel. No.	Fax No.
Sussex Area	Planning Liaison Manager NRA Southern 3 Liverpool Gardens Worthing WEST SUSSEX BN11 1TF	01903 215835	01903 215884
South Western			
Cornwall Area	Regulation Officer NRA South Western Sir John Moore House Victoria Square Bodmin CORNWALL PL31 1EB	01208 78301	01208 78825
Devon Area	Regulation Officer NRA South Western Manley House Kestrel Way EXETER EX2 7LQ	01392 444000	01392 444238
North Wessex Area	Regulation Officer NRA South Western Rivers House East Quay SOMERSET TA6 4YS	01278 457333	01278 452985
South Wessex Area	Regulation Officer NRA South Western Rivers House Sunrise Business Park High Shaftesbury Road BLANDFORD DT11 8ST	01258 456080	01258 455998
Thames			
North East	Senior Planning Liaison Officer NRA Thames Gade House London Road Rickmansworth HERTS WD3 1RS	01992 635566	01992 645451
South East	Senior Planning Liaison Officer NRA Thames Sunbury Yard Riverside Works Fordbridge Road Sunbury on Thames TW16 6AP	01932 789833	01932 786463
West Area	Senior Planning Liaison Officer NRA Thames Isis House Howberry Park Wallingford OXON OX10 8BD	01734 535000	01734 535900
Welsh			
Northern	Development Liaison Officer	01248 370970	01248 370747

Region/Area	Contact Address	Tel. No.	Fax No.
	NRA Welsh Bryn Menai Holyhead Road Bangor GWYNEDD LL57 2EF		
South Eastern Area	Development Liaison Officer NRA Welsh c/o Rivers House St Mellons Busoness Park St Mellons CARDIFF CF3 0LT	01222 770088	01222 798555
South Western Area	Development Liaison Officer NRA Welsh Lys Afon Hawthorn Rise Haverfordwest DYFED SA61 2BH	01437 760081	01437 760881

Appendix 3 - Pollution Prevention Guidelines

1 General guide to the prevention of pollution of controlled waters

2 Above ground oil storage tanks

3 The use and design of oil separators in surface water drainage systems

4 Disposal of sewage where no mains drainage is available

5 Works in, near or liable to affect watercourses

6 Working at demolition and construction sites

7 Fuelling stations: construction and operation

8 Safe storage and disposal of used oils

9 The prevention of pollution of controlled waters by pesticides

10 Pollution from highway depots

11 Preventing pollution on industrial sites

12 Prevention of pollution of controlled waters by sheep dip

13 High pressure water & steam cleaners

14 Inland waterways: marinas and craft

15 Retail food stores and similar sites

16 Schools and educational establishments

17 Dairies and other milk handling operations

18 Spillages and fire fighting runoff

In preparation:

19 Dairies

20 Airfields

21 Timber treatment plants

22 Garages

Note that these notes may be referred to as PPGs but should not be confused with the Government Planning Policy Guidance series (also known as PPGs).

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF RESERVOIR PROJECTS

1. Introduction

This guidance note seeks to identify the potential impacts of reservoirs upon the water environment. It is intended to form the basis of a detailed general scoping brief to cover the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of reservoir schemes. The NRA has an interest in reservoir projects owing to its statutory responsibilities with respect to water resources and the general aquatic environment. As such, the NRA will require certain environmental information and, preferably, an environmental assessment. The responsibility for such an assessment lies with the developer. The conclusions of the EA will require proper justification and raw data should be accessible.

There are distinct advantages in conducting EA in advance of detailed planning with the proper consideration of alternatives. In addition, the early involvement of the NRA will help to identify the environmental constraints of the scheme, such as sensitive areas to be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage.

The developer should refer to NRA catchment management and flood protection plans where these exist. In addition, there may be relevant provisions by the NRA in local plans.

Fundamentally, the need for a reservoir should be adequately justified. The NRA will require a convincing case to be made which shows that other alternatives have been properly investigated and shown to have greater adverse environmental impacts. It should be demonstrated that all existing licensed sources are being used fully and effectively and that reductions in demand have been investigated, such as water conservation and leakage control measures.

A variety of literature is available, particularly in relation to the Cow Green, Craig Goch, Kielder and Roadford (instream) reservoirs (e.g. MAFF/NWC 1976, Brooker 1981, Milner *et al.* 1981, Crisp *et al.* 1983, Cave 1985, Lawson *et al.* 1991 and various unpublished reports). The Construction Industry Research and Information Association have recently produced a manual (CIRIA 1994) on the environmental impacts of construction schemes, including reservoirs as water engineering projects.

2. Development control

Reservoirs come under the Town and Country Planning system and therefore require planning permission from the Local Planning Authority.

Reservoirs may be developed in a variety of forms and thus may have differing potential impacts and controls. Fundamental differences will occur between a reservoir that is "instream", i.e. an interrupted part of a watercourse, and one that is "off-line", i.e. a pumped storage reservoir that is remote from a watercourse and receives water pumped directly from rivers. Storage reservoirs of treated water from water treatment works are not considered; the impacts of these are similar to those of a constructed building. Both instream and pumped storage reservoirs may be developed as hydroelectric schemes, which may have additional impacts in relation to the release regime for power generation. The release regime of instream reservoirs without generation will have important, but less drastic impacts. For some reservoir developments, water may be transferred from one river catchment to another leading to a additional concerns on the two catchments affected, most notably, perhaps, being the possible effects on the homing abilities of migratory fish in the mixed river waters.

Excavated reservoirs may be complicated by regulations affecting mineral extraction (see guidance note on mining and quarrying).

3. Environmental Assessment

Reservoirs are classified as Schedule 2 developments under the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 Nº 1199) and therefore a formal Environmental Statement will be required if a reservoir is expected to have 'significant' effects.

4. NRA licences

Both **abstraction** and **impounding licences** will be required by the NRA. **Discharge consents** may be required for dewatering operations during construction and will be required for any planned discharges from water treatment works associated with the reservoir. There will be certain requirements for discharges from instream reservoirs with respect to flow and water quality.

A **land drainage consent** will be required for any works on the bed and banks of a river or construction of any structure likely to impede the flow. Land drainage consents are issued under Sections 109 and 110 of the Water Resources Act 1991 for designated main rivers. For non-main rivers this is covered under Section 23 and 24 of the Land Drainage Act 1991. Local authorities and Internal/Inland Drainage Boards also have responsibility for the latter.

A **navigation consent** or licence will be required to undertake works in, on or over a navigable river where the NRA is the navigation authority.

If stocking of fish into the reservoir planned, a **fisheries consent** is required from the NRA for the introduction of fish into an inland water under Section 30 of the Salmon and Freshwater Fisheries Act 1975.

5. Major/Potential impacts

5.1 Construction impacts

The period of construction is defined as the time to when the reservoir is filled. Many of the impacts associated with the flooding of land in unlined reservoirs (e.g. terrestrial habitat loss) would occur earlier in lined reservoirs with the installation of the lining.

5.1.1 Water quality

Bad practice in the storage, handling and disposal of spoil, chemicals and containers, oil, fuel and cement, and the discharge of water from dewatering operations may lead to water pollution. Runoff from vehicle storage areas and access roads can have potentially adverse water quality impacts, particularly with respect to oil and suspended solids. Dam material may also be a significant source of solids entering watercourses. Disturbance of contaminated land may result in increased leaching of contaminants into surface and groundwaters. (The proximity of a reservoir to contaminated land may be a major limiting factor in its approval). Other potential impacts may arise from the sewerage arrangements for construction and, later, operational staff. Also, the construction of the reservoir may necessitate the relocation of pipelines (e.g. sewage) which may lead to further impacts.

5.1.2 Flood defence

Where reservoirs are to be constructed instream or otherwise in the vicinity of watercourses, debris from tree felling and general construction works may lead to the blockage of such watercourses, increasing flood risk. During construction there may be a loss of flood plain capacity.

5.1.3 Conservation

Bankside tree removal will have a direct impacts as a loss of bird and bat roosting sites, the loss of bank stability and loss in landscape/amenity value. The stripping of topsoil before lining (or flooding) of the reservoir will lead to a general loss of surface cover with the possibility of increased soil erosion, increased sediment load in rivers, altered infiltration (possibly with increased runoff) with resultant effects upon aquatic flora and fauna. In addition, compaction of reservoir banks by heavy machinery may lead to a loss in bank stability and the destruction of soil structure.

Noise and general intrusive activities during construction will lead to the disturbance to fauna in the vicinity of construction and possibly the outward migration of sensitive species.

In-channel work may disturb wildlife and act as a barrier to migrating fish. In addition, habitat changes may occur as a result of the temporary diversion of streams, losses of river substrate and changes to channel geomorphology.

The creation and use of vehicle access roads may lead to impacts of habitat loss, soil erosion and compaction, noise and other disturbance. The laying of water distribution and other pipelines may lead to similar impacts.

Sites of archaeological interest may be disturbed by construction. The excavation of dam material may leave a scarred landscape.

5.1.4 Recreation

During construction there may be restrictions of access to the river.

5.2 End state/Operational impacts

The major end state impacts of reservoirs of interest to the NRA are those on water resources, water quality, fisheries, conservation and recreation.

5.2.1 Water resources

Whilst the development of a reservoir will increase the water resource available distribution network, water resources may be affected in the source catchment, with implications to both groundwaters and surface waters. Where reservoirs are lined, groundwaters may suffer from the general loss of recharge capacity. Changes to groundwater flow may be expected from both lined and unlined reservoirs. Adjacent land may be affected by changes to water table level. Impoundment of surface waters will affect downstream flows and sedimentation patterns, with resulting impacts on fisheries, stream ecology, conservation and navigation. The significance and extent of downstream effects will largely depend on hydrological changes brought about by reservoir operation and the nature of the catchment.

5.2.2 Water quality

The source and downstream waters will have water quality objectives protected by water quality standards (WQSs). It will be necessary to demonstrate that the standards set are not adversely affected by the development. If the reservoir is identified as a "controlled water", WQSs may be applied to the reservoir itself. Reservoirs may also fall under the definition of a "sensitive" water under the terms of the Urban Waste Water Directive thus requiring control on the discharges of nutrients from sewage works upstream.

The water quality of the reservoir will be very much dependent on the quality of source waters, which will need to be protected for the use of water abstracted for potable supply. Reservoir water quality will vary from that of river sources as a result of impounding water with an increased retention time and from influences of the flooded land when a reservoir is unlined. In addition, water treatment practices may affect reservoir water quality. For instance, the direct addition to the reservoir of ferric sulphate to remove phosphorus will raise dissolved sulphate levels and give rise to a ferric phosphate floc. The indirect re-circulation or accidental spillage of chemicals used in water treatment works, such as aluminium sulphate, may lead to elevated levels of these in the reservoir, downstream waters and public supply. Impacts on water quality may also affect the potential quality of water for potable supply. Interbasin transfers of water in connection with reservoir developments may lead to changes in the chemical equilibrium of the recipient watercourse and impacts on ecology. (See separate scoping guidance).

Nutrients and algal growth - Algal growth will be primarily affected by retention time and nutrient inputs from source waters, sediments and the atmosphere. The coloured appearance of water due to algal blooms may be aesthetically detrimental as would be algal scums, usually due to blooms of blue-green algae. The latter may also have toxic effects on both aquatic (e.g. fish) and terrestrial organisms (e.g. dogs). The collapse of algal blooms may have severe effects on dissolved oxygen levels, particularly when coinciding with thermal stratification, should it occur. Growths of fixed or filamentous algae may also cause some aesthetic and water quality problems. Algae may cause taste problems and algal breakdown products may combine with disinfectants to produce chemical contamination of waters, necessitating further treatment. Algal or nutrient control techniques may have impacts on water quality.

Suspended solids - The construction of an instream reservoir will lead to sedimentation within the impoundment and the loss of sediment and suspended solids to downstream areas. Where loads of suspended solids are particularly high, there may be implications for the longevity of the reservoir, dredging needs and the impacts of these.

Other contaminants - There may be mobilisation of chemicals from flooded areas in unlined reservoirs depending on the geology and past and present uses of the land. Leaching of toxins from contaminated land could lead to severe and prohibiting water quality problems. Particularly where thermal stratification occurs, the water in the bottom layers of the reservoir (hypolimnion) will demonstrate different characteristics to those of the upper epilimnion. The hypolimnetic water may have a lower temperature, dissolved oxygen and algal concentrations, but raised iron, manganese and phosphorus levels. These parameters will have an impact downstream through the precipitation of iron and temperature effects on the life cycles of invertebrates and the timing and success of the hatching, emergence and feeding of salmonid fish. Levels of bacteria and viruses in the reservoir will determine the recreational uses of the water body permitted by local health authorities and also the health risks to users. The use of powered boats on the reservoir may result in problems with oil pollution and surface oil films.

5.2.3 Recreation and amenity

The development of a reservoir will affect many of the previous uses of the flooded area, but these may be compensated for by opportunities, particularly for water-based sports on the new water body. However, the impacts of such developments will require consideration.

5.2.4 Flood defence

Depending upon design, a reservoir may have positive or negative effects on flood defence. A raised bunded design within a floodplain will reduce flood plain capacity, an instream reservoir will potentially increase storage capacity.

5.2.5 Conservation and wildlife

The fundamental change in habitat from a river valley or predominantly terrestrial habitat will be reflected by changes in communities associated with the reservoir. A still water community will develop which will be influenced by the reservoir water source. Impounded rivers may retain many features in both the reservoir and downstream. The reservoir is likely to have positive benefits, becoming utilised by a variety of wildfowl, including those birds resident all year and seasonal visitors. However, riverine species such as dippers and kingfishers may be adversely affected.

Downstream of impounded reservoirs the community will be influenced by the quality of water discharged and the flow regime. Filter-feeding invertebrates will benefit from the development of algae and other plankton discharged with reservoir water. Inadequate compensation flow may lead to a loss of downstream aquatic habitat and reductions in the frequency and magnitude of flood events may lead to changes in the ecology of flood meadows and other wetlands.

The nature of the margins of the reservoir will depend on design, but their ecology will be influenced by the dewatering effect of drawdown, and practices of management for the banks, such as mowing regimes, the use of weedkillers, and the extent of public and animal access. The margins and reservoir itself may be more likely to freeze in winter conditions which may lead to thermal and physical damage and water quality impacts.

The reservoir will have a major impact on the landscape, with a large water body replacing whatever previous features existed. The dam wall may be a particularly prominent feature.

Flooded areas may become of historic/landscape interest at times of drought when buildings are revealed.

5.2.6 Fisheries

Where instream reservoirs are constructed there will be impacts on migratory fish due to the physical barrier to migration in the form of the dam. Migration patterns may also be affected by the water quality of discharges and downstream flow regimes. Resident fish will be affected by both changes of habitat within the reservoir and downstream, where spawning areas may become affected by siltation and dewatering. Particularly where there is the creation of a new off-river impoundment, there will be the creation of a potential still water fishery. On some reservoirs, fish cages have been installed for reservoir stocking or fish farming purposes. The use of such cages may have a variety of possible impacts, particularly on fisheries and water quality, and should not occur without prior consent of the NRA. Drawdown may effect the survival of fish species such as char and coregonids that may utilise marginal areas for spawning and may be sensitive to temperature fluctuations associated with variable water depth.

The "homing" ability of migratory fish may be disturbed by interbasin transfers of water away from original nursery streams.

5.2.7 Navigation

Instream reservoirs may impact upon navigation of the river. Obstructions in flooded areas may present a navigational hazard within the reservoir.

5.3 Dam failure

The unlikely failure of a reservoir dam or retaining wall could potentially result in catastrophic flooding and great losses to both natural and human environments. The risk of failure will be greater in areas prone to seismic activity.

(Reservoirs impounding more than 25000 m^3 come under the provisions of the Reservoirs Safety Act and have to be registered with the County Council and inspected regularly by a Panel Civil Engineer.)

6. Mitigation measures

Various mitigation measures should be considered as required by the NRA. In particular, the justification for the reservoir and alternative sites and sources of supply should be considered. Section 16 of the Water Resources Act 1991 requires that structures such as reservoirs enhance the environment ('further the conservation and enhancement of natural beauty and conservation of flora, fauna and geological or physiographical features of special interest'). This is a duty imposed on both water undertakings as promoters and on the NRA in considering the proposals, and should be regarded as a fundamental part of the scheme. The NRA have published an environmentally sustainable water resources development strategy (NRA 1994).

Intakes of off-line pumped storage reservoirs should be designed so as to minimise risks of entrainment or entrapment to fish and other aquatic life. Further guidance is available in Solomon (1992) and a guidance note on points of large abstraction.

Water quality impacts of discharges from the reservoir may be reduced by aeration and variable level off-takes. The latter may also be required to attain good water quality for drinking water supply. Mixing of reservoir water may bring benefits to both downstream and drinking water quality. Such measures, usually to combat problems caused during thermal stratification, may only be required in summer months following dry periods with little wind. The mobilisation of chemicals (nutrients, organics, iron, manganese etc.) from the bottom substrate may be reduced by stripping of topsoil, vegetation etc. in the construction of the reservoir or by lining it. Eutrophication problems may be relieved by control of nutrient inputs, such as through reductions of fertiliser and water treatment, or by destratification.

Competing water requirements should be considered. For example, downstream of instream reservoirs, compensation flows and flow regimes should be suitable to fisheries, wildlife and abstracters downstream. Fish spawning areas should not vulnerable to dewatering by maintaining flows (and reservoir height) during times of spawning. In addition to compensation flows, 'releases' of water to simulate high flow conditions may assist fish migration and recreational uses such as canoeing. Such releases may also be used to relieve water quality problems in the river or estuary, which may often concur with low river flows. The additional capacity for releases should be planned at an early stage. Abstraction to pumped storage reservoirs should be conducted at times of high river flow.

Suitable design with an operational use of the reservoir at a less than 100% capacity may allow for some flood storage.

Temporal and spatial zoning of use of the reservoir will reduce conflicts between users and provide havens for wildlife. Strict seasonal controls of disturbance may reduce the risks of disturbance to protect breeding and overwintering birds. Nature conservation may be higher priority use of water space than recreation, particularly active and noisy sports. Access to the reservoir for various recreational activities should be maintained or developed in accordance with such zoning.

Where the reservoir interrupts the passage of migratory fish, the provision of a fish pass would reduce this impact. The loss of upstream spawning areas may more generally be compensated for by the provision of hatchery facilities and stocking of juvenile fish at various stages.

Where a reservoir fishery is planned, stocking of the reservoir with fish may produce a fishery more rapidly, although for instream reservoirs stocks from within the river catchment should be utilised where possible to preserve genetic integrity. Fish production may be enhanced by the habitat improvement measures such as the provision of artificial reefs. Retaining natural features such as rocks and trees in areas to be flooded may also be useful in this regard. Angling quality may also be enhanced by the provision of landing stages and boats.

The margins of the reservoir may be contoured or otherwise developed to provide habitats of variable depth. However, the reservoir design should consider filling and drawdown regimes and the impacts on wildlife. Small ponded areas may provide valuable amphibian habitat. In areas likely to be frequented by otters, trees with exposed root systems should be retained and the provision of artificial holts considered.

Natural and manmade features may be retained in the reservoir to provide additional wildlife habitats and also viewpoints of interest at various reservoir levels. Such features should be removed or well marked where they represent a hazard to navigation.

Excavation of dam material may be best done locally to reduce impacts of transportation. If excavation occurs within the site of the reservoir, the scarring effect on the landscape will be hidden on flooding.

7. Baseline surveys

A variety of surveys should be conducted to ascertain the importance of a site and likely impacts of reservoir construction. The developer should conduct initial desk studies and consult with statutory bodies, including the NRA, to identify sensitive areas such as:

- river floodplains;
- lakes, wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable fisheries;
- contaminated land likely to lead to polluting runoff or leachate;
- "vulnerable" aquifers outlined in the NRA's *Policy and practice for the protection of groundwater* (NRA 1992); and
- upland areas of catchments with particular sensitivities

The NRA will provide information on the relevant data it has. In addition, the NRA will require the developer to review other information sources and provide further baseline information. Surveys will generally be required using relevant timescales and recommended methods. The surveys required will be case-specific but would generally include the following:

- river corridor surveys;
- aquatic biology;
- fisheries;
- landscape/amenity;
- recreation;

- soils;
- geology;
- hydrogeology;
- water quality;
- hydrology and drainage; and
- geomorphology.

8. Monitoring and audit

Monitoring should be conducted after and, if appropriate, during construction to assess the effects of the development. Monitoring programmes should be relevant to the predicted impacts and remedial/mitigation works and over a relevant timescale.

9. General guidance and references

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NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF MARINAS

1. Introduction

This guidance note seeks to identify the potential impacts of issues relating to marinas upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of marina schemes. The potential impacts of marinas are of interest to the NRA because of the authority's responsibilities for water quality, water resources, flood defence, fisheries, conservation, recreation and, in some areas, navigation.

Proposed marina developments may require EA is carried out under the relevant regulations. Where an EA is not formally required, the EA process may remain a useful means of conveying environmental information to those commenting on the proposals. The responsibility for obtaining information and/or an EA lies with the developer. There are distinct advantages to contact the NRA and conduct environmental studies well in advance of the proposed development; enabling environmental constraints to be identified and avoided, and appropriate mitigation to be designed into the planned development. The developer should be able to demonstrate a reasonable consideration of alternatives.

2. Development control

The development control mechanism for marinas will generally be via the Town and Country Planning system in areas under the jurisdiction of local authorities (i.e. inland and some coastal areas). Other sectoral controls may be relevant in both these and other areas, e.g. the Department of Transport has powers control works affecting navigation and the Ministry of Agriculture, Fisheries and Food has powers to control construction projects in the sea.

3. Environmental Assessment

Yacht marinas are listed as Schedule 2 projects in the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI No. 1199) and therefore require EA where significant impacts are expected. General guidance on the assessment of significance is set out in DoE Circular 15/88 (WO Circular 23/88) and DoE/WO (1989); key factors in marina developments are likely to be their physical scale size and proximity to sensitive locations. Guidance on the need for EA are also given in Department of the Environment Circular 3/95 (Welsh Office 12/95) for marinas (and harbours) in the context of permitted development.

4. NRA authorisations

The following licences/consents may be required from the NRA in connection with the development.

i. **Land drainage consent** - will be required for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

ii. **Abstraction/impounding licence** - for abstraction or impoundment of water.

iii. **Discharge consent** - for discharges of trade or sewage effluent to inland and coastal surface waters, and groundwaters.

iv. **Navigation consent** - for the construction of works on, in or over a river.

5. Major potential impacts

5.1 Construction issues

The impacts of even small marina developments are potentially very significant due to their essential proximity to watercourses or water bodies. Marinas may be built in lakes, rivers, estuaries or coastal locations. Similar types of impacts may be expected for the different locations, although terminologies may be different, e.g. impacts on river flow may be similar to those on tidal currents, those on riverbanks similar to those on coastal shores. Potential impacts are described using a predominantly river-based outlook, rivers being a key area of NRA concern (and jurisdiction). The impacts of associated infrastructure, e.g. buildings and roads, are discussed in more general guidance on construction. A report by the Construction Industry Research and Information Association (CIRIA, 1994) also discusses the impacts of river and coastal engineering.

Land take - Marina developments involve some degree of land take, this includes the aquatic area.

Preparation of the working area and construction of buildings access roads etc. Site preparation works may result in damage to the site fauna and flora from direct damage and physical disruption of bankside soils and riverine sediments. Excavation may unearth and damage archaeological interests. The temporary disposal of excavated materials may extend the affected area. Bankside operations may also cause bank instability.

Fauna may be affected by habitat loss both within the water channel and on the bankside, e.g. bankside trees and vegetation may be used by birds and bats as nesting or roosting sites. In addition, trees may also provide shade; tree loss may result in raised water temperatures, and problematic algal growth.

Increased runoff resulting from soil compaction and vegetation losses may result in increased river flows and therefore flood risk. Runoff and soil disturbance may lead to increased soil erosion with an associated increased sediment load in rivers. High suspended solid loadings reduce water quality and have direct impacts on flora and fauna and the aesthetic appearance of a watercourse. Sedimentation of solids will in turn alter substrate quality for invertebrates and plants, and organisms favouring a more silty sediment may become more dominant. Fish spawning areas may be particularly damaged by siltation. Reduced fish stocks or a change in species composition will affect angling quality.

The general operation of machinery and vehicles may contribute to problems of soil compaction and instability. Fuel and oil may leak from vehicles and machinery or be spilt whilst in delivery or storage. This may result in contamination of both groundwater and surface waters. Shuttering release oils may also affect water quality.

In-channel construction - The construction of within water structures will inevitably lead to the disturbance of sediments and increase suspended solids. Placing of concrete and cement in river channels may also cause water quality problems.

Major works within or close to the channel are likely to cause disturbance to wildlife and may necessitate a temporary cessation of use for both boat and other users (e.g. fishermen and windsurfers).

Isolation and dewatering of aquatic areas may lead to fish mortalities from altered water quality within the isolated area and physical damage from pumping etc. Diversion of flow around major works, e.g. around coffer dams, may cause erosion of the river bed in the temporarily narrowed channel.

Geomorphology - Marina construction will almost certainly result in an altered channel morphology with respect to width, depth, shape, gradient and bedform (riffles, pools etc.) and will lead to an altered deposition regime. Changes in the riverine environment will have an impact on the aquatic fauna and flora.

Coastal impacts - In coastal areas construction may similarly affect habitats, fisheries and recreation. The natural processes of erosion and deposition may be altered affecting intertidal habitats, sea defences etc.

5.2 Operational issues

There are a variety of operational issues that may have environmental implications, ranging from boat movements on the waterway to dredging to maintain its use for marinas.

Habitats - The marina may create a new habitat area of relatively uniform depth but with some habitat complexity from man-made structures, e.g. moorings, pontoons etc. This may be suitable for a different fauna and flora than previously, including fish. There may be a loss of species more associated with flowing waters. The installation of rigid bankside structures may prevent use of the bank as habitat. e.g. for voles, kingfishers etc., and access points for wildlife may also be affected. Boat, vehicle and pedestrian movements may cause habitat disturbance and result in the loss of sensitive species.

Recreation/amenity - Marinas themselves will improve recreational facilities for some users, e.g. boat use should increase. However, there may be an aesthetic loss of "naturalness" in rural settings.

Flow changes - There will generally be reduced water flow within enclosed marinas. Algal blooms and stagnation in the marina may result in deterioration of water quality. In estuarine areas or areas close to the tidal limit, salinity changes through saline intrusion may occur. Freshwater species may be lost, fish populations and movements may be altered and recreational activities, such as angling, affected. There may be a localised rise in the water table adjacent to enclosed marinas.

Locks - Marinas may require locks to maintain access to waterways, particularly in estuarine areas. However, the use of locks will also have a flow regulation effect with intermittent flows downstream and may act as a barrier to fish migration and movement and cause disruption to existing navigation rights. However, the installation of use of locks will generally improve access for boats and may also have a flood defence function. Locks may also provide pedestrian crossing points and amenity areas.

Boats - Pollution may be caused through the release to the waterway of oil/fuel, chemical or organic waste (e.g. "grey" water and sewage). Also, rubbish may be accidentally or deliberately released from boats. Chemicals in antifouling paints may gradually seep into the water and reduce water quality, particularly in marinas and docks where is a high boat density and a low rate of water exchange. This can lead to the build up of high levels of contaminants in these areas in water and sediment.

Boat hull cleaning may result in the loss of antifoulant paint residues to water.

Pollution from marinas may affect the quality of adjacent fisheries, including shellfisheries which may be particularly affected by contamination from bacteria, heavy metals and oil.

Boat movement - waves and so-called "boat-wash" may cause erosion of the banks and/or riverbed, bankside habitats and wildlife, and result in high levels of solids maintained in suspension and increased channel width. Nesting birds may be disturbed. Increased sediment loads may lead to increased turbidity and sedimentation downstream. Pollution may be caused through the resuspension of contaminated sediments. Boat-wash and movements may also disturb anglers and other users (e.g. commercial navigation), resulting in conflicts between user groups. Moored boats may block access to the river for anglers and other users.

Dredging - From time to time marinas and navigation channels may need to be dredged, resulting in various impacts. Navigation may be disrupted whilst the dredging operations are underway. Dredging operations will decrease the bed load but at the same time cause a loss of stability of bankside and benthic sediments resulting in an increased suspended solid loading, through the remobilisation of sediments back into the water column. A variety of contaminants including oil, pesticides, and other chemicals, may be associated with the sediment particles. Eutrophication may also occur. Thus, the net effect may be a reduction in water quality and which may seriously impact on aquatic fauna and flora and other water uses. Bankside users will also be affected as access to the banks may be limited by the temporary deposition of dredged materials along the shoreline. The material will have a physical impact on underlying soils and associated flora and fauna, and may have amenity impacts from its appearance, odour and from flies which are attracted to it. Dredged sediments may also pollute soils and water from leaching and runoff of associated contaminants.

Buildings and car parks - Runoff and site drainage are likely to become contaminated with oil and fuel, leading to a deterioration of surface and/or groundwater quality. Waste reception and disposal (including sewage) from boats and land facilities may cause further pollution.

Chemical storage and use - Spillage and leakage of chemicals in storage, delivery and in their use may result in contamination of surface and groundwaters.

6. Mitigation measures

Site location - Sensitive areas should be totally avoided, such as wetlands, saltmarshes, valuable fisheries etc.

Site design - At the chosen site location, the more sensitive and important habitats should be avoided and protected. For example, a marina could be constructed below the mean low water level to minimise any impact on the ecological interest of the intertidal area. Permanent and temporary land take should be minimised and original habitat features maintained. Trees and other bat or bird habitats should be retained. Opportunities should be sought to replant appropriate trees and create new habitats.

Construction practice - Building regulations, codes of good practice etc. should be followed. Staff, including supervisors, should be made aware of risks of site activity to the environment. Dealing with the environmental impact of the site should be the responsibility of a designated manager, who should establish contact with local NRA staff at the earliest possible opportunity. Ideally, an environmentally qualified and experienced site supervisor will be employed to ensure the protection and enhancement of the environment.

General disturbance - Disturbance to wildlife, plants and habitats can be reduced by restricting the width of operations and the appropriate phasing of construction work avoiding sensitive times, e.g. sensitive times for bird populations include the breeding season, roosting and migratory concentrations. Noise and intrusion should be minimised and avoided at sensitive times, e.g. in the evenings where birds roost in adjacent sites.

Similarly, disturbance to recreation caused by construction works can be minimised by timing operations carefully. For example, construction work on locks should be executed outside of main boating season, and alternative access and crossing arrangements should be made. The duration of construction and other works should be minimised without jeopardising other environmental issues or safety.

Storage and handling of soil - Soil handling and storage should be such that the area affected is minimised but the structure of soils to be restored is maintained as much as possible (i.e. avoid mixing topsoil with underlying material). Stored and other exposed soil or spoil should be covered to minimise silt runoff. Imported material should be avoided where this may contain polluting substances or propagules of invasive plants. Seeding of landscaped areas may or may not be appropriate with suitable seed. Opportunities to create wetland or other habitats should be considered.

Compaction of soils - Soil compaction by heavy machinery should be minimised, particularly in sensitive sites, with the use of boards and other temporary supporting structures.

Boat movements - The imposition of mandatory speed limits on vessels will reduce wave action and the impacts of boat-wash on bank and bed sediments and the aquatic communities. The number of boats may also be limited. Where marinas are constructed in association with barrages/locks, fish pass facilities should be protected from disturbance by boats.

Stagnation within locks/marinas - Stagnation may be prevented by periodic or continuous (trickle) flushing and aeration.

Dredging - Dredged material should be disposed of with consideration of the sensitivity of receiving site and the level of sediment contamination in mind. Disposal to landfill may be required for particularly contaminated material. Disturbance to recreational users from dredging activities may be minimised by timing operations carefully.

Foul drainage - All foul drainage from the site should be connected to the public drainage system via a private sewer. If this is not possible, suitable private sewage treatment facilities should be incorporated, the discharge from which being subject to consent. Cesspools and septic tanks may also be acceptable for small-scale developments. Direct discharges from boats should be prohibited within marinas (and discouraged generally).

Chemicals, fuel and oil - Chemicals etc. should be suitably stored in areas away from sensitive groundwaters, watercourses and drains, with adequate bunding to prevent pollution should spillage occur. Drip trays should be used with pumps and other such machinery to catch leaking oil. Particular care should be taken when handling cement or pouring concrete near watercourses. The risk of pollution from vandalism and theft should be reduced by using tamper proof valves, adequate fencing and security. If pollution of any sort does occur, the NRA should be notified immediately and prompt action taken to minimise effects. Sewerage and waste disposal arrangements should be adequately considered.

Locations used for the fuelling of craft should be designed and operated to minimise risks of pollution.

Contingency plans - Plans to be used in the event of a major pollution within the marina should be set up. These should include emergency procedures on how to deal with the pollution itself. Where appropriate booms and absorbent should be available. They should be stored so that they are readily accessible and maintained in good condition.

7. Baseline surveys

Surveys may be required to ascertain the value and sensitivity of sites to marina developments. Surveys should be appropriate with respect to timing, timescale and methods used.

The surveys required are case- specific but are likely to include:

- water quality;
- aquatic ecology, e.g. river corridor surveys;
- fisheries;
- recreational use;
- archaeology;
- geomorphology; and

- hydrology.

8. Monitoring and audit

Monitoring that is relevant to the predicted impacts and mitigation measures is recommended. Monitoring data should be regularly reviewed, such that action may be taken to resolve issues arising.

9. References and guidance

Construction Industry Research and Information Association (1994) *Environmental Assessment*. Special Publication 96. CIRIA, London.

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to the procedures*. HMSO, London

Department of the Environment/Welsh Office (1992) *Planning Policy Guidance: Sport and Recreation*. PPG 17. HMSO, London.

Department of the Environment/Welsh Office (1992) *Planning Policy Guidance: Coastal Planning*. PPG20. HMSO, London.

Department of the Environment/Welsh Office (1993) *Development Below Low Water Mark*. HMSO, London.

Humphreys, H. (1994) *National Water Resources Strategy - a strategic overview*. National Rivers Authority, Bristol.

Waggoner, J.P. and Feldmeth, C.R. (1971) Sequential mortality of the fish fauna impounded in the construction of a marina at Dana Point, California. *Fish Game*, **57**, 167-176.

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF BARRAGE PROJECTS

1. *Introduction*

This guidance note seeks to identify the potential impacts of barrages upon the water environment. It is intended to form the basis of a fairly detailed scoping brief to cover the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of barrage schemes. The potential impacts of barrages are of concern to the NRA because of the Authority's fundamental responsibilities for environmental protection, pollution control, water resources, flood and coastal defence, fisheries, recreation and conservation management. As such, the NRA will require information on expected environmental impacts in all cases and would wish to see a detailed Environmental Statement (ES) in most.

It is the responsibility of the barrage scheme promoter (or developer) to carry out the EA and to present the results in an appropriate manner to address the questions raised by the NRA. Barrages in coastal areas may create potential conflicts in coastal zone management and scheme promoters are referred to Planning Policy Guidance 20 *Coastal Planning* and also to the Government Circular dealing with Development and Flood Risk (DoE Circular 30/92, WO Circular 68/92). Proper justification will be required for any conclusions in an EA and access to the raw data may be required to examine particular issues in more detail.

It must be stressed that there are distinct advantages for the promoter to undertake an EA in advance of planning and licensing applications. Indeed, the early involvement of the NRA will enable the identification of environmental constraints and sensitive areas to be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage. The proposed routing of the barrage and an assessment of alternatives should be a part of preliminary consultations.

Barrages are constructed, usually in estuarine areas, for the purposes of urban regeneration, flood defence or power generation. Amenity use is a frequent spin-off benefit. Those constructed in tidal areas may be total exclusion, partial exclusion or tidal barrages. Storm barrages, operated only during storm surges to prevent inland flooding, are a further design. Tidal barrages would principally be used for power generation. Partial exclusion barrages (those allowing limited tidal flow) and total exclusion barrages are the most commonly proposed, usually as an amenity or focus to stimulate the redevelopment of the surrounding area.

Where extensive areas of land are to be developed adjacent to the site of the barrage, there will further environmental assessment implications (e.g. surface drainage and runoff, storage of fuel and chemicals and spillage risk, sewage and other effluent disposal, the development of contaminated land, use of weedkillers) to be considered at an appropriate stage of planning. Other NRA guidance may be appropriate to such additional aspects of a development.

A variety of literature has been produced in association with barrage proposals (e.g. STPG 1989, STPG 1993, EAU 1991). Jones (1994) described the role of the NRA with respect to environmental protection and barrage proposals.

2. Development control

In the past, barrages have been promoted as Parliamentary Bills but in the future are most likely to be promoted by means of an Order under the Transport and Works Act 1992. Under this Act the NRA are statutory consultees. Barrages could also potentially be promoted within the Town and Country Planning framework. Proposed barrage developments may also be affected by local bylaws which cannot be accounted for in this general briefing.

3. Environmental Assessment

An ES is usually required for a barrage, regardless of the legislative framework under which it is promoted. The Application Rules for an Order under the Transport and Works Act 1992 are such that an ES is normally required (unless the Secretary of State directs otherwise). Hybrid or Private Bills require an ES under the Standing Order adopted in May 1991. Under the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988/1199), barrages are classified as Schedule 2 developments and therefore a formal Environmental Statement will be required if a barrage is expected to have 'significant' effects.

4. NRA authorisations

The nature of authorisations required from the NRA will depend on the details of a scheme and also the legislative framework under which it is promoted. In general, a licence is required for the impoundment of water. Similarly, licences are required for water abstractions, and for any trade effluent discharges to inland and coastal surface waters that are established during the construction and operation of the barrage. In addition, a land drainage consent will be required for any works on the bed and banks of a river or the construction of any structure likely to impede the flow.

Land drainage and **impounding licences** must be obtained in advance of any construction, regardless of whether planning permission has been granted. Similarly, permission to discharge must be obtained prior to operation.

Test pumping of groundwaters will require a consent and active dewatering would be authorised by an **abstraction licence** or a conservation notice.

A navigation consent or licence to undertake works in, on or over a navigable river where the NRA is the navigation authority.

If stocking of fish into the barrage impoundment is considered, a **fisheries consent** is required for the introduction of fish into an inland water under Section 30 of the Salmon and Freshwater Fisheries Act 1975.

5. Major potential impacts

Impacts upon the aquatic environment are expected in both the construction and operation of the barrage. The EA should state the extent of predicted impacts and whether impacts are temporary or permanent. In general, the creation of an impoundment in a river or estuary site will have profound and permanent effects on the aquatic ecosystem and, in particular, on migratory fish and water quality. The river, estuary, and coastal waters in the area of the proposed development should have existing water quality objectives and further

objectives should be established for the waters upstream and downstream of the completed barrage. It will be necessary for the scheme promoter to demonstrate by appropriate mathematical modelling that such objectives will not be adversely affected.

5.1 Construction impacts

5.1.1 Water quality

The construction of a barrage may affect existing water quality due to a variety of factors which will depend on both construction techniques and operations. Examples may include the mobilisation of contaminants in sediments, and general increases in suspended solids associated with land and sediment disturbance and movements of soil. There may a risk of pollution from site runoff (e.g. oil, cement) and spillages of fuel etc. and the discharge of water from dewatering operations.

It will be necessary to demonstrate that current water quality objectives are met during the construction of the barrage and necessary pollution control measures taken.

5.1.2 Fisheries, conservation, recreation and navigation

Fisheries

Fisheries may be affected during construction of the barrage, particularly through obstructions to the passage of migratory fish, e.g. by in-channel work. Water quality changes may create unfavourable conditions for fish life. Restrictions to access for anglers and changes to water depth, flow and quality may have knock-on effects on angling quality and success.

Conservation

Construction activities may damage the conservation interests of aquatic and riparian habitats. The stripping of topsoil and general loss of surface cover may lead to the direct loss of habitat and species, and also cause increased runoff and soil erosion with an increased sediment load in the river and estuary. General noise and intrusion may cause disturbance to river and estuary fauna, particularly birds, and the outward migration of sensitive species.

Sites of archaeological interest may be damaged by construction access and activities.

Recreation

Recreation and amenity uses of the area may be disrupted by construction operations, such as through limitations of access, noise and visual impact.

Navigation

Navigation may be impaired during barrage construction.

5.1.3 Flood defence

Flood defence may impaired by in-channel obstructions and any breaches in defences made during construction.

5.2 End state/operational impacts

5.2.1 Water quality

Water Quality Objectives

The NRA will specify the water quality objectives for the waters of the impoundment and those upstream and downstream of the newly-created water body. Such water quality objectives may in the future have statutory status; their achievement must be assured. To achieve the water quality objectives specified, the NRA will set appropriate water quality standards. The impoundment may be designated as a "sensitive" area under the Urban Waste Water Treatment Directive and necessitate strict controls on nutrient inputs from sewage treatment works upstream.

It will be necessary for the promoter to demonstrate by appropriate modelling that water quality will not be adversely affected by the construction and operation of the barrage and that specified water quality standards are met at all times.

Water quality impacts

Water quality impacts may occur both upstream and downstream of the barrage and are affected by some of the major physical changes in the water body, e.g. changes in tidal flows and sedimentation. The following issues should be considered in the EA.

Tidal flows - The creation of an impoundment will interrupt natural tidaland river flows, affecting water velocity and salinity and the flushing and mixing effects of such flows.

Sedimentation - Upstream of the impoundment there may be an increased rate of sedimentation, principally due to reductions in water velocity. Depending on the type of barrage, the quantity of maritime sources of sediment may be reduced. Changes in sedimentation patterns may affect water quality, the hydraulic capacity of the barrage and requirements for the physical removal (dredging) of deposits.

Downstream of the impoundment, sedimentation rates and patterns are also likely to be affected, due to changes in tidal flows, flushing and scouring. There again may have implications for dredging requirements and the impacts of these. Similarly, if releases of water from the impoundment are considered for scouring purposes, these may have effects both within and downstream of the barrage, particularly with respect to water quality.

Salinity - The salinity of the impounded water and its stability will be a key factor determining the nature of the ecology of impoundment and will be related to the frequency and extent of salt water intrusion, a factor that will vary with the extent of tidal exclusion of the barrage. Saline water entering the impoundment will be naturally denser than fresh water and tend to sink, leading to stratification of the water column. Where barrages are used for power generation upstream salinities may increase as a result of over pumping at high water.

The salinity regime downstream of the barrage will affect the downstream ecology and may have implications for the passage of migratory fish.

Dissolved oxygen - The concentration of dissolved oxygen of the impounded water will have major implications for populations of fish and other organisms, and may particularly affect the passage of migratory fish from below to above the impoundment, bearing in mind that fish may remain both downstream and within the impoundment for some time. The downstream passage of fish through the impoundment and barrage structure may also be impaired. Reductions in dissolved oxygen levels are likely to occur due to the reduced flow and mixing of the impounded water. Factors affecting such a decline are the extent of organic enrichment of the water body, temperature, growths of algae and the extent of saline stratification. Undisturbed organic rich sediments will also exert a strong oxygen demand on the overlying water.

Where discharges such as sewage are re-routed downstream of the barrage, there may be implications for downstream water quality, particularly dissolved oxygen and ammonia concentrations. Again, migratory fish and resident species may be affected as these may congregate downstream of the barrage awaiting suitable conditions to enter the impoundment.

Ammonia - Ammonia is usually derived from the breakdown of organic wastes and is a significant component of sewage effluents. There may be a significant release of ammonia from organic rich sediments into the impounded water. This is particularly likely to occur if stratification of the water column leads to the formation of a deoxygenated lower layer. The unionised form of ammonia is particularly toxic to fish and the proportion that is unionised is dependent on other water quality parameters, particularly pH, but also temperature, salinity and dissolved solids. Changes occurring to these parameters and to sources of ammonia may alter the concentration of this important parameter, particularly in the impounded water.

Temperature - Water temperature regimes may have impacts, particularly through thermal stress to organisms and thermal stratification of the impounded water, which could lead to deoxygenation of the water column. Thermal stress may take effect both directly and indirectly through the reduction of dissolved oxygen levels. Downstream temperatures will be affected by the temperature and volume of water leaving the impoundment and the influence of solar radiation on mud banks exposed at low tide.

Thermal inputs from power stations may be an additional complication and add to the risks of thermal stress. In such cases, there may be the imposition of a temperature standard.

Nutrients and algal growth - The creation of an impoundment will generally result in an extended retention time of water in more lentic conditions. Water clarity may increase due to reduced concentrations of suspended solids. Algal growth, which may be stimulated by these conditions, will be dependent on a number of factors, including the concentrations of nutrients derived from upstream sources. In addition, the sediment within the impoundment may become a significant source of nutrients, particularly phosphorus. In general, the coloured appearance of water due to algal blooms is aesthetically detrimental, as are algal scums, usually resulting from blooms of blue-green algae. The latter algae also may have toxic effects on both aquatic (e.g. fish) and terrestrial organisms (e.g. dogs), as may blooms of certain other algae, e.g. dinoflagellates. The collapse of algal blooms may have severe effects on dissolved oxygen levels, particularly when coinciding with thermal or saline stratification. Growths of fixed or filamentous algae may also cause aesthetic and water quality problems.

Bacteria and viruses - The levels of bacteria and viruses in the impoundment should be predicted as this will affect the potential uses of the water body. Consultation should occur with appropriate Environment Health Departments of Regional Health Authorities.

Other contaminants - The sediment of the impounded water is a potentially significant source of contaminants, both from existing deposits and those anticipated from upstream following impoundment. The extent of contamination of the water column from sediments will be related to disturbance of the sediment (e.g. from boat movements and dredging operations), oxygen levels at the water-sediment surface interface, and food chains involving substrate-dwelling organisms. Organic matter accumulating and depositing in the impoundment will exert an oxygen demand and may affect dissolved oxygen levels. Increased boat usage may also result in unsightly and polluting surface oil films and contamination from antifoulant paints. Rubbish and floating detritus may be unsightly, particularly if caught up in algal scums.

The location of storm discharges occurring both upstream and downstream may impact both aesthetic and chemical water quality, although there should be a presumption against such discharges to the impoundment.

5.2.2 Fisheries, conservation, recreation and navigation

The major physical alteration to the aquatic and riparian environment will usually have implications for each of these NRA functions.

Fisheries

The NRA will require that the implications of barrage construction on fish species are fully considered. Of particular concern will be effects on migratory fish passing through the area, but the NRA will also require information on resident estuarine, freshwater and, in some cases, marine fisheries. (The term 'fisheries' refers to not only the populations or stocks of fish {per se}, but also the legal and licensed exploitation of these.)

Migratory fisheries - The major impact to migratory fish will be due to the interruption of normal river and tidal flows and the creation of a barrier to migration in the form of a barrage, albeit with a fish pass. Patterns of water quality will also influence fish behaviour and water quality gradients may act as 'barriers' to migration. Migratory fish include those migrating from the sea to spawn in estuaries or rivers (e.g. Allis shad, Twaite shad, smelt, salmon, sea trout, river and sea lampreys) and those migrating from rivers to the sea to spawn (e.g. eel and flounder). The flow patterns through the barrage and the efficacy of any fish pass design will influence the degree of impact on the fish species. Impacts may occur in the passage of species both upstream and downstream, although different life stages may be involved. The promoter must identify the nature and scale of any impact on fish passage in both directions for each species of fish and each life stage. Where barrages are used for hydroelectric generation, passage through turbines may be particularly damaging to fish (ETSU 1988). Commercial fisheries are often based in estuaries and may be affected by the presence of a barrage. Recreational fisheries will be affected with changes of access to waters and the availability of fish.

Estuarine fisheries - The impact on estuarine fisheries (e.g. sea bass, common goby and various mullet species) will primarily result from losses of estuarine habitat, including spawning and nursery areas. Some fish may be able to utilise the generally more stable environment within the impoundment, depending on salinity tolerance and regime. Again, commercial and recreational fisheries may be affected. In most areas the management of sea fish is not the responsibility of the NRA, although most of the exceptions where the NRA has sea fishery responsibilities lie within estuaries.

Freshwater fisheries - The impact on the freshwater fisheries upstream of the barrage will principally be due to the change in habitat from a flowing river to a lentic water body. The water quality and ecological characteristics of the latter will result in a change in fish community type. Species characteristic of flowing waters (e.g. trout, chub and dace) may be replaced by species more characteristic of slow flowing or still waters (e.g. carp and bream). Impacts on recreational fisheries may reflect these changes and the availability of fish. Additional changes may result from any changes of access to the fishery.

Conservation

The impact on the flora and fauna of the area will reflect the fundamental habitat changes and general disturbance through recreational and operational practices. Where intertidal areas are lost, bird species utilising such areas (e.g. waders) will be displaced. Species downstream of the barrage may be affected by changes in flow regimes and water quality, such as turbidity, salinity and nutrient supply. Some fish species of conservation interest (e.g. Allis shad and Twaite shad) will be affected by barrage construction, where these occur. Impacts on both aquatic and terrestrial organisms, including invertebrates and plants should be considered. A number of species are likely to benefit from the creation of an impoundment. Some species may cause aesthetic problems, such as chironomid midge species which may swarm in great numbers upon hatching. Midge problems may only be a short term problem until a balanced ecological community is established in the impoundment.

The timing of operations will be critical in relation to breeding, feeding or other seasonal or diurnal behavioural patterns. The significance of impacts to a particular species will be related, in part, to its regional, national and international rarity. Effects may be brought about by changes to water levels and quality in riparian and other associated habitats, e.g. wetland and drainage ditches.

In addition to impacts on the wildlife of the area, impacts are likely to occur to natural physiographic and geological features. Also, buildings, sites and objects of archaeological or historic interest and the general landscape may be impacted by the construction of a barrage.

Recreation

Impacts on existing recreational users will primarily result from the suitability of the water body for recreational use. In general, there should be opportunities to develop recreational use of the impoundment, although there may be constraints of water quality, space and the zoning of activities. The public health implications of water contact sports in particular must be fully addressed by the developer and the local authority's department of Environmental Health. Impacts on existing users (bird watching, walking, sailing etc.) may occur from both the construction of the barrage, its operation and the development of recreation on a new impoundment. Also, public access to places of natural beauty or to sites or objects of archaeological, architectural or historical interest may be restricted. The general amenity value of the impoundment and surrounding area may be affected by problems such as algal growths, accumulations of sewage-associated and other litter. The development of midge populations may be a particular short term impact affecting residents and users of the surrounding area.

Navigation

Navigation will be affected by the construction of a barrage and there would generally be a requirement for locking facilities on the barrage. Impacts on users of these facilities may include general delays and restrictions associated with tidal or barrage operating regimes. Further impacts will result from altered siltation patterns leading to altered channels and dredging requirements. The responsibility for navigation is not usually that of the NRA but rests with the local Navigation Authority. However, in a few instances the NRA will be the local Navigation Authority.

5.2.3 Water resources

The creation of an impoundment may affect both the quality and quantity of water resources. Barrages may be constructed specifically for the benefit of water resources.

Surface water resources

In general, the creation of an impoundment with higher water level of fresh water will accrue a net benefit to abstractors within an otherwise tidal or brackish reach. The water quality of the impounded water may be altered by algal growths and reductions in suspended solid loads. Abstractors such as power stations may be affected by altered discharge requirements resulting from barrage construction.

Barrages constructed as part of hydroelectric schemes may have implications for new abstraction applications from upstream of the scheme, depending on the nature of the scheme and whether abstraction for generation is made a protected right.

Groundwater resources

The creation of an impoundment with a sustained high water level may have considerable implications for groundwater levels and resources. In general, a higher groundwater level would be expected and this may have consequences for the quality of existing groundwater, a primary NRA concern. Groundwater pollution may occur where rising groundwaters come into contact with contaminated land, such as landfill or coal-gas production sites. Saline intrusion into aquifers may occur if high levels of saline water are retained upstream of barrages. In addition, buildings, other structures and natural systems, such as wetlands, may be affected by rises in water level. Where active dewatering is used to reduce groundwater levels there may be impacts of such operations on both groundwater and surface water quality.

5.2.4 Flood Defence

Barrages will generally have implications for flood defence, and may be specifically constructed as a flood defence measure with an appropriate cost-benefit analysis. Impacts will result from a generally higher water level within the impoundment. Sedimentation within the impoundment will lead to a reduced capacity. There are a number of potential primary impacts of a barrage on flood defence interests. There may be both an aggravation or improvement of flood risk, depending on the operation and design of the barrage, tidal and river flow conditions. Agricultural drainage may be impaired due to the interruption of gravity drainage from low lying land adjacent to the impounded area. There may be increased maintenance requirements following barrage construction, e.g. through increased bank erosion.

6. Mitigation measures

Alternative routing, designs and operational features of the proposed barrage and the environmental acceptability of each should be broadly considered. For the chosen routing, mitigation options should be carefully considered to reduce the net impact of the development scheme. To achieve environmental protection, the promoter should seek any bylaws necessary. In addition to the barrage itself, the siting of access roads, storage and waste disposal facilities used during construction and thereafter should be considered.

6.1 Water quality

During construction, appropriate measures (e.g. Bunding) must be taken to prevent pollution from runoff and spillage's from the site(s) of operations.

In order to achieve the water quality standards stipulated by the NRA for both the impoundment and downstream of the barrage structure, a number of measures may have to be taken by the developer. These could include: the diversion or improved treatment of effluent discharges; the reprofiling of the channel bottom, facilities for the automatic flushing of the impoundment and/or automated artificial aeration and circulation to prevent the formation of a stratified bottom layer of deoxygenated water, and algal skimmers where algal blooms are predicted to develop.

It will be the responsibility of the developer/promoter to carry out post-construction monitoring in order to demonstrate achievement of water quality standards.

6.2 Fisheries, conservation, recreation and navigation

6.2.1 Fisheries

Construction activity that interrupts the passage of fish, if unavoidable, should be phased to periods when the impacts on migratory fish are minimal. In operation, there almost certainly will be a requirement for a fish pass to enable the passage of migratory fish. The design of the pass will be subject to approval from the Ministry of Agriculture, Fisheries and Food or the Welsh Office, who are likely to liaise closely with the NRA. It should be noted that fish passes have a poor efficiency, different species require different types of passes, and attraction of fish to the pass is crucial. The operation of the barrage and the fish pass should consider the seasonal and diurnal migration patterns of every migrating species and the influence of flow, temperature and salinity on fish movement. Pre- and post-scheme monitoring by the developer will be required to demonstrate the impact of the barrage. Where detrimental impacts are demonstrated, measures such as fish pass modification, trapping and relocating fish, and fish stocking may be required.

Where the creation of an impoundment results in changes in suitable freshwater fish communities due to alteration of the habitat (e.g. the creation of a still water from a river or estuary), stocking with suitable fish species should occur where stocks do not currently exist to maximise the potential of the fishery, providing there are no impacts on other fisheries (e.g. predation on migratory fisheries). Habitat improvement measures, such as the installation of artificial reefs and shallow weeded areas may benefit fish and other wildlife.

The siting and operation of the barrage should attempt to minimise downstream impacts on estuarine and marine fish. Any abstraction intakes and turbines should be suitably screened to minimise damage to fish.

6.2.2 Conservation

Conservation measures might include the creation of artificial tidal lagoons, scrapes, islands, reed beds, areas of variable depth and other habitats. Such habitats should be designed primarily for the species likely to be displaced by barrage construction, e.g. a tidal lagoon for wading birds, but should also be considered to enhance newly created habitats such as a freshwater lake. The operation of the barrage should consider the needs of existing and artificially created habitats. For instance, there may be possibilities to simulate natural tidal regimes with respect to salinity and inundation patterns for tidal barrages, and, if marginal reed beds are planted to enhance a freshwater impoundment, drawdown should be minimised. Disturbance caused by barrage construction and operation should be minimised (particularly with respect to breeding, feeding or roosting birds). The relocation of sessile species should be considered where damage is inevitable.

The barrage development should retain natural features such as trees and grassland, where possible, and even manmade features such as buildings where these are of importance, e.g. as bat roosts. If possible, riparian areas should be maintained with a minimum width and area. Tree planting and landscaping should be considered, particularly in areas affected by the development.

Sites of archaeological and other interest should be preserved *in situ*, where feasible, with the provision of facilities for visitors. However, relocation may need to be considered.

6.2.3 Recreation and amenity

The recreation and amenity value of the barrage may be heightened by adequate access and the provision of features for particular users (e.g. ramps and pontoons for sailing, 'pegs' for angling, hides for bird watching).

6.2.4 Navigation

Construction works should try to minimise impacts on navigation, minimising disruption in busy periods, such as the summer, and maintaining access through the barrage where possible, particularly for commercial boats. Adequate locking facilities should be installed for navigation past the barrage, and charges for the use of these should be affordable. The maintenance of navigation channels should be improved, or at least not adversely affected.

6.3 Water resources

Residual flows will be important for the fish pass, ecological and other identified needs.

A staged increase in water levels may be necessary to enable assessment of groundwater levels and quality. Adjusting operating water levels in the barrage may reduce groundwater influx. Contingency measures agreed with the NRA should be established to counter problems arising from rising groundwater levels, such as from contaminated land. Staged increases in water level will, however, have impacts on the efficacy of a fish pass, if installed, and fishery needs must be taken into account. There will be a need to budget water requirements in the worst case scenario to protect fish pass operation and downstream effluent dilution, including allowance for maximum possible lock usage etc.

6.4 Flood defence

The impacts to flood defence may be influenced by barrage design, principally height, and operating procedures. For example, flood risks may be reduced by discharges from the impoundment in anticipation of high river flows. Operating agreements covering the routine operation and maintenance for the barrage should be drawn up including emergency requirements such as flood warning and systems to respond to events of major flooding. Dredging may be used to maintain the capacity of the impoundment. Where land drainage is impaired by higher water levels, pumping schemes may be of use. Erosion protection measures may reduce bank erosion resulting from barrage construction.

7. Baseline surveys

The promoter should ensure that the characteristics of the area of the development are ascertained and sensitive areas identified, such as:

- bird feeding or roosting areas
- migratory fish movement patterns
- fish nursery areas
- invertebrate surveys

- saltmarshes
- fish migration routes
- rivers and river corridors of high ecological or amenity value
- rivers supporting valuable fisheries
- contaminated land likely to lead to polluting runoff
- vulnerable/important aquifers as outlined in the NRA's *Policy and practice for the protection of groundwater* (NRA 1992).

The characterisation should be conducted by a review of information currently held by competent authorities and surveys conducted or commissioned by the promoters. The surveys should be appropriate with respect to timing, timescale and methods used.

The surveys required are case-specific but are likely to include surveys of water quality, river and tidal flows, groundwater levels, fisheries, aquatic biology, river corridors, recreational use, buildings, physiographic and geological features, sites and objects of archaeological or historic interest and the general landscape.

The impacts of the barrage on dynamic systems, e.g. water quality and algal growth, should be modelled where possible. Mathematical models should be produced to predict the conditions following impoundment for a variety of water quality parameters, and for any other parameters identified as a potential problem. For some parameters, models will be required for pre-barrage as well as post-barrage conditions in order to fully calibrate and validate models prior to barrage construction. The models developed should be subject to sensitivity analysis.

River flows and tidal conditions should be characterised, with consideration of extreme events (in isolation and combination) and rising sea levels. The data collated should form the basis for models to assess drainage patterns and flood risk.

Detailed geological and hydrological studies should be undertaken to ascertain baseline groundwater conditions and enable the prediction of impacts of barrage construction. Existing data should be collated and evaluated and monitoring boreholes drilled to measure groundwater levels. Test pumping may be required to evaluate aquifer properties. The location of contaminated land needs to be identified. This includes land currently or previously used in connection with activities such as coal, gas manufacture, landfill sites, chemical production and heavy industry. Monitoring around these sites will be required particularly in association with staged increase in impoundment water levels.

The levels of fish stocks and their exploitation should be assessed. The normal patterns of migration of migratory stocks should be established before impoundment.

Detailed surveys of affected habitats should be conducted to identify the distribution and abundance of aquatic and riparian species affected by the construction and operation of the barrage. The national rarity of the species found should be assessed.

8. Monitoring and audit

Monitoring data should be provided to the NRA's specification, with the design of monitoring programmes being relevant to predicted impacts and any remedial or mitigation works. For example, the monitoring of groundwater levels and quality associated with a staged increase in water levels may be required, along with more long-term monitoring. Water quality within an impoundment should be regularly monitored, with automatic monitoring installed for some parameters, particularly dissolved oxygen. Water levels should be continuously monitored both within the impoundment and in rivers upstream to aid flood control procedures. The migration pattern and abundance of migratory fish stocks should be monitored following impoundment.

9. General guidance

It should be stressed that the NRA will require that the responsibilities of the management of the barrage and impoundment are clearly defined (and adequately financed) for all stages, i.e. before, during and after construction.

References and further guidance

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Department of Transport (1992) *Transport and Works Act 1992: A Guide to Procedures for obtaining orders relating to transport systems, inland waterways and works interfering with rights of navigation.* HMSO, London.

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NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF FISH FARMS

1. Introduction

This guidance note seeks to identify the potential impacts of fish farms upon the water environment. It is intended to act as a fairly detailed general scoping brief to cover the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of fish farm schemes. The NRA has particular interests in fish farm projects due to its responsibilities for fisheries, water quality, water resources and consenting The NRA are statutory consultees for developments for the purposes of fish farming. Environmental studies are likely to be necessary because, as a minimum, certain information will be required by the NRA before issuing relevant licences etc. The responsibility for such studies lies with developer and the results should be presented in an appropriate manner to address the questions raised by the NRA.

Early consultation with the NRA is recommended to enable the identification of environmental constraints and sensitive areas, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage. Proper justification will be required for any conclusions and access may be required to the raw data to examine particular issues in more detail.

2. Development Control

Fish farms may be either land-based or offshore developments. Land-based developments (and cages in freshwater lakes) require planning permission within the Town and Country Planning framework. Offshore farms do not require planning permission as such, but a licence granted by the Crown Estate Commissioners, who manage the sea bed below the low water mark, is required for the installation of fish or shellfish rearing facilities.

Crayfish farming is likely to be the subject of increasing regulation, particularly with respect to the control of escapement of non-native farmed species and the containment of disease (see Section 5.4). MAFF controls place restrictions on the permitted locality of crayfish farms, which require licences from MAFF. Crayfish farms are banned in rivers where native crayfish predominate. This is in connection with recent EC legislation, which requires the establishment of protected areas for the native crayfish *Austropotamobius pallipes*.

3. Environmental Assessment

For land-based salmon farming, an EA may be required under SI 1988 Nº 1199 The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988. "Salmon hatchery" and "installation for the rearing of salmon" are listed on Schedule 2, i.e. those projects which "are likely to have significant effects on the environment by virtue of factors such as their nature, size or location". A Department of the Environment/Welsh Office circular (DoE 15/88, WO 23/88) and guidance (DoE/WO 1989) suggests a threshold of annual production of 100 tonnes of fish a year, below which an EA should not normally be required. However, the significance of a project will depend very much on its location and an EA may well be necessary at lower production levels and where future expansion is planned.

Trout, char, coarse fish, crayfish and other land-based "fish" farming activities may be exempt from EA requirements as only salmon are specified in the regulations. However, environmental information may be required by those considering the application and the NRA would strongly recommend an EA.

Offshore fish farm developments are subject to the Environmental Assessment (Salmon Farming in Marine Waters) Regulations 1988 (SI Nº 1218), under which the Crown Estate Commissioners will consider an environmental statement from the developer, and comments from consultees and the public, before granting a lease where the development may have significant environmental effects.

4. NRA licences

In order to operate a fish farm, a combination of the following licences and consents will be required from the NRA.

i. **Discharge consent** - for discharges to inland and coastal surface waters. This includes discharges from caged fish farms.

ii. **Abstraction/impounding licence** - the Water Act 1989 removed the agricultural exemption for all abstractions in excess of $20m^3$/day. A licence is also required for impounding.

iii. **Land drainage consent** - will be required for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

Land drainage and impounding licences must be obtained in advance of any construction, regardless of whether planning permission has been granted. Permission to discharge must be obtained prior to operation.

5. Major Potential impacts

The high water quality requirements of fish farms often results in their siting on sensitive watercourses and in sensitive areas, thus amplifying their potential effects upon the environment. Impacts will occur largely in operation, but construction activity such as the excavation of ponds, installation of tanks, raceways, screens and other farm construction may have a variety of impacts, including land take, pollution of watercourses, disturbance of sensitive species and damage to archaeological interests. Further NRA guidance should be referred to for the impacts of general construction activity.

The following sections concentrate on operational impacts.

5.1 Water quality

Fish farm activities may affect a variety of water quality determinands. The NRA will impose a discharge consent to adequately protect receiving water courses. Key aspects of water quality that may be affected by fish farms include levels of nutrients, oxygen, ammonia, other chemicals and temperature.

Nutrient enrichment - The leaching of inorganic nutrients from solid wastes and soluble nitrogenous fish excretion may cause eutrophication of receiving waters. Resulting algal blooms can be toxic to fish, and may be unsightly. Phosphorus is usually the nutrient limiting algal (and other plant) production in freshwaters, and nitrogen in marine waters. Other than causing algal blooms, nutrient enrichment may lead to changes in macrophyte communities, with excessive growth of some species. Nutrient-stimulated algal and plant growth may affect dissolved oxygen levels through respiration and decay.

Oxygen depletion - Direct oxygen depletion will be caused by fish respiration. Indirect depletion will result from the degradation of inorganic and organic wastes (which combine to give a biochemical oxygen demand or BOD). Low oxygen levels in the fish farm and receiving waters may result in the death of fish and other aquatic life.

Ammonia - Ammonia may result from excretion by fish, or the breakdown of waste products. High ammonia levels may be toxic to aquatic life, particularly fish. In addition, ammonia may also contribute to eutrophication, where nitrogen is the limiting nutrient.

Suspended solids - Solids may arise from waste food, faeces and disturbance of pond/tank sediments. High levels of suspended solids may cause direct damage to aquatic life, indirect damage through light attenuation, and may have an adverse aesthetic impact. Settlement of solids may cause smothering effects and change the nature of sediments. Settlement of solids may reduce the survival of eggs of gravel spawning fish, such as salmon and trout in streams, and whitefish (e.g. vendace) in lakes. The decay of solids may lead to low oxygen conditions in the sediment and overlying water, affecting benthic organisms and leading to the release of certain chemicals, including nutrients. Sediments may act as a significant source of nutrients in eutrophication.

Temperature - The temperature of fish farm effluent may be at variance with that of receiving waters, and have sublethal impacts as a result. Growth rates and the duration of embryonic development may be altered.

Other chemicals - There are three principal sources of chemical pollution from aquaculture:

- components of fish foods which are not assimilated by the fish;
- chemicals used for disease prevention or for the treatment of fish; and
- disinfectants and chemicals used as antifoulants.

The use of antibiotics, malachite green, formaldehyde and (in the marine context) treatments containing dichlorvos (e.g. Nuvan, Aquaguard) is of concern. Recently, the unapproved use of ivermectin has also been of particular concern.

Disease organisms - Disease and parasitic organisms may pass out from the fish farm with the discharge and infect wild populations. The spread of crayfish plague from crayfish farms to native stocks is a particular concern. The burial of diseased or other carcasses may be a source of further infection and contaminate groundwater with bacteria and organic material.

5.2 Water resources

Although the use of water by fish farms is generally non-consumptive, i.e. the volume of water from a river abstracted closely matches that discharged, there may be a section of river between intake and discharge affected by a reduced flow. The abstraction licence granted in association with a fish farm may contain a residual flow condition in order to protect the reach of river between abstraction and discharge points. In addition, the cumulative effects of several fish farms in a catchment may limit the available resource to other users. Where fish farms use groundwater supplies, abstraction may be a contentious issue, with the possible impact of falls in water table level.

5.3 Conservation and wildlife

A variety of impacts on conservation and wildlife may occur as a result of water quality changes as indicated above. For example: a loss of aquatic plant diversity may result from nutrient enrichment favouring faster growing aquatic plant species; eutrophication and algal growths may lead to adverse conditions for a variety of species; chemicals, temperature changes, ammonia, reduced dissolved oxygen and smothering may all affect aquatic fauna. Low flows between intake and discharge points create unfavourable conditions. In addition, disturbance of natural habitat and predator control methods may affect mammal and bird populations.

5.4 Fisheries

In addition to the effects on fisheries arising from changes in water quality, there may be the following impacts.

Escaped fish - Fish escaping from fish farms pose a threat to wild populations via competition for food and breeding sites, predation, genetic contamination and the transfer of disease. Escaped fish may be less valued by anglers than more natural stocks as escapees may be non-indigenous species such as rainbow trout and/or easier to catch, and thus angling quality may be reduced.

Similarly, crayfish escaping into the wild may become established, upsetting existing ecosystems and competing with (and predating upon) the indigenous and legally protected native crayfish, *A. pallipes*. In addition, non-native species (particularly signal crayfish, *Pastifastacus leniusculus*) can carry crayfish plague, a disease which has decimated many wild crayfish populations. It is now an offence under Section 9 of the Wildlife and Countryside Act 1981 to release, or allow to escape, three non-native species, the signal, noble (*Astacus astacus*) and narrow-clawed or Turkish (*Astacus leptodactylus*) crayfish. Non-native crayfish may also be a nuisance to anglers, the crayfish taking bait before target (fish) species, and cause damage to river/canal banks.

Depleted or diverted flow - Abstraction from a river may result in a significantly depleted flow, which may present a barrier to migrating fish, render sites unsuitable for spawning and may exacerbate water quality problems. The use of a weir to divert flow into the farm may present a further barrier to fish migrating upstream. Diversion of water from a river through a fish farm with insufficient screening can have serious implications for native fish, particularly smolts migrating downstream through the farm.

5.5 Recreation and amenity

Aesthetic effects may arise from the visual impact of fish farm buildings on the banks of scenic rivers, reduction in water quality, and eutrophication. Fresh and marine water cages will similarly have a visual impact and may hinder sailing and other water sports, and may also occupy prime anchorage sites. Reductions in river flow may affect recreation and navigation on some rivers.

The quality of angling may be affected by impacts on native stocks and the presence of escapees.

6. Mitigation measures

There are many technological innovations which can be used to minimise the environmental impacts of aquaculture. At the design stage, the basic design criteria can be adapted to be more sensitive to the environment. For instance, dual drainage arrangements can be incorporated to allow therapeutic/other chemical treatment processes to be isolated from the main effluents and held for separate treatment etc. During operations, technological waste control measures may be incorporated. The timing of fish migration should be considered when planning the operating regime of a fish farm. Fish farmers should follow the Codes of Practice from the British Trout Association, which was agreed with the NRA and contains more detailed mitigation measures.

6.1 Basic design criteria

The distance between intake and discharge should be minimised so that as little river habitat as possible is subjected to reduced flow.

The adoption of multiple outlets should be avoided so as to reduce the monitoring workload.

To reduce the risk of entrapment of migrating fish, the following are recommended:

- intakes should not be located close to impounding structures as salmonids and cyprinids aggregate immediately up or downstream of such structures;
- screens of small aperture should be installed and maintained on inlet and outlet channels; and
- where possible, inlet channels should incorporate an unobstructed route back to the river.

Solomon (1992) provides guidance on the design of screens for intakes and outfalls.

Ponds, tanks or cages should be suitably designed and adequately screened to prevent the escape of fish. Crayfish are particularly adept at escaping and suitable measures should be adopted, such using smooth surfaced materials for pond walls, having the water supply falling through pipes and fencing with overhanging tips. There should be no direct outfall to watercourses. In general, specialist advice should be sought. The design of cages, tanks and ponds should be ensure adequate protection from predators (e.g. netting) and thus obviate the temptation to use more drastic (and generally illegal) control measures.

Angling and other recreational facilities may be provided at the fish farm.

6.2 Waste minimisation

Food pellets with lower settling velocities should be used, where appropriate, to give fish more time to consume the food before it settles out as waste. Fish should not be over fed. In addition, pellets with a reduced phosphorus content should be used to reduce the risk of eutrophication of freshwaters.

Settling devices (e.g. settling ponds, swirl concentrators and triangle filters) should be used to reduce concentrations of solids in suspension. The cleaning out of ponds and other control devices should be done with care to avoid discharges of high suspended solid loads. The disposal of solids should be by an approved method. Where space provides, reed bed treatment may be considered to remove solids and nutrients, and potentially add to the conservation value of the site.

Filtration using a gravel substrate may remove ammonia. Widespread use of recirculation in conjunction with biological filtration of the final effluent will produce a cleaner effluent and reduce water demand. Farms using heated water may reduce the risk of environmental damage by using heat conservation methods and heat exchangers.

6.3 Operational aspects

Farms should be stocked with fish and crayfish from parasite and disease-free sources. The use of sterile fish (triploids) is the only sure way to prevent genetic contamination or the introduction of non-indigenous species, although the adoption of vandal proof screens would ameliorate the problem. Restocking should involve fish derived from local gene pools.

The use of cleaner wrasse should be considered as an alternative to chemical treatment to prevent sea lice. Where chemicals are used (e.g. Nuvan), treatment should be restricted to enclosed treatment baths or incorporation into fish diets.

The timing of operations should be phased such that peak water demand (and hence risk of entrapment) avoid periods of the peak movement of migratory fish.

Fish carcasses and other wastes should be safely disposed of, away from watercourses. Composting using recent technologies should be considered.

7. Baseline surveys

Detailed information is likely to be required to determine the impact of the fish farm upon the aquatic environment. The following surveys are likely to be recommended (depending on the sensitivity of the location).

i) Land-based farms

- river corridor survey including information on local statutory/non-statutory conservation sites and species
- sediment and water quality assessment

- benthic assessment of flora, fauna and physical features
- monitoring of flow rates and dispersion potential of the river
- fish population surveys
- aquatic invertebrate survey.

ii) Caged units

- current modelling
- ecological survey

Details of baseline survey work should be discussed with the NRA as soon as possible as parameters are likely to be diurnally and seasonally variable.

8. Monitoring and audit

An appropriate monitoring strategy should be developed on the basis of baseline information and potential impacts. Fish farm operators should monitor discharges for compliance with consent conditions (as will be practiced by the NRA) and to assess the performance of fish farm design and treatment processes. There will be a requirement for the abstractor to measure the volume of water taken.

9. General guidance and references

There should be a limit to the number of fish farms on any stretch of river. Cumulative effects, if more than one farm is present, should be taken into consideration.

Serious consideration should be given to prohibiting further development in salt or freshwater bodies with a low dispersion potential and/or limited flushing.

The nature of pollutants in discharges from land-based farms and the formal controls exercised by the NRA are described in more detail in . Effluent treatment options are discussed in Cripps and Kelly (1994). Marine fish farms occur more frequently in Scotland. The Crown Estate Commissioners have produced guidance (CEC 1989) on the siting and design of marine fish farms in Scotland, and an updated document is expected from the Scottish Office. The Crown Estate Commissioners have also commissioned a report (Cobham Resource Consultants 1987) along with a number of other bodies into the environmental impacts, particularly landscape effects, in Scotland.

Cobham Resource Consultants (1987) *An Environmental Assessment of Fish Farms*. Countryside Commission for Scotland/Crown Estate Commissioners/Highlands and Islands Development Board/Scottish Salmon Growers' Association.

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NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF PIPELINES

1. Introduction

This guidance note seeks to identify the potential impacts of pipelines upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) with respect to the environmental impacts of pipeline schemes. The potential impacts of pipelines are of interest to the NRA because of the authority's general environmental responsibilities. Early consultation with the NRA, particularly on the proposed routing of the pipeline will help to identify any environmental constraints and sensitive areas which may or should be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage. Examples of sensitive areas include river corridors of high ecological or amenity value, sites of archaeological interest, upland areas of catchments with particular sensitivities, and areas in which the groundwater is vulnerable to contamination (the principles of aquifer vulnerability are outlined in the NRA's *Policy and practice for the protection of groundwater* (NRA 1992). Locations in which pipeline construction could add to pollution risk include contaminated land, waste disposal areas, etc.

Legislation may require that a Environmental Assessment is carried out for proposed pipelines. The responsibility for this assessment lies with the developer. It is advantageous to conduct the EA in advance of the design phase to enable proper consideration of alternatives. The EA's conclusions, generally presented in an Environmental Statement (ES) require proper justification and the raw data should be accessible. Where an EA is not necessarily required, the NRA may still require certain environmental information in connection with NRA licences or consents.

The Department of Trade and Industry have published comprehensive guidelines for the environmental assessment of cross-country pipelines (DTI 1992) which are generally relevant to most pipeline schemes, but are particularly targeted at schemes falling under the Pipe-lines Act 1962. This note also predominantly deals with overland pipelines; a guidance note on long sea outfalls should be referred to for guidance on offshore pipelines.

2. Development control

The planning and construction of pipelines fall under the Town and Country Planning framework with the construction of some pipelines being permitted development under the Town and Country Planning (General Permitted Development) Order 1995. Pipeline construction may also come under a number of Acts, such as:

- The Pipe-line Act 1962 - various cross-country and local pipelines, e.g. oil pipelines;
- Land Power (Defence) Act 1958 - Government pipelines;
- Factories Act 1961 - factory pipelines;
- Mines and Quarries Act 1954 - mine and quarry pipelines;
- Gas Act 1986 - gas pipelines; and

- Water Industry Act 1991 - water pipelines and sewers.

3. Environmental Assessment

Under the EC Directive 85/337/EEC "oil and gas pipeline installations" are listed as Annex II projects requiring Environmental Assessment when significant environmental impacts are anticipated. These requirements are set out in The Electricity and Pipe-line Works 1990 (Assessment of Environmental Effect) Regulations (SI. 1190 442). Under these Regulations the Secretary of State decides the need for an Environmental Assessment. Water pipelines, as long distance aqueducts, are also Annex II projects and may require EA the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI No. 1199). Guidance on the need for EA for long distance aqueducts in the context of permitted development is given in Department of the Environment Circular 3/95 (Welsh Office 12/95).

In instances where there is not be a statutory requirement for EA, it may represent the most efficient process by which to take into account expected environmental impacts.

4. NRA licences

The NRA are the licensing body for a variety of licences and consents.

i. **Land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

ii. **Discharge consent** - for discharges to "controlled waters", i.e. groundwaters, inland and coastal surface waters. Therefore, consent may be required for the disposal of runoff and the discharge of water from dewatering operations and that used in pipe testing or sterilisation. Consents apply to both direct and indirect (i.e. after treatment) discharges to a watercourse.

iii. **Abstraction licence** - may be required for any pumping or lowering of the water table.

With respect to pipelines, land drainage consents are likely to be the most relevant. These must be obtained in advance of any construction, regardless of whether planning permission has been granted.

5. Major/potential impacts upon the aquatic environment

In most cases, the majority of potential impacts will occur in the construction, rather than during operational use of a pipeline. Exceptions will be where major leakage and/or pipeline failure occurs, potentially causing serious long-term impacts.

5.1 Construction impacts

Construction impacts will include those arising from the preparation of the working (pipeline and access) areas, trench digging and the general operation of machinery and vehicles. Impacts may be particularly significant at river crossings.

Preparation of the working area and excavation of the pipeline trench - This may result in damage to the site flora from direct damage and through compaction and other physical disruption of the soil. In addition, the temporary disposal of excavated soil may extend the area affected. There may be a loss of bank stability from bankside operations. Fauna may be affected that are dependent on trees and other vegetation, e.g. birds and bats may utilise trees as nesting or roosting sites. Bankside trees may also be used as habitat by otters and may also provide shade for rivers; tree loss may result in significantly increased river temperatures and plant or algal growth.

Increased runoff resulting from soil compaction, vegetation losses and channelling of water through trenches may result in increased river flows and therefore flood risk. In addition, groundwater may be affected by reduced infiltration of precipitation. Dewatering of excavated trenches may lead to localised lowering of the water table, affecting wetland sites and localised water resources. The discharge of water from dewatering operations may lead to direct pollution of watercourses. Runoff and soil disturbance may lead to soil erosion with subsequent pollution from raised levels of suspended solids, decreasing water quality. Pollution by suspended material may have effects on sensitive aquatic life from abrasion or more rapid attenuation of light in turbid water. In addition, sedimentation in rivers may affect substrate characteristics for aquatic flora and fauna, and reduce the quality of gravels for fish spawning, particularly trout and salmon. Reduced fish stocks will affect angling opportunities for such stocks. Angling, recreation and navigation may also be impaired by construction activities, e.g. at river banksides and crossings.

Machinery and vehicles - The general operation of machinery and vehicles may contribute to problems of soil compaction and soil instability. Leaking or spilled fuel and oil from stores, vehicles or machinery may contaminate both groundwater and surface waters.

River crossings - At river crossings the use of machinery on the river bed itself or banks may result in the loss of aquatic flora and fauna from physical damage and also through water pollution such as high concentrations of suspended sediments (with subsequent sedimentation) and from oil or fuel spills. The use of construction materials such as cement near to watercourses may also lead to pollution. Machinery and construction materials in the watercourse may also represent a barrier to migrating fish. Temporary structures and machinery in the river channel may also cause changes to flow patterns, leading to changes to channel geomorphology and loss of river substrates.

General construction activity may disturb aquatic wildlife disrupting feeding and/or reproduction. Recreational use of watercourses, angling and navigation may be particularly affected by disruption and loss of access at river crossings.

Certain archaeological features, e.g. those arising from ancient fords, mills and bridges, may be particularly threatened by river crossings.

5.2 End state/Operational impacts

End state impacts will arise from the routing of the pipeline, maintenance requirements and from any failure and leakage from the pipeline. The general ecological impacts from construction itself will usually be fairly temporary.

Pipeline routing - Where the pipeline crosses a river bed pipeline structure and other alterations to the stream bed may increase hydraulic roughness or otherwise increase flood risk. Again, changes to flow patterns may lead to changes in channel geomorphology, leading to upstream deposition and siltation, disturbance to bed form (i.e. pools, riffles etc.), loss of habitat and decreased channel stability.

Pipelines crossing over and above a river will generally be very noticeable, affecting amenity/landscape value; they may also increase flood risk and possibly affect navigation and angling interests. Overground pipelines, particularly along watercourses will have further visual impacts and will develop a localised flora along the pipeline route.

Pipeline passing underground may affect movement of groundwater, possibly blocking flow across the pipeline and channelling flow along it. Where the pipeline channels flow, it may act as a drain, thus dewatering wetlands and other habitats dependent on water table levels.

Pipeline maintenance - The installation of access provisions to the pipeline may result in the permanent loss of habitat along the access route. The use of access may have occasional impacts of disturbance to wildlife, trampling of plants etc. The use of herbicides, both in construction and routine maintenance may lead to pollution of groundwater or surface waters.

Pipeline failure - Depending on the substance carried, extent and location of failure, a pipeline failure causing leakage may cause significant pollution of groundwater and /or surface waters, with corresponding effects on water resources, losses of invertebrates, plants and fish, angling, recreation and amenity etc.

6. Mitigation measures

Careful planning and design, combined with the use of sympathetic construction techniques and reinstatement, can generally minimise the environmental impacts of pipelines. Routing and other mitigation measures are discussed below.

Routing - Alternative routing of pipelines should be considered (particularly to avoid sensitive areas) with respect to acceptability on environmental grounds. For instance, the NRA will object to oil pipelines for the strategic transfer of hydrocarbons in areas with more vulnerable aquifers. The siting of access roads, storage tanks and waste disposal facilities used during construction should also be considered. At an early stage in the planning process land-use mapping should be carried out, including identification of architectural, Sites of Special Scientific Interest (SSSIs) and other nature conservation sites. This will enable timely re-routing, or early consideration of suitable mitigation measures should re-routing not be feasible, whilst the project is still at an desk study stage - thus avoiding costly alterations and/or delays later.

The NRA will be particularly interested in the following factors in the choice of pipeline route:

- watercourses;
- aquifer vulnerability and proximity to potable supplies;
- areas of archaeological or cultural interest in the floodplain;

- areas of (aquatic) conservation interest; and
- areas of landscape or amenity importance in the floodplain.

The depth of pipelines may also be an important factor. Pipelines in contact with groundwater (e.g. at or below the water table) may directly affect groundwater quality. Also, pipeline material may degrade more rapidly from such contact, e.g. through corrosion.

The DTI (1992) discuss the wider variety of factors which may need to be considered when designing and choosing a route for a pipeline (such as development plans, population density, topography, geology, buildings, roads, railways, and other pipelines).

Damage to plants and habitats - Damage to plants and wildlife habitats can be minimised by restricting the working width of pipelaying operations, trenches, access roads etc. Damaged habitats should be restored to their former soil profiles and reseeded (using seeds from the original, disturbed vegetation or vegetative fragments). Grazing animals should be excluded during restoration. Reinstatement of wetlands is complex and therefore early consultation with the NRA is recommended so that the best available and practical methods are employed. Alongside rivers the NRA may seek opportunities to design in habitat enhancement.

The need for felling of mature trees should be avoided by route planning and tunnelling under such trees.

General disturbance to wildlife will be reduced by the carefully timing of operations. Appropriate phasing and timing of construction work to avoid sensitive times will reduce the environmental impacts. The most appropriate timing will depend on the wildlife at risk. A sensitive time for many bird populations will be the breeding season in spring/summer. For others, winter concentrations of migratory birds may be the sensitive period. Trout and salmon spawn in the autumn, but coarse fish in the spring/summer. Extensive maintenance works should also avoid sensitive periods.

Noise should be minimised by careful selection and use of machinery and also by the use of baffles or screens, where appropriate. Dust generation should also be minimised, particularly near sensitive vegetation and watercourses.

River crossings - River crossings should not be made immediately upstream of abstraction points or ecologically sensitive waters to avoid damage from construction or from pipeline failure. Non-invasive methods (e.g. thrust boring) are preferred. (The increased cost of the thrust boring technique is offset by the decreased risk of pollution, increased speed of operation and reduced likelihood of weather impacting). The fluming of rivers and streams may avoid interruption of the watercourse and may help to minimise the occurrence of suspended solids. Disturbance of river beds and banks should be minimised and care taken with the handling of cement and concrete near watercourses.

Care should also be taken when crossing other linear habitats, such as hedges and ditches, which may act as wildlife corridors in a similar manner to rivers.

Access - Access routes to construct the pipeline should be via suitable existing roads, where possible. Where new access routes are required these should generally be temporary, avoid riparian zones, minimise erosion and if necessary use appropriate construction materials. Special provisions may be required where habitats need to be protected. For example, if a wetland needs to be crossed, bog mats could be employed. Where unavoidable, culverts should be designed so as not to disrupt fish movement. Disruption to public accessibility should be mitigated for by the construction of gates, bridges or stiles, or arrangements for alternative access to be made. Disruption should avoid peak periods of recreational activity, e.g. angling, navigation.

Soils - Topsoil and subsoil should be carefully removed and stored separately so that reinstatement of soils can be carried out properly. Stockpiles should be protected (e.g. covered with sheeting) to minimise silt runoff and settlement facilities may be required for such runoff. Subsoil may need to be ripped prior to the spreading of topsoil. Compaction, may be reduced by restricting traffic movement and the use of protective boarding and low ground pressure machinery. Compaction may be reduced by minimising operations in wet periods and winter. working on wet soils. Mixing unlike soil materials should be avoided. Permanent disposal of spoil, when required, should be off-site.

Operations close to rivers should be properly engineered to avoid affecting the stability and long term performance of river banks and flood defences.

Storage of on-site equipment - On-site equipment and materials including fuel and oil, should be carefully stored. Proper bunding should be provided for fuel tanks, away from water (preferably off-site) and locked when unattended. Bunds should be constructed such that all openings and fuel pipes are within the bund walls and that the bund itself has an adequate capacity. Drip trays should be placed under stationary machinery to collect oil and grease. NRA Pollution Prevention Guidelines give detailed advice on the design of storage facilities.

Site and trench drainage - Drains from access routes and construction areas should be designed to drain road areas only and to discharge to buffer areas (areas of land around watercourses that are unaffected directly by the development) where drainage water is likely to contain high sediment loads. Oil separators (interceptors), silt traps, wet balancing ponds, open ditches, and the use of coagulants should be also be considered, where appropriate, to reduce water quality impacts. Soakaways may be useful, although NRA guidance should be sought on design as their use as they may increase groundwater quality impacts. If necessary, header drains should be used and water stops installed in trenches. Stops will certainly be required to prevent the course of the completed pipeline acting as a drain and thus dewatering wetlands.

Field drains and ditches - These should be identified and carefully reinstated to prevent flooding and maintain the character of the landscape.

Archaeological sites and sites of other interest - These should be preserved *in situ*, where feasible, with the provision of facilities for visitors if appropriate. Relocation should be considered where damage is unavoidable.

Pesticides - The use of pesticides should follow relevant guidance, e.g. NRA (1995) for the use of herbicides near watercourses.

Pipeline testing - Testing requirements should be carefully considered, particularly with respect to the times, points and rates that water can be drawn off or discharged for hydrostatic testing. Due to the higher risk of failure during precommissioning testing, no pipeline should be tested with liquid product - water should be used (if appropriate). Approval to dispose of test water is normally required from the NRA, particularly if inhibitors or biocides have been added to the test water.

Pipeline failure - Pipelines should be adequately designed, operated and monitored such that there is only a remote risk of failure. Emergency arrangements, including notification of the NRA, should be prepared for the unlikely event should it happen. Pipeline failure could have adverse effects on the surface or groundwater particularly if carrying hazardous materials it is therefore prudent for routes to avoid sensitive aquatic habitats and aquifer recharge zones. If air patrols are used for monitoring markers should be positioned to aid route location and the aircraft should fly at a sufficient height to minimise disturbance to wildlife.

7. Baseline surveys

Field surveys should be appropriate with respect to timing, timescale and methods used and preferably include surveys at the same time of the season as the proposed construction, in the year prior to the works.

Field surveys should be sufficient to:

- establish the pre-construction (baseline) state of the site;
- aid the identification of construction practices with the least environmental risk;
- determine the best operational conditions for the aquatic environment during construction, such as water level in wetlands, water flow in rivers and allowable sediment load or deoxygenation effects on river biota especially fish;
- provide a basis for immediate and informed advice when critical environmental factors arise during construction; and
- optimise the reinstatement of channels or wetland areas by the appropriate choice or extent of use of a specific technique.

The surveys required are site specific but are likely to include physical, chemical, and morphological data on water, soils and topographic features in addition to the species and numbers of the major organisms present. Important indicator species include flowering plants, dragonflies, amphibians, reptiles and native and migrant birds. The presence and habitats of rare species should particularly be identified. Information on fisheries, recreational use archaeology and the river corridor as a whole will also need to be collected.

8. Monitoring and audit

Monitoring that is relevant to the predicted impacts and mitigation measures is recommended and should not only make use of baseline surveys but also consider further pre-scheme surveys. Post-scheme monitoring data should be regularly reviewed. The review or audit should also include compliance with agreed management practices.

9. References

Department of Trade and Industry (1992) Guidelines for the Environmental Assessment of Cross-country Pipelines. HMSO, London.

NRA (1992) *Policy and practice for the protection of groundwater*. HMSO, London.

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF LONG SEA OUTFALL PROJECTS

1. Introduction

This guidance note seeks to identify the potential impacts of long sea outfalls upon the water environment. It is intended to form the basis of a fairly detailed scoping brief to cover the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of long sea outfall schemes. The NRA has an interest in such projects in relation to its duties primarily with respect to water quality but also with respect to amenity, recreation, conservation, fisheries and flood defence. To be able to adequately comment on such schemes the NRA would need at least certain environmental information and preferably a full EA, which the local planning authority may require under planning legislation. The responsibility for the assessment lies with the promoter/developer of the scheme. Any conclusions from such an assessment may require proper justification and raw data should be accessible. There are distinct advantages to conduct an EA in advance with a proper consideration of alternative treatment/disposal options and outfall routes. Early

NRA involvement will enable the identification of environmental constraints and the avoidance of sensitive areas, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage.

Outfalls may be used for the disposal of a variety of wastes including sewage effluents and industrial discharges. A variety of literature on outfalls is available, particularly with respect to sewage discharges. Nixon (1990) provided an assessment of the environmental effects of long sea outfalls based on the findings of a detailed study by Cooper and Thompson (1989) on two outfalls discharging domestic waste. The studies concluded that discharges from a properly designed outfall should have a negligible effect on the environment. Environmentally sensitive outfall design was considered by Neville-Jones and

Dorling (1986). Some of the construction issues are also discussed by CIRIA (1994).

2. Development control

Development control of headworks and outfall structures will generally fall under two different statutes. The Town and Country Planning framework applies only to development above Mean Low Water. Under the Food and Environmental Protection Act (FEPA) licences are required from the Ministry of Agriculture, Fisheries and Food (MAFF) or the Welsh Office) for work below Mean High Water Spring.

The construction of long sea outfalls may require an environmental assessment under the terms of SI 1988/1199, The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988, if the outfall is considered as part of a waste water treatment plant, e.g. where there are significant headworks. In addition, long sea outfalls may require consent from the Ministry of Transport under the Coast Protection Act 1949.

NRA is a statutory consultee for developments involving sewage, slurry or sludge treatment or disposal.

3. NRA licences

A discharge consent is required for the discharge of effluents to coastal waters. Permission to discharge must be obtained prior to operation of the outfall.

4. Major/Potential impacts

Impacts may occur in both the construction and operation of the outfall. In addition the decommission of the structure may require consideration.

4.1 Construction impacts

4.1.1 Water quality

Construction operations, including dewatering, may lead to disturbance of sediments and runoff leading to localised high sediment loads. Oil, fuel, cement and chemicals used in construction may cause localised water and sediment pollution. In addition, there may be the mobilisation of other chemicals from contaminated land or sediments into site drainage water or directly to the sea.

4.1.2 Amenity and Recreation

The construction works may cause visual and obstructive disturbance to the amenity and recreational use of a site, particularly beaches and associated waters. Noise from pile driving, pumps and vehicular movements may also disturb users. Severance of amenity resources may occur across the course of the outfall.

4.1.3 Conservation

The course of the pipe laying works and access roads may pass through sites of conservation interest, such as sand dunes, saltmarshes and bird roosting or feeding sites. There may be direct damage of such sites or disturbance through noise and intrusion. Compaction of coastal margins by heavy machinery may lead to a loss in soil stability and structure and increased rates of erosion.

4.1.4 Fisheries

Construction operations may interfere with commercial shellfisheries, netting or potting activities and recreational angling.

4.1.5 Flood defence.

There may be a requirement to temporarily breach coastal defences during construction with an associated loss of protection.

4.2 End state/Operational impacts

4.2.1 Water quality

The receiving waters of the discharge will be the subject of Surface Water Quality Objectives with associated Environmental or Water Quality Standards which the NRA will require to be maintained at all times. More rigorous standards will be applied to waters designated as bathing beaches (under the EC Directive on bathing water quality 76/160/EEC), shell fisheries (under the EC Directive on the quality required shellfish waters 79/923/EEC) and 'sensitive' waters (under the EC Urban Waste Water Treatment Directive 91/271/EEC). Particularly where the outfall is designed to receive industrial discharges, standards may be applied with respect to compliance with the Dangerous Substances Directive (76/464/EEC) and the Titanium Dioxide Directive (78/176/EEC).

For sewage, the major parameters of concern are likely to include the following.

i. **Bacteria and viruses** - Sewage effluents contain a high level of microbial contamination of potential risk to human health. The viability of commercial shellfisheries may be affected by microbial contamination.

ii. **Solids** - Faecal solids, grease balls, condoms and sanitary towels in a discharge represent potential aesthetic, amenity and health risk problems. These and other 'litter' items may also represent a hazard to wildlife. A localised build up of solids in the vicinity of the outfall may alter the benthic community.

iii. **Dissolved oxygen demand** - Sewage discharges generally have a high biochemical oxygen demand and may thus cause a depression in dissolved oxygen levels in the receiving waters with implications for benthic and pelagic organisms.

iv. **Ammonia** - Sewage discharges generally contain high concentrations of ammonia with implications for benthic and pelagic organisms. Ammonia also contributes to nutrient loads.

v. **Nutrients** - In the marine environment nitrogen (often measured as total inorganic nitrogen) is usually the nutrient limiting algal and other plant growth and the principal cause of marine eutrophication. Algal blooms may have aesthetic, toxic and other water quality effects.

vi. **Heavy metals and organics** - Sewage discharges may contain elevated concentrations of heavy metals and organic chemicals, depending on the 'catchment' of the discharge. These may have implications for benthic and pelagic organisms either directly or through sediment and bioaccumulation pathways.

vii. **Other contaminants** - there may be elevated concentrations of other contaminants (e.g. oil) depending on the 'catchment' of the discharge. Again, these may have implications for benthic and pelagic organisms. Where disinfection of discharges occurs, residual products may arise which may themselves have water quality impacts.

For outfalls receiving storm sewage the nature of the discharge will be related to flow and recent weather conditions, and the catchment of the discharge. For industrial outfalls the parameters of concern will relate to the particular industries.

4.2.2 Amenity

The outfall may be visually obtrusive where its structure and or associated buildings such as pumping stations are above ground level. Pumping operations may cause noise disturbance. Solids originating from the discharge will have an obvious detrimental impact.

4.2.3 Recreation

Bacterial and aesthetic water quality may potentially limit recreational activity. In addition, the completed outfall structure may potentially represent a hazard to water users if exposed from the sediment. Exposed pipelines running across beaches may also cause severance of the beach.

4.2.4 Conservation

The discharge may affect the ecology of the receiving waters through physical smothering by settling solids and other water quality impacts. In addition, the ecology may be affected by localised changes to substrates (including the outfall structure) and flow patterns.

4.2.5 Fisheries

The discharge could potentially alter the quality of fish and shellfish through water quality effects. However, under Asset Management Plan 2 (AMP2) guidance a discharge should not alter the existing classification under the Shellfish Hygiene Directive.

4.3 Decommission

The outfall may have a relatively limited design life (40-50 years). The subsequently fate of the pipeline should be considered as it may continue to represent an obstructive hazard.

5. Mitigation measures

The NRA may require certain mitigation measures to reduce the impact of the scheme. These may be subject to certain timing constraints.

- **Water quality** - The suitable siting and design of outfalls for adequate dispersion should reduce the impacts of microbial and other contamination on water quality and inshore use. The survival of microbial organisms generally reduced by prolonged exposure to light and sea water. Bacterial contamination may also be reduced by disinfection, although the impact of the disinfection process should be considered. Solids may be reduced by suitable primary treatment and screening in the head works.

- **Amenity** - The construction operation should be restricted to a time of low beach use, e.g. outside of the summer months. Visual intrusion and severance should be reduced by laying the pipeline below the ground surface as much as possible. The use of screens and treatment of storm sewage to remove solids will reduce litter and other aesthetic impacts on amenity.

- **Recreation** - Construction operations should be concentrated at times of low beach use (although outside of the such periods weather conditions may hamper construction works. Collision and other snagging hazards should be reduced by laying the pipeline below the beach surface.

- **Conservation** - The construction operation should endeavour to minimise or avoid noise, vehicular movements and other forms of disturbance during seasons and/or times of the day when affected sites are important for bird roosting or feeding.

- **Fisheries** - Water quality standards should be adequate to have a minimal impact on fisheries. Pipelines should be laid below the beach surface to reduce the snagging of nets and other fishing gear.

- **Flood defence** - The breaching of coastal defences should be of a minimal duration and conducted at a time of low flood risk, e.g. neap tides in summer.

6. Baseline surveys

Early consultation with the NRA (and others) and a literature review should identify sensitive areas such as important bathing areas, shell fisheries, fisheries and 'sensitive' waters under the terms of the Urban Waste Water Treatment Directive (UWWTD). Such exercises will also identify the less sensitive High Natural Dispersion Areas under the UWWTD. The NRA should provide the promoter of the outfall with details of data held by the Authority. The NRA will generally insist on further baseline information and surveys, with requirements specified with respect to timescales and recommended methods. Tidal patterns should be identified by tracer studies, use of drogues etc. There should be modelling of tidal flow dispersion. Sediments should be characterised in the proximity of the discharge and along dispersion routes. Ecological studies should be carried out to characterise the ecology along the course of pipeline, in the vicinity of the discharge and along dispersion routes. Seasonal and diurnal bird counts may be required.

Surveys undertaken should include:

- assessment and modelling of input budgets and loadings;
- hydrographic surveys and the assessment of tidal patterns;
- bathymetric surveys;
- assessment of meteorological data;
- dispersion surveys and modelling of tidal flow dispersion;
- characterisation of sediments in the proximity of the discharge and along dispersion routes; and
- ecological surveys along the course of pipeline, in the vicinity of the discharge and along dispersion routes.

7. Monitoring and audit

Monitoring should be conducted to assess the impacts of the outfall, both from the discharge itself and from outfall construction. Such monitoring should be relevant to predicted impacts and any mitigation works.

8. References

The number and volume of outfall discharges in a given area will be limited by the assimilation capacity of the receiving waters.

Cooper, V.A. and Thompson, M.J. (1989) Effects of sea outfalls on the environment. Foundation for Water Research. Report Nº FR 0031.

Construction Industry Research and Information Association (1994) *Environmental Assessment*.Special Publication 96. CIRIA, London.

Neville-Jones, P.J.D. and Dorling, C. (1986) Outfall design guide for environmental protection. WRc Report Nº ER209E.

Nixon S.C. (1990) Effects of sea outfalls on the environment - executive summary report. Foundation for Water Research Report Nº FR 0093.

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF POINTS OF LARGE ABSTRACTION

1. Introduction

This guidance note seeks to identify the potential impacts of large abstraction points upon the water environment. It is intended to form the basis for a scoping brief to cover the concerns of the National Rivers Authority (NRA) in the environmental assessment or appraisal of proposed large abstractions. The NRA has an interest in abstraction proposals due not only to its responsibilities for water resources and as a licensing body, but also due to responsibilities for water quality, fisheries, conservation, navigation and recreation. In order to comment on applications for abstraction licences the NRA will usually require an environmental report (ER) with information from environmental studies on the potential impacts of abstraction. Responsibility for these studies lies with developer. The ER may be in the form of an Environmental Statement. The conclusions of the ER will require proper justification and if required the raw data upon which these are based should be accessible.

Informal discussions with the NRA prior to environmental studies and licence application will ensure that the ER addresses the NRA concerns. Early contact will also enable the identification of environmental factors constraining permissible abstraction and mitigation measures that may be appropriate.

2. Development control

The construction at abstraction points of pump houses, boreholes etc. may require planning permission under the Town and Country Planning Framework. Abstraction points are not subject to formal Environmental Assessment (EA) in connection with planning applications, although environmental information may be required by local planning authorities. However, formal EA may be required for associated schemes, such as reservoirs, as set out in government guidance (e.g. DoE/WO 1989).

3. NRA licences

Under the terms of the Water Resources Act 1991, an abstraction licence is required from the NRA for all significant abstractions. Where abstraction is combined within impoundment of a watercourse an impoundment licence is also required. Guidance on abstraction licensing may be found in the NRA leaflet *Abstraction Licensing and Water Resources*.

Section 32 consents will be required in advance of groundwater abstraction, to authorise the construction and test pumping of boreholes, wells or any other works intended for abstracting water (see NRA leaflet *Searching for groundwater*).

The NRA is also the body responsible for:

land drainage consents - required for any works on the bed and banks of a river or construction of any structure likely to impede the flow (e.g. pump houses on a riverbank); and

discharge consents - for discharges to inland surface and groundwaters, and to coastal waters. Non-consumptive use of abstracted water may result in a discharge subject to consent.

Consent is also required for the introduction of fish to impoundments.

4. Major potential impacts

4.1 Construction impacts

The construction of boreholes, intakes and pump houses may cause localised damage to soil and vegetation in the area of construction and access roads. Bankside activities may lead to bank instability and erosion. The use of construction materials, e.g. cement, may pollute waters. Pollution may arise from leakage from machinery, on-site fuel and chemical stores, latrines and slurry lagoons.

Drilling may affect groundwater quality and drilling fluids or cutting may cause pollution of surface waters if discharged. Also, discharges of "clean" water from test pumping of boreholes may have impacts, primarily on the hydrology of receiving streams.

Impacts arising from the construction of impoundments are discussed in separate guidance (on reservoirs).

4.2 Impacts of operation/abstraction

The major impacts of abstraction upon the aquatic environment may relate to direct effects on groundwater and surface waters from their abstraction resulting in reduction in groundwater levels and river flows respectively. More indirect effects may also occur, for example groundwater abstraction may lead to reduced flows in spring-fed streams.

Water supply - Abstraction can potentially affect the availability of water for other users. These may include others with the 'protected right' to abstract water themselves. New abstraction may affect the availability and derogate from existing abstraction rights.

Water quality - Due to the lack of river flow, and hence mixing and dilution of pollution, there may be a relative increase in the impacts of pollution. The problems of pollution may be exacerbated by reduced aeration in less turbulent river flows and higher summer water temperatures. The NRA will be anxious that changes in the concentration of pollutants, dissolved oxygen and water temperature do not compromise Environmental Quality Standards, ascribed to the watercourse or water body. Reduced flows and higher concentration of plant nutrients, particularly phosphates, may result in prolific plant and algal growth. Aside from effects on aesthetic and ecological quality, such growths may alter water quality through changes in pH, biochemical oxygen demand (BOD) and dissolved oxygen levels. Raised pH levels during periods of intense photosynthesis may affect the toxicity of chemicals such as ammonia. Algae may also produce toxins under certain conditions.

Reduced river flow in tidal areas may result in the increase penetration upstream of saline water, affecting water quality and river/estuarine ecology. Similarly, groundwater abstraction in coastal areas may result in saline intrusion into aquifers. Likewise, abstraction of groundwaters in the vicinity of contaminated land may draw in pollutants water.

Fisheries - Fish habitat may be affected by reductions in river flow itself and by reductions in the depth and wetted width of rivers. In shallower water, fish will be particularly vulnerable to predation, angling and poaching. Fish may also be stranded by sudden changes in water depth due to intermittent abstraction. Reductions in water quality may seriously affect fish survival. In addition, fish may be more vulnerable to parasites and disease. Reduced river or estuarine flows may act as a barrier to fish migration, thus preventing access to both spawning grounds and exploitation by anglers upstream. Also, where headwater areas of streams are particularly important spawning and nursery areas, direct abstraction or abstraction of connected groundwaters may affect the survival of fish eggs laid in gravels from dewatering and reduced through-gravel flow. Gravels may also be affected by increased siltation rates arising from reduced river flow.

Aquatic ecology - Aquatic life other than fish may also be affected by changes in water quality, depth, and wetted width. Whilst algae and some plants may benefit from low flow conditions other species of plant and fauna may be affected by blankets of weed covering the river bottom, reducing the quality of the substrate, or blooms of planktonic forms affecting water quality. Reductions in water quality including may also affect dogs and livestock that may drinking the water. Whilst predators such as kingfishers and otters may benefit from the increased vulnerability of prey, this will not be sustainable in the long term.

Fish and other aquatic life may suffer from entrainment at the point of abstraction.

The noise and vibration of pumps may disturb wildlife (and other river users).

Wetlands and other riparian habitats may be affected by reduced water table levels arising from groundwater abstraction (and, more rarely, reduced river flow). Many wetland and riparian species require wet conditions created by a high water table. Agricultural production may also be affected.

Navigation, recreation and amenity - Significant reductions in river flow may affect navigation, there being insufficient depth of water for the passage of boats. The amount of water in locks may constitute a substantial element of river flow. Other recreational use of waterways may be affected by reduced flows, e.g. canoeing and angling. Water quality deterioration, e.g. algal blooms, may create unpleasant conditions for water-based recreation.

The amenity value of rivers or lakes may be affected by abstraction, due to the reduced flow itself and the increased visibility of pollution, algal and plant growths. Severely reduced water depth may result in extensive areas of exposed substrate that may be unsightly. The total absence of flow in spring-fed systems will seriously affect the amenity value of these systems and the landscape. Construction and operation of abstraction devices and pumps may affect amenity use.

Heritage and archaeology - Reductions in groundwater levels may affect the foundations of buildings of archaeological or other heritage interest.

River geomorphology - Increased river flows and altered flow regimes may result in altered geomorphology of watercourses, arising from altered sedimentation and erosion patterns.

5. Mitigation measures

The proposed abstraction should avoid sensitive areas such as:

- lakes, wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable fisheries;
- contaminated land; and
- upland areas of catchments with particular sensitivities.

Ideally, new developments with high abstraction demands should be planned for areas where water supplies are more plentiful and abstraction is less likely to have serious impacts on supplies.

Also, impacts may be reduced by avoiding unnecessary abstraction and restricting abstraction to certain times of year, e.g. wetter winter months, thus avoiding periods of natural low flow. The impacts of abstractions in tidal areas may be reduced by restricting abstraction to certain states of the tide. Where seasonal restrictions are imposed or desirable, the construction and use of storage areas may reduce water demands in more sensitive periods.

Alternative sources of water from less sensitive areas may be available for use to compensate for abstraction or to provide an alternative supply. However, compensation flows from alternative sources may have impacts relating to the mixing of different types and the transfer of species.

Impacts from groundwater abstraction on wetland areas may be reduced by pumping water directly onto key wetland areas to raise flows and water levels.

During construction of intakes, pump houses etc., chemicals, fuel and oil should be suitably stored in areas away from watercourses with adequate bunding should spillage occur. Drip trays should be used with pumps and other such machinery to catch leaking oil. Particular care should be taken handling cement or pouring concrete near watercourses. The risk of pollution from vandalism and theft should be reduced by using tamper proof valves, adequate fencing and security. If pollution of any sort does occur, the NRA should be notified immediately and prompt action taken to minimise effects. Site sewerage and waste disposal arrangements should be adequately considered. Boreholes should be constructed with suitable casings, grouting, and plugging (as necessary) to avoid contamination of groundwaters.

Abstraction points should be adequately screened (physically) to minimise losses of fish and other life through impingement and entrainment. Systems employing warning stimuli from air bubbles, light, electricity, water velocity and pressure changes may be appropriate to reduce fish losses. Solomon (1992) discusses intake designs in more detail.

6. Baseline information

To ascertain the impact of abstractions baseline information on the following surveys may be required using approved methods and timing:

- groundwater resources (including hydrogeology);
- surface water resources (including hydrology);
- water quality;
- river corridor surveys - wildlife conservation;
- fisheries;
- aquatic biology;
- landscape/amenity;
- recreation;
- modelling of tidal/river flow; and
- geomorphology.

Some of the information may be available from the NRA and other sources. However, surveys may be required to gather the remaining information. The NRA will generally not release information on existing rights, which will be used along with the ER to decide on the application.

7. Monitoring

Monitoring of volumes abstracted may be a condition of the licence. Other monitoring, relevant to the predicted impacts and remedial/mitigation works, may be recommended.

8. References

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to the procedures*. HMSO, London

Drake, P.J. and Sherriff, J.D. F. (1987) A method for managing river abstractions and protecting the environment. *Journal of Water and Environmental Management*, 27-38.

National Rivers Authority (1994) Abstraction Licensing and Water Resources. A brief guide for potential abstractors. NRA, Bristol.

Solomon, D.J. (1992) Diversion and Entrapment of Fish at Water Intakes and Outfalls. NRA R&D Report 1. HMSO, London.

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF POINTS OF LARGE DISCHARGE

1. Introduction

This guidance note seeks to identify the potential impacts of large discharge points upon the water environment. It is intended to form the basis for a scoping brief to cover the concerns of the National Rivers Authority (NRA) in the environmental assessment or appraisal of proposed large discharges. The NRA has an interest in discharge proposals due not only to its responsibilities for water quality and as a licensing body, but also due to responsibilities for water resources, fisheries, conservation, navigation and recreation. In order to comment on consent applications for large discharges the NRA will usually require an environmental report (ER) with information from environmental studies on the potential impacts of the discharge. Responsibility for these studies lies with developer. The ER may take the form of an Environmental Statement. The conclusions of the ER will require proper justification and if required the raw data upon which these are based should be accessible.

Informal discussions with the NRA prior to environmental studies and applications for consent will ensure that the ER addresses NRA concerns. Early contact will also enable the identification of environmental factors constraining permissible discharge and mitigation measures that may be appropriate.

Separate guidance to this note is available on long sea outfalls.

2. Development control

The construction of associated infrastructure pump houses, outfalls etc. may require planning permission under the Town and Country Planning Framework. Discharge points are generally not subject to formal Environmental Assessment (EA) in connection with planning applications, although environmental information may be required by local planning authorities. However, formal EA may be required for developments that are the source of the discharge. Indeed, government guidance (DoE/WO 1989) on assessing the need for EA in certain developments, includes a criterion on discharges, i.e. "whether the project is likely to give rise to particularly complex or adverse effects, for example, in terms of the discharge of pollutants".

Under the Food and Environmental Protection Act (FEPA) licences are required from the Ministry of Agriculture, Fisheries and Food (MAFF) or the Welsh Office) for work below Mean High Water Spring.

3. NRA licences

A discharge consent will be required from the NRA for discharges of sewage or trade effluent to "controlled waters" (i.e. inland surface waters, coastal waters and groundwaters). The NRA's approach to consenting discharges is set out in the report *Discharges Consents and Compliance - the NRA's approach to control of discharges to water* (NRA 1994).

The NRA is also the body responsible for:

land drainage consents - required for any works on the bed and banks of a river or construction of any structure likely to impede the flow; and

abstraction/impoundment licences - for abstracting or impounding waters.

Discharges from certain industries or "prescribed processes" under Integrated Pollution Control will require consent from Her Majesty's Inspectorate of Pollution (HMIP) under the terms of the Environmental Protection Act 1990.

4. Major potential impacts

4.1 Construction impacts

The construction of outfalls and pump houses may cause localised damage to soil and vegetation in the area of construction and access roads. Bankside activities may lead to bank instability and erosion. The use of construction materials, e.g. cement, may pollute waters. Pollution may arise from leakage from machinery, on-site fuel and chemical stores and latrines.

4.2 Impacts of operation/discharge

The major impacts of discharges upon the aquatic environment will include and stem from changes in the quality and levels or flow of groundwater and surface waters. Large discharges will primarily be point discharges to surface waters. Therefore this note does not discuss diffuse discharges and those to land.

Water quality - The potential impacts of a discharge on the quality of the receiving water will be related to the relative quality and volume/flow of the discharge to the receiving water. The NRA will ensure, through its consenting procedures, that the discharge does not adversely affect water quality and damage the environment.

A major potential impact on water quality is that water quality objectives ascribed to a watercourse or water body potential may be compromised if water is polluted by a discharge and becomes unfit for certain uses, e.g. drinking water, recreation. Water resources and downstream users may also be affected by pollution. Also, of major concern will be the ecological impacts of pollutants. Some of the impacts of specific types of pollutants are indicated below.

Plant nutrients such as phosphates and nitrates may cause eutrophication and the prolific growth of algal and plants. Algal blooms may be particularly problematic, as they may produce toxins and other chemicals affecting water quality, unsightly scums may form, other species may be outcompeted by the algae, and the collapse of blooms may lead to deoxygenation of water through algal decay. Intense photosynthetic activity from plants and algae can change the chemical nature of the water through pH and associated effects.

Organic material is characterised by a high BOD (Biochemical Oxygen Demand), organic pollution can have a serious deoxygenating effect, thus potentially harming fish and other life. Sewage effluents typically contain organic material, ammonia and suspended solids.

Ammonia may be directly toxic, particularly to fish, and have a deoxygenating effect from its chemical transition to nitrate. Increased nitrate levels may stimulate plant and algal growth.

Suspended solids can have a direct effect from abrasion and smothering. Indirect effects include reduced visibility of prey, increased attenuation of light and reduced plant growth, and alteration of substrate characteristics through sedimentation. Sedimentation within gravels used by salmon and trout may affect the survival of eggs and therefore fisheries.

Acidity/alkalinity is measured as pH. This can have direct effects on life or more indirect through changing water chemistry. The toxicity of certain chemicals, e.g. ammonia and aluminium, may be strongly influenced by pH levels.

Cyanide is very toxic to fish and other aquatic life.

Metals such as cadmium and zinc may be toxic to aquatic life. Metals may persist in the environment by accumulating within organisms in food chains (bioaccumulation) and in sediments.

Pesticides are particularly toxic to target and related species or species groups. Pesticides, particularly organochlorines, may be particularly persistent and bioaccumulate within foodchains.

Thermal discharges may be lethal due to temperature changes raising the ambient temperature above the limits that are tolerated by particular organisms. Indirect effects may occur through changes in water chemistry and stratification of water bodies.

Changes to aquatic life may affect other organisms, e.g. otters and kingfishers may be seriously affected by the loss or contamination of fish.

Water flow - Large discharges may substantially increase river flow and generally alter the flow regime/hydrology of receiving waters. This may have direct effects on river ecology, with a switch to more flow tolerant species. Shallow water habitats may be lost. Raised water levels may affect riparian flora and fauna. Changes in water table level may arise, altering adjacent land use (e.g. agriculture) and wetlands.

Sediment transport patterns may change leading to changed substrate quality and general river geomorphology.

Increased flow in rivers may reduce the penetration of saline water into estuaries, thus affecting estuarine ecology.

Migratory fish may alter their behaviour as a result of flow changes. Fish may also be attracted to the points of discharge and attempt to enter discharge outlets.

Flood defence - Increased water depth and flow may cause downstream areas to have an increased risk and frequency of flooding.

Amenity - The colour, flow, odour and presence of litter and other debris may be aesthetically displeasing and reduce the amenity value of a receiving water.

Recreation - Changes in flow, and the presence of bacteria, litter, algal growth may compromise recreational use, e.g. water contact sports may be particularly unpleasant or banned by health authorities in polluted waters. Changes in water depth, flow and fish species may affect angling quality.

Navigation - Increased water depth may benefit navigation and particularly canoeing.

Heritage and archaeology - Raised groundwater levels may affect the foundations of buildings of archaeological or other historic interest. The discharge may cause visual disturbance.

River geomorphology - Increased river flows and altered flow regimes may result in altered geomorphology of watercourses, arising from altered sedimentation and erosion patterns.

5. Mitigation measures

The proposed discharge should avoid sensitive areas such as:

- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable (or potentially valuable) fisheries; and
- upland areas of catchments with particular sensitivities.

The impacts on water quality may be reduced by improved treatment before discharge, e.g. by using treatment works, settling lagoons, reed beds etc.

The impacts of water flow may be mitigated by reducing the volume of discharges, by utilising on-site recycling systems and flow regulation of intermittent discharges using balancing lagoons.

Discharge outlets should be designed so as to discourage the entry of migratory fish. Solomon (1992) has produced some relevant guidance.

During construction of discharge outfalls, pump houses etc., chemicals, fuel and oil should be suitably stored in areas away from watercourses with adequate bunding. Drip trays should be used with pumps and other such machinery to catch leaking oil. Particular care should be taken handling cement or pouring concrete near watercourses. The risk of pollution from vandalism and theft should be reduced by using tamper proof valves, adequate fencing and security. If pollution of any sort does occur, the NRA should be notified immediately and prompt action taken to minimise effects. Site sewerage and waste disposal arrangements should be adequately considered.

6. Baseline information

To ascertain the impact of large discharges, baseline information on the following may be required using approved methods and timing:

- water quality;

- water resources;
- hydrology;
- river corridor surveys - wildlife conservation;
- fisheries;
- aquatic biology;
- amenity/landscape;
- recreation; and
- geomorphology.

Some of the information may be available from the NRA and other sources. However, surveys may be required to gather the remaining information.

7. Monitoring

Monitoring of the rate and quality of the discharge may be a condition of the consent. Other monitoring, relevant to the predicted impacts and remedial/mitigation work, may be recommended. .

8. References and general guidance

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to the procedures*. HMSO, London

Department of the Environment/Welsh Office (1991) *Integrated Pollution Control: A practical guide*. HMSO, London.

Fraser, J.C. (1972) *Regulated discharge and the stream environment*. In: Oglesby *et al.* (eds) *River Ecology and Man*, pp263-286. Academic Press, New York.

Hawkes, F.B. (1974) Heated discharges from thermal power stations. *Effluent Water Treatment Journal*, **14** No.10, 549-559.

National Rivers Authority (1994) *Discharges Consents and Compliance - the NRA's approach to control of discharges to water*. Water Quality Series No. 17. HMSO, London.

Solomon, D.J. (1992) *Diversion and Entrapment of Fish at Water Intakes and Outfalls*. NRA R&D Report 1. HMSO, London.

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF SEWAGE TREATMENT WORKS (EXTENSION AND INSTALLATION)

1. Introduction

This guidance note seeks to identify the potential impacts of sewage treatment works (STWs) upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of STW schemes. The NRA has an interest in STWs, particularly due to potential impacts on water quality, water resources, flood defence, fisheries and conservation.

EA may be formally required for new STWs. Where EA is not formally required, it may still be a useful process to convey environmental information to interested parties such as the NRA. The responsibility for obtaining information and/or environmental assessment lies with the developer. There are distinct advantages to contact the NRA and conduct environmental studies well in advance of the proposed development, such that environmental constraints can be identified and avoided and appropriate mitigation can be designed into the planned development. The developer should be able to demonstrate a reasonable consideration of alternatives.

Other NRA guidance notes have been produced for various other development types, and may be relevant, particularly those on general construction, points of large discharge, sea outfalls, waste disposal facilities and pipelines. In addition, guidance on the NRA's approach to the aspect of discharge consents (NRA 1994) may be useful.

2. Development control

Development control of STWs will be through the Town and Country Planning system. Under the recently consolidated General Development Order, the NRA are statutory consultees for development relating to the sewage treatment or disposal and development for sludge disposal.

3. Environmental Assessment

Local Planning Authorities will require EA for proposed STWs where significant impacts are expected as STWs are Schedule 2 projects under the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No. 1199). Schedule 2 includes "a waste water treatment plant" under which most STWs may be expected to fall. Sludge disposal may also require separate EA, "a site for sludge deposition" being a further category under Schedule 2. Guidance on the need for EA for STWs in the context of permitted development is provided by Department of the Environment Circular 3/95 (Welsh Office 12/95).

4. NRA licences

It will be necessary to obtain the following authorisations from the NRA:

- **discharge consent** - for discharges to inland surface and coastal waters, and groundwaters; and

- **land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

The NRA may also require **abstraction** and **impounding licences** where these are applicable. Breaches of licence or consent conditions and pollution of surface and groundwaters may result in criminal proceedings.

5. Major potential impacts

Primarily the NRA will be concerned about impacts affecting water quality, water resources, flood defence, fisheries, aquatic biology, conservation, recreation and amenity. In general, it will be necessary to demonstrate that none of the water quality objectives applied to watercourses are adversely affected during construction and operation of the plant. Impacts may arise from the construction of the works and associated infrastructure and in their operation.

5.1 Construction impacts

The guidance note on the impacts of general construction should be referred to as many of the issues arising in the construction phase of a new STW or the extension of an existing one are broadly the same as for other construction works. The construction of a STW will generally consist of inlet works connecting to the collecting sewerage system, screens, tanks for settlement and treatment, treatment systems, outfalls, sludge storage and treatment areas, and pumping stations. The laying of associated infrastructure such as power and water supply will generally also be required.

Land take - The general destruction of habitats and displacement or loss of species will result from land take.

Preparation of the working area and construction of buildings, roads and tanks - Site flora and fauna may be damaged through direct damage and through compaction and other physical disruption of the soil. The disposal of excavated soil may extend the area affected. Fauna that are dependent on trees and other vegetation may be affected, e.g. birds and bats may use trees as nesting or roosting sites. Bankside trees may also be used by otters and may also provide shade for rivers; tree loss may result in significantly increased river temperatures and plant or algal growth.

Increased runoff resulting from soil compaction and vegetation losses may result in increased river flows and therefore flood risk. In addition, groundwater may be affected by reduced infiltration of precipitation. Runoff and soil disturbance may lead to increased soil erosion with an associated increase in sediment load to rivers. High concentrations of suspended solids loadings reduce water quality with direct impacts on flora and fauna and the aesthetic appearance of a watercourse. In addition, sedimentation of solids will affect substrate quality for invertebrates and plants. Fish spawning areas may be particularly damaged by siltation, reducing egg survival.

Machinery and vehicles - The general operation of machinery and vehicles may contribute to problems of soil compaction and stability. Leaking or spilled fuel and oil from vehicles, machinery or storage areas may contaminate both groundwater and surface waters

River outfall - The use of machinery on the river bed or banks may result in a loss in bankside stability, and the loss of aquatic flora and fauna from physical damage. Losses may also result from water pollution, e.g. suspended solids and oil. The use of construction materials such as cement and concrete near to watercourses may also lead to pollution. Machinery and construction materials in the watercourse may represent a barrier to navigation and migrating fish, and may result in the loss of (recreational) access to the river. Flow patterns may be altered, leading to changes in channel geomorphology and loss of river substrates.

Coastal STWs and outfalls - Compared to inland works, coastal STWs connected to long sea outfalls may provide more limited treatment (e.g. screening and primary settlement) and be the headworks for the outfall. Construction of coastal STWs, headworks and outfalls may damage coastal habitats and disrupt recreational use, among other impacts (see guidance on long sea outfalls).

Pipe laying - New STWs and extensions to existing works may require new sewerage pipelines which is a permitted development not requiring planning permission (and EA). However, there may be impacts and reference should be made to separate guidance on pipelines for extensive works or work in sensitive areas.

5.2 Operational impacts

The NRA has a declared "no deterioration" policy which enforces any new discharge proposal. The following potential impacts will be taken into account in assessing consent conditions.

Discharge of treated effluent - The physical flow of the discharge may result in significantly altered stream hydrology with increased river flows and velocities, potentially causing bank degradation, erosion and other geomorphological changes. The net result may be increases in channel width and average suspended sediment load. High suspended solid loadings will reduce water quality with direct impacts on flora and fauna and also on the aesthetic appearance of a watercourse. Sedimentation of solids will in turn alter substrate quality for invertebrates and plants. Fish spawning areas may be particularly damaged by siltation, reducing egg-fry survival.

The chemical characteristics of the effluent itself will reflect the nature of the sewage "catchment", i.e. the relative proportion of industrial and domestic sewage, and treatment efficacy. Typically, organic waste, ammonia, phosphates and suspended solids may be expected from domestic wastes, with increasing contamination from heavy metals etc. from industrial wastes. The water quality of the receiving water may generally be directly affected by the quality of the effluent. Potential impacts may arise from: microbial contamination; an increase in suspended solids, debris and rubbish; chemical pollution; temperature changes; deoxygenation and nutrient enrichment. The fauna and flora may be impacted by the altered water conditions and as a result of growths or blooms of sewage fungus, algae and plants. The temperature of the effluent may be different to that of the river potentially causing thermal stress, stratification and ecological changes reflecting the altered temperature regime.

Discharges to watercourses may also result in adverse odour, foaming, other nuisances, health risks and degrade facilities for water users.

If upgrading works are being carried out at a STW, the quality of the receiving water should generally improve, leading to changes in aquatic communities and potential water uses.

Site runoff - Runoff from buildings, car parks etc. will further alter stream hydrology, increasing flows after rainfall, and reduce infiltration to groundwater.

Odour - Site processes such as cleaning screens and emptying tanks may result in odours which may present a nuisance.

Noise - Noise and vibration caused during construction (e.g. from piling and machinery) and during operations (e.g. from pumping and sludge activation) may disturb sensitive wildlife and recreational water use.

Visual - The STW may have negative effects on riverine or coastal landscapes.

Sludge disposal - A variety of impacts may arise due to sludge disposal (e.g. to land or incinerator) and may give rise to such as contamination of groundwater and surface waters. These are discussed more widely in separate guidance on waste disposal. On-site storage, handling and treatment of sludge may also lead to contamination of groundwaters and land. Odour problems at the STW may also be exacerbated.

Spillages and leakages - Sludge, oil, fuel or chemicals may lead to the contamination or pollution of both groundwater and surface waters.

6. Mitigation measures

The location and size of developments will be key factors in determining impact significance. Where possible, construction activities should avoid sensitive areas, such as:

- flood risk areas, e.g. floodplains;
- wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting or potentially supporting valuable fisheries;
- areas of conservation importance;
- contaminated land likely to lead to polluting runoff;
- vulnerable aquifers; and
- upland areas of catchments with particular sensitivities.

The **choice of treatment processes** for the proposed STW will have differing impacts, but will be dependent on a number of factors including the amount of land available and the capacity of the receiving waters to take effluent discharges. The NRA's primary requirement is compliance with consent conditions. However, where available land space permits, there may be net conservation benefits to use more extensive low energy design options such as percolating filters and reed beds. These options, and reed beds in particular, provide useful habitats for birds and other wildlife. Reed beds and finishing lagoons may also be effective treatment methods, improving the quality of effluent discharged.

Energy recovery, e.g. from sludge recovery should be considered.

The **timing** of activities should be such that sensitive periods, such as bird nesting and fish spawning seasons, are avoided, if possible. Where breeding/roosting/hibernating sites are inevitably going to be affected, access to these should be prevented prior to and during the relevant period.

Developers and their contractors should follow building regulations, codes of good practice etc., where these are applicable. Staff, including supervisors, should be made aware of risks of site activity to the environment. Dealing with the environmental impact of the site should be the responsibility of a designated manager, who should establish contact with local NRA staff at the earliest possible opportunity. Ideally, an environmentally qualified and experienced site supervisor will be employed to ensure the protection and enhancement of the environment.

Both **permanent and temporary land take** should be minimised and original habitat features maintained where possible. Opportunities to create suitable new habitat features should be considered.

The **storage and handling of soil** should be such that the area affected is minimised but the soil structure is maintained (i.e. avoid mixing topsoil with underlying material). Exposed soil/spoil mounds should be covered to reduce the runoff of silt. Imported material should be avoided as this may contain polluting substances or propagules of invasive plants that may rapidly spread through river corridors. Seeding of landscaped areas may (or may not) be appropriate with suitable seed. Borrow pits should not be excavated in sites of wildlife or other value. Opportunities to create wetland or other habitats should be considered.

Compaction of soils by heavy machinery should be minimised, particularly in sensitive sites, with the use of boards and other temporary supporting structures.

Bank instability should be mitigated by careful reinstatement of damaged parts and reinforcement of areas at risk.

Trees and other wildlife habitats should be retained. Opportunities should be sought to replant appropriate trees.

In-channel work should avoid periods of maximum disruption to relevant seasonal activities, i.e. navigation, fish spawning. Interruption to recreational access and navigation should be minimised, although public safety should not compromised. Methods of working should be used that minimise the extent of disturbance to the banks and bed of the river.

Where **culverting** is unavoidable, the bottom should be continuous with that of the natural stream to allow the uninterrupted passage of fish, and headroom should be maximised light entry and permit the passage of birds and mammals.

Adequate headroom and/or screening will also reduce flood risks

Access roads should avoid sensitive areas. Boards and temporary bridges may reduce soil compaction and other damage. Compounds, car parks and other areas associated with the site of construction should be carefully located to minimise any added impacts.

Chemicals, fuel and oil should be suitably stored in areas away from watercourses and drains with adequate bunding should spillage occur. Drip trays should be used with pumps and other such machinery to catch leaking oil. Particular care should be taken when pouring concrete or handling cement near watercourses. The risk of pollution from vandalism and theft should be reduced by using tamper proof valves, adequate fencing and security. If pollution of any sort does occur, the NRA should be notified immediately and prompt action taken to minimise effects.

Sewage and waste disposal arrangements should be adequately considered.

Noise and intrusion should be minimised and avoided at sensitive times, e.g. in the evenings where birds roost in adjacent sites.

Dust may be dampened down to reduce aerial transmission, but should not be washed into drains etc. Vehicle (wheel) wash facilities should be constructed with adequate containment and subsequent treatment of washings.

Runoff from the site should be contained where it may be polluting. Oil separators (interceptors) should be considered if oil is a likely pollutant. Isolation points designed into the drainage system may be useful to prevent pollution of watercourses where there are high risks of damage from spillages.

Outfall design should be such so as to encourage mixing. The installation of blockstone weirs may be acceptable as an aeration aid in rivers. Discharge points should not be placed where there is a risk of stagnation.

Back up/alarm systems should be installed in the event of process failure.

7. Baseline surveys

In order to ascertain the detailed impacts of a development, baseline surveys will generally be required, although some relevant information may be available from the NRA and other bodies. Surveys should be conducted at relevant times of year using recommended methods. The findings should highlight particularly sensitive sites, habitats or species.

In general, the NRA will require information on (from surveys or otherwise):

- river corridor survey (for wildlife conservation);

- aquatic biology;
- fisheries;
- water quality;
- hydrology;
- water resources;
- hydrogeology;
- landscape/amenity;
- recreation;
- river/estuary/coastal geomorphology; and
- archaeology.

8. Monitoring and audit

Monitoring to assess compliance with discharge consent conditions will be carried out by the NRA. A monitoring programme relevant to assessing predicted impacts and the success of mitigation works is recommended.

Audits of site management practices during construction may ensure that the construction techniques and practices proposed in the environmental assessment do not alter without due consideration for the environment.

9. General guidance and references

Construction Industry Research and Information Association (1994) *Environmental Assessment*. Special Publication 96. CIRIA, London.

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to the procedures*. HMSO, London.

Fehr, G. ad Jurging, M. (1993) EIA of sewage treatment plants - the importance of the assessment process and its impact on the official decision. *GWF - Wasser/Abwasser*, **134**, No.8, 474-481. (In German, English Summary).

National Rivers Authority (1994) Discharge Consents and Compliance: *The NRA's approach to control of discharge to water. Water* Quality Series № 17. HMSO, London.

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF LARGE RESIDENTIAL AND BUSINESS PARK PROJECTS

1. Introduction

This guidance note seeks to identify the potential impacts of large residential and business park schemes upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of such schemes. Where an EA is not required by the planning authority, this note should also be useful for voluntary EA and other environmental studies done in connection with the development.

It is the responsibility of the developer to carry out the EA and to present the results in an appropriate manner to address the questions raised by the NRA. Proper justification should be required for any conclusions and access may be required to the raw data to examine particular issues in more detail.

2. Development Control

New housing and business parks require planning permission and as such are approved by local planning authorities under procedures set out under the Town and Country Planning Act 1990. As the development comprises a number of smaller units, it is common for the concept to be approved by the issuing of outline planning permission subject to the design details being finalised at a later date. Hence, Environmental Statements (ESs) for such developments are frequently vague as a result of the rudimentary stage of project designs when they are prepared. However, it should still be possible to identify and address fundamental issues. Consultations will be necessary at a later stage to sort out details.

3. Environmental Assessment - The Regulations

An EA may be required for housing, business parks and other related infrastructure developments under the terms of SI 1988 № 1199. As their potential impacts upon the water environment are broadly similar, they are considered together.

DoE Circular 15/88 (WO 23/88) divides infrastructure projects into three main types:

- industrial estate developments;
- urban development schemes; and
- other projects, e.g. holiday village or hotel complex.

It suggests threshold criteria of size where an EA may be required. These vary according to project classification.

4. Interpretation of the Regulations

In practice, some confusion has arisen as to which category many infrastructure developments fall under as there is clearly scope for overlap between project categories and, consequently, uncertainty as to which thresholds to apply.

In addition, the thresholds are widely accepted as being very high. Developments below the size criteria can still have a serious environmental impact. Such is the detrimental nature of some infrastructure development projects on the aquatic environment that the NRA wish to be involved in the screening of projects. This would indicate whether an EA is required.

Location is an important factor and, in line with its general environmental duties, the NRA are likely to require an EA under the following circumstances:

- where valuable river, wetland or lakeland habitats are likely to be destroyed or impoverished;
- where the development may cause a decline in water quality or a breach in water quality objectives;
- for developments likely to have significant impact upon the availability of water resources or upon groundwater quality or quantity;
- for developments in the headwaters or for developments likely to cause a significant increase in flood risk; and
- developments necessitating modification to existing sewage treatment works.

5. NRA Licences

Housing developments and business parks are likely to require a combination of the following licences and consents from the NRA.

i. **Discharge consent** - for "trade effluent" which is likely to be contaminated, such as water draining from large car parks, lorry loading bays, fuel storage and filling areas. Consent will also be required for treated sewage effluent to a watercourse or soakaway. Main sewerage will have to be adequate to serve the development. Discharge consents may be required for vehicle washing and other cleaning activities, e.g. cooling waters and discharge from air-conditioning and refrigeration plant. The Prohibition Notice Procedure now applies under the Water Resources Act 1991, for surface water from housing and "clean" business parks.

ii. **Land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow. Local bylaws also forbid obstruction or infilling of the floodplain without consent.

iii. **Abstraction licence** - for all abstraction in excess of $20m^3$/day. Consent is also required for test boreholes and impoundments.

iv. **Impounding licence** - for any impounding of water, e.g. the creation of artificial ponds and lakes.

Land drainage and impounding licences must be obtained in advance of any construction, regardless of whether planning permission has been granted. Permission for abstraction and discharge must be obtained prior to operation.

6. Major Impacts

This note does not consider particular large-scale industrial developments or aspects of holiday villages/hotel complexes beyond the buildings themselves. Other guidance, e.g. on large industry and on golf courses may be appropriate. In addition, many construction issues may be covered in more detail by guidance on general construction.

Impacts on the aquatic environment may arise as a result of construction activities or due to the final development (operational). Business parks and other infrastructure developments are likely to incorporate a number of associated developments and activities. These are often neglected in EAs. Particular attention should be paid to such activities as they may have the most serious impacts upon the water environment.

The major impacts identified here relate to alteration in catchment responses to rainfall including loss of groundwater and aquifer recharge capacity; water quality and water resource implications; increased pressure on existing infrastructure (water supply and sewage disposal) and conservation and recreation issues (dependent upon the project location).

6.1 Associated activities

Business parks frequently comprise a number of separate developments and it is crucial not to neglect the impacts of associated developments such as:

- access roads;
- car parks;
- bridges;
- river diversions
- vehicle washing areas;
- lake infilling; and
- creation of lakes and ponds;

The impacts of some associated activities are outlined below whilst others are covered in separate guidance notes. It is important to be aware of specific impacts which result from separate activities, e.g. vehicle washing areas draining to the surface water system will be prohibited by the NRA, unless adequate treatment facilities are provided.

a) River diversion

A river is a dynamic system and, if disturbed, will try to regain equilibrium, leading to a change in the erosion and deposition patterns. Any physical alteration to river channels such as meander removal, regrading or river diversion will have long-term effects upon channel geomorphology, downstream flooding, flora, fauna, fisheries and landscape.

In line with its conservation duties, the NRA seeks to promote river corridors as a valuable resource and must be involved at the earliest stages in any proposed diversions.

b) River crossings, bridges and embankments

Insensitive design or the inappropriate location of river crossings may constrict river flow, increasing flood risk. Bank instability may result from rivers undermining such structures. The NRA has a presumption against culverting, and would wish to set design criteria for river crossings, bridges and embankments so that they do not detract from the river environment or pose a flood risk.

6.2 Construction impacts

One or a combination of the following related construction activities may have a significant effect upon the water environment. The timing of construction relative to the bird nesting season and salmonid migration is often crucial. The following list is illustrative rather than definitive.

Activity:	**Bankside tree removal**
Impacts	loss of bird and bat nesting/roosting sites
direct	loss of bank stability increased water temperature due to loss of shading increased light leading to algal problems loss in landscape and amenity value.
Activity:	**Stripping of topsoil and loss of surface cover**
Impacts	increased soil erosion
direct	increased sediment load in rivers altered infiltration increased runoff
indirect	effects upon aquatic flora and fauna effects upon fisheries and angling.
Activity:	**Bad practice in the disposal of spoil, chemicals and containers** **Care not taken with oil handling** **Cement poured in or near watercourses and groundwater** **Discharge of water from dewatering operations** **Work near or in operational sewers**
Impacts	pollution of watercourses and groundwater

direct	blockage of watercourses by debris leading to flooding
indirect	effects upon aquatic flora and fauna effects upon fisheries, angling and recreation.

Activity:	**Compaction of river banks by heavy machinery;**
Impacts	loss in bank stability
direct	destruction of soil structure destruction of bankside flora.

Activity:	**Noise, intrusion**
Impacts	disturbance to river fauna
direct	outward migration of sensitive species.
Activity:	**In-channel work**
Impacts	disturbance to wildlife (feeding/mating)
direct	barrier to migrating fish loss of access to the river (recreation) loss of river substrate changes to channel geomorphology sediment resuspension leading to water quality problems.

6.3 Operational impacts

a) Infrastructure requirements - Third party discussions

New housing and industrial developments place an increased demand upon the existing infrastructure and efforts should be made to ensure that the appropriate facilities are available to accommodate future water supply and sewage disposal. The appropriate water supply and sewage disposal companies should be contracted to obtain this information and to provide them with sufficient time to phase any necessary projects. Combined Sewer Overflows may operate with increasing frequency causing water quality problems in receiving waters.

If new development necessitates the initiation of additional water resources projects, then the matter becomes in NRA concern. In keeping with its duties to manage water resources, the NRA would not wish developments to be occupied until a water supply source could be found which had no adverse effect on the environment.

b) Site drainage

The site drainage characteristics are likely to change as a result of increased runoff from paved areas, roofs and drained landscaped areas which may:

- alter the catchment response to rainfall; and
- change the surface water flow characteristics.

Existing watercourses and lakes should not be subject to adverse impact from the predicted stormwater runoff. The source control measures should be applied wherever possible, including swales, infiltration systems and balancing ponds where appropriate. Such ponds should be off-line.

c) Surface water quality implications

Surface water quality is likely to be reduced as a result of pollution from a number of disparate sources, for instance:

- contaminated road and surface runoff (salt, soil and debris);
- increased risk of spillage or pollution incidents;
- sewage disposal;
- redevelopment of any contaminated land; and
- any other consented discharge.

d) Groundwater implications

Groundwater may be affected by reduced recharge from the surface or pollution from pollutant seepage into groundwater including that from the sources above and from incorrectly located or designed soakaways. Groundwater levels may also be affected. Attention should be paid to groundwater levels in any excavations.

e) Flood defence

Flood defence concerns may arise as a result of the development itself either being sited in a vulnerable location with insufficient protection (e.g. on a river floodplain) or exposing other properties to an increased flood risk. This may occur as a result of reduced infiltration rates and increased surface runoff. Urbanisation of a catchment will produce a more "peaky" hydrograph after a rainfall event. Thus, development in the headwaters of a catchment is likely to increase flood risk for downstream properties.

It is contrary to NRA policy to provide flood defence to facilitate new developments. However, in some cases, it may be acceptable for the developer to carry out appropriate flood protection himself, bearing in mind the need to minimise and mitigate fully any adverse environmental impacts. Source control is to be encouraged wherever possible. Agreements may be made under Section 106 of the Town and Country Planning Act 1990.

Flood defence issues are likely to arise as a result of:

- an altered catchment response to rainfall;
- developments having an effect upon the integrity of existing river or coastal defences;
- development in the floodplain, washlands or coastal areas; and
- river diversion or any blockage or impediment to flow.

f) Conservation and wildlife

Direct loss of habitat will result if river corridors or lakes are destroyed. Increased noise and disturbance may have an effect upon wildlife as will changes in water quality. Potential disturbance of new habitats may result from increased visitor pressure and recreation activities occurring as a result of the development.

g) Archaeology

Excavation in river floodplains or river diversions may uncover archaeological remains. Arrangements must be made to contact the County Archaeologist to establish any risk of damage and the need for the removal or preservation of any findings.

7. Mitigation measures

Measures which should be taken to mitigate adverse effects will have to be discussed with reference to the project in question. The NRA may issue relevant Pollution Prevention Guidelines which should be followed. Guidance on the control of highway drainage (Luker and Montague 1994) may also be relevant. In general, the following principles apply.

a) Drainage

Refuse, litter and other waste should be stored in designated areas.

All storage areas should be roofed. Uncontaminated roof water should be kept separate from surface runoff and drained to a soakaway, if possible, or a watercourse.

Areas designated for handling "abnormal materials" (i.e. potentially polluting materials such as milk or pesticides) should be drained to the foul sewer via a grit trap.

Car parks should be drained to the surface water system via an adequate oil separator (interceptor) where there is a moderate to high risk of oil pollution. Operation and maintenance of such devices should be agreed in advance. (The NRA may require other surface water to be discharged via an adequate oil separator (interceptor)).

Where combined drainage systems are proposed, there should be some certification that all foul connections have been correctly made.

The NRA may require the discharge of surface water to be controlled to a "greenfield rate" by provision of attenuation ponds. These may also be designed to provide treatment where necessary.

b) Balancing ponds

Balancing ponds are a common mitigation measure. Balancing ponds should be off-line (instream ponds may alter stream ecology including the proliferation of algae). Such ponds can serve a variety of functions including the following.

i. **Water quality** - They may provide a primary treatment for surface runoff by allowing for the settlement of suspended solids.

ii. **Flood defence** - They may provide flood storage areas.

iii. **Groundwater Recharge** - They may provide groundwater recharge which helps to support river baseflows.

iv. **Conservation**- If suitably designed and maintained, areas of conservation and amenity value may be created. This may be limited by the level of pollution in the runoff. Biological treatment of surface runoff by reed beds should reduce pollution levels.

c) Conservation of river corridors

The NRA wish to promote river corridors as conservation and amenity areas. As such they are opposed to developments likely to have a significant detrimental effect on river corridors. However, in some cases, appropriate mitigation may be acceptable including measures such as the following.

i. An adequate river corridor width between the development and existing or proposed river channels. This should preferably be with public access. A figure of 50 m from either bank has been widely quoted as appropriate to preserve the river continuity.

ii. 8 m or 9 m minimum (depending upon local land drainage bylaws) on each bank to be provided beneath bridges and river crossings. Local stone or brickwork should be selected to blend in with the local environment.

iii. If culverting is unavoidable, the length should be kept to a minimum, a freeboard above the top water level should be maintained to allow the free passage of debris. Reinstatement of the bed with a suitable substrate and maintenance of access for migratory fish and mammals should be carried out.

iv. Transfer of alien plant species must be avoided.

e) Sewerage

Sewerage and sewage treatment facilities should be adequate, and extended if necessary, so that receiving water quality is not compromised by discharges (both from sewage treatment works, outfalls and combined sewer overflows).

f) Conservation of water resources - demand management

Where abstraction licences are required, the NRA would wish to see efforts made to cut site losses of water. Examples include reducing leakage through cracked pipes and recycling of water within systems. Where water supply is from the mains, this matter should be discussed with the appropriate water supply company.

8. Baseline Information

The following information will be required:

a) a river corridor survey for any channel affected by the development;

b) the capacity of the existing infrastructure;

c) the predicted current and future demands which will be placed upon it by the development;

d) an indication of whether the private water supply and sewage disposal companies have been contacted and if and how they propose to meet this demand within an agreed timescale.

Other surveys which may be required include:

- wildlife conservation;
- aquatic biology;
- fisheries;
- geomorphology;
- recreation and amenity;
- water quality;
- hydrology and drainage;
- hydrogeology;
- archaeology; and
- landscape;

Details of baseline survey work should be discussed with the NRA as soon as possible, as parameters are likely to be diurnally and seasonally variable. Where outline planning permission is applied for, it is common for the NRA to place a holding objection upon such applications until sufficient information is supplied.

9. Maintenance

Facilities should be provided for access to watercourses and provisions made for regular maintenance.

10. Monitoring and Maintenance

An appropriate monitoring and maintenance strategy should be devised, based upon initial findings and the predicted impacts of the project. Audit may be required in certain cases.

11. Further guidance

Construction Industry Research and Information Association (1992) *Scope for the control of urban runoff*. Report R123/124. CIRIA, London.

Construction Industry Research and Information Association (1994) *Environmental Assessment*. Special Publication 96. CIRIA, London.

Luker, M. and Montague, K. (1994) *Control of pollution from highway drainage discharges*. CIRIA Report 142. Construction Industry Research and Information Association, London.

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF LARGE INDUSTRIAL/MANUFACTURING DEVELOPMENTS AND OPERATIONS

1. Introduction

This guidance note seeks to identify the potential impacts large industrial developments upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of such schemes. Other notes have also been produced for various development issues that may be relevant; these are referred to in the text. Large industrial development types covered more specifically by other guidance include a oil refineries and power stations. The NRA has an interest in large industrial developments, particularly due to potential impacts on water quality, water resources, flood defence, fisheries and conservation.

Large industrial developments, by virtue of their size alone, will generally require EA. In instances where EA is not formally required, the process remains a useful means of conveying environmental information to the NRA and other interested parties. Indeed, certain information may be required by the NRA in connection with licence/consent applications (Section 4). The responsibility for obtaining information and/or EA lies with the developer. There are distinct advantages to contact the NRA and conduct environmental studies well in advance of the proposed development. It enables environmental constraints to be identified and avoided and appropriate mitigation to be designed into the planned development. The developer should be able to demonstrate a reasonable consideration of alternatives for a scheme. There should also be some consideration of strategic issues such as the availability of water resources to meet the particular development.

2. Development control

Industrial and manufacturing developments are generally subject to development controls within the framework of Town and Country Planning.

3. Environmental Assessment

Under the terms of the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI Nº 1199) an EA is mandatory for project types listed in Schedule 1 of the Regulations, and would normally be required for those listed under Schedule 2 when significant impacts are expected. Relevant Schedule 1 projects include:

- integrated works for the initial melting of cast-iron and steel;
- installations for the extraction, processing or transformation of asbestos products; and
- integrated chemical installations.

Relevant Schedule 2 projects include:

- various metals processing operations;
- various chemical industries (other than those under Schedule 1);
- glass manufacture;
- textile, leather, wood and paper industries;
- rubber industry;
- industrial estates;
- manufacture of artificial mineral fibres;
- manufacture or processing of gunpowder and other explosives; and
- modifications of Schedule 1 developments.

Fuller description of development types and guidance on the significance of impacts for Schedule 2 projects has been produced by the Department of the Environment and Welsh Office (as DoE Circular 15/88 (WO Circular 23/88) and DoE/WO (1989)). For large industrial developments Schedule 2 EA may be required by virtue of size alone.

Many of the above developments will include prescribed processes requiring the application of Integrated Pollution Control (IPC) under the Environmental Protection Act 1990. These will require an assessment of Best Practicable Environmental Option (BPEO) and use of Best Available Techniques Not Entailing Excessive Costs (BATNEEC). The NRA are statutory consultees for developments involving IPC authorisation (and waste disposal) and should be contacted at an early stage for such developments.

4. NRA authorisations

The following licences/consents may be required from the NRA in connection with the development.

i. **Discharge consent** - for discharges to "controlled waters", i.e. groundwaters, inland and coastal surface waters.

ii. **Abstraction/impounding licence** - for abstraction or impounding of water.

iii. **Land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

Discharge controls under IPC fall under the jurisdiction of Her Majesty's Inspectorate of Pollution (HMIP). The NRA are statutory consultees on the quality of such discharges to controlled waters.

5. Major potential impacts

Impacts will occur in both the construction and operation of industrial sites. Other guidance is available for general construction issues which may be useful in addition. Where the development consists of low impact light industry, guidance on large residential and business parks may be more applicable than this note.

In general, a major concern of the NRA will be the effects of discharges and accidental spills on water quality. It will be necessary to demonstrate that none of the water quality objectives applied to watercourses are adversely affected. Pollution of surface and groundwaters may result in criminal proceedings, as may any breaches of consent conditions.

5.1 Construction phase

Land take - Virtually all new developments involve some degree of land take. In the case of large industrial and manufacturing developments the amount of land take is likely to be considerable, resulting in the general destruction of habitats and displacement or loss of species.

Preparation of the working area and construction of buildings, roads and plant - Site flora and fauna may be damaged through direct damage and through compaction and other physical disruption of the soil. In addition, the temporary disposal of excavated soil may extend the area affected.

Increased runoff resulting from soil compaction and vegetation losses may result in increased river flows and therefore flood risk. In addition, groundwater may be affected by reduced infiltration of precipitation. Runoff and soil disturbance may lead to increased soil erosion with an associated increased sediment load in rivers. High suspended solid loadings reduce water quality and can have direct impacts on flora and fauna and the aesthetic appearance of a watercourse. Sedimentation of solids may, in turn, alter substrate quality for invertebrates and plants. Fish spawning areas may be particularly damaged by siltation. Imported base/infill material may cause pollution from leaching or runoff.

Machinery and vehicles - The general operation of machinery and vehicles may contribute to problems of soil compaction and instability. Leaking or spilled fuel and oil from machinery and vehicles whilst in use or in storage may contaminate both groundwater and surface waters.

Noise and vibration from the use of machinery and vehicles may cause habitat disturbance resulting in the loss of sensitive species from the area.

Contaminated land - Where the project involves the redevelopment of contaminated land, construction activities may lead to the mobilisation of contaminants and pollution of groundwater and/or surface waters. Separate guidance is available on such redevelopment.

In river works - In or near channel work such as the construction of water intakes and waste discharge points is likely to cause disturbance to wildlife; it may also present a barrier to navigation and migrating fish, result in the loss of (recreational) access to the river, and lead to changes in the river substrate and channel geomorphology. Sediment resuspension may lead to reduced water quality and siltation downstream. Erosion and runoff may add to these loads.

Stream diversion - Where diversion of streams occurs there will be a loss of a section of river with its associated and long-established habitats, flora and fauna. The newly created section will initially be ecologically poor and may lack habitat features. It may also be unstable, leading to bank and bed erosion and flood defence problems.

Culverting - Culverting of rivers may result in shading and the loss of natural bankside and substrate along the affected section of river. This may lead to temperature changes, a loss of plants and faunal changes. The culvert may also act as a barrier to the migration of fish, birds and mammals and increase flood risk.

Associated works - Compounds, workers accommodation, car parks and other areas associated with the site of construction may extend the area of impact beyond that of the immediate development. Also, impacts may arise from associated infrastructure, e.g. it may be necessary to construct pipelines to and from a new industrial development for carriage of water, fuel, and/or wastes to and from the site. (Guidelines on the impacts of pipelines are available).

5.2 Operational impacts

Impacts arising from the operation of the completed industrial/manufacturing plant will be depend to some extent on the nature of the plant.

Site runoff - Runoff from the industrial site and associated storage areas, roads and car parks is likely to become contaminated with oil and fuel from vehicles and operations. Runoff may also become contaminated with metals, chemical, organic matter etc. depending on the type of industrial process. Runoff may cause a deterioration of surface and/or groundwater quality.

Discharge of effluents - Effluents which are discharged from the site will result in increased river flows and velocities which may cause bank degradation and erosion. The net result may be alterations in channel width suspended sediment loads and deposition/erosion patterns.

Water quality may be decreased by the addition of the effluent; microbial contamination, increases in debris/rubbish, chemical pollution, deoxygenation and/or eutrophication may occur. The temperature of the effluent may be different to that of the river and may exacerbate impacts of other pollution; thermal stratification may also occur. The fauna and flora may be impacted by the altered water conditions, algal blooms may form in nutrient-rich, low flow conditions.

Separate guidance is available on the impacts of large discharges.

Emissions - Atmospheric emissions may lead to local deposition of contaminants and may give rise to acidification of more distant freshwater systems in soft water areas with a low buffering capacity, causing damaging effects on the water quality of receiving waters and their communities. Low pH in itself can be acutely toxic to fish and but effects are more usually associated with pH-related changes in aluminium toxicity. Acid-stressed systems may show reduced densities and diversity of aquatic fauna, including fish.

Abstraction of water - Water abstraction may be necessary. The severity of impacts will depend on the location and volumes extracted. Abstraction this will cause an altered hydrography, including a lowered water table and reduced flows. In addition, the stream's mixing and dilution capacity will be decreased. The lower flows may cause changes in stream morphology due to increased sedimentation downstream and physicochemical properties of the water may alter due to the reduced volume. If too great a proportion of flow is abstracted, the lack of water may present a significant barrier to fish migration and movement, thereby affecting breeding success, feeding etc. Secondary effects may be exerted on other water users, e.g. fishermen. The effects of abstraction are likely to be most severe during low flow conditions. The aquatic community may be altered due to the change in habitat and physicochemical properties.

Spillages and leakages - Bad practice or a lack of care in a variety of construction and operational activities may cause pollution of watercourses. Examples of such activities include: the disposal of chemicals and containers, oil handling and storage, the pouring of cement near watercourses, the discharge of water from dewatering operations, site sewerage and work near, or on, operational sewers. Chemical or organic pollution may affect aquatic flora and fauna directly or indirectly through a lack of food. The loss of fish may reduce angling success. Downstream water resources may be jeopardised as may other uses, e.g. recreation. The aesthetic appearance of the watercourse may be reduced. Direct blockage of watercourses may arise from various debris and lead to flooding.

Site management - The use of pesticides and/or fertilisers on the site may result in the contamination of surface and/or groundwaters potentially resulting in a deterioration in quality and loss of aquatic life.

6. Mitigation measures

The location and size of developments will be key factors in determining impact significance. Where possible, construction activities should avoid sensitive areas, such as:

- flood risk areas, e.g. floodplains;
- wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable fisheries;
- areas of conservation importance;
- vulnerable aquifers; and
- upland areas of catchments with particular sensitivities.

The careful timing of activities may avoid sensitive periods, e.g. bird nesting and fish spawning seasons.

Construction practices - Building regulations, codes of good practice, NRA guidance etc. should be followed where appropriate. Staff, including supervisors, should be made aware of the risks of site activities to the environment.

Permanent and temporary land take - Land take should be minimised and original habitat features maintained. Compounds, car parks and other areas associated with the site of construction should be carefully located to minimise additional impacts.

Wildlife habitats - Important habitats should be retained. In addition, opportunities should be sought to create new habitats, particularly ones similar to those lost in the development. Where feasible, soils, sediment, plants etc. should be transferred to the new habitats, including movement of such material to the course of diverted channels.

Where breeding/roosting/hibernating sites are inevitably going to be affected, access to these should be prevented prior to and during the relevant period.

The storage and handling of soil - The area affected should be minimised and the soil structure maintained, i.e. avoid mixing topsoil with underlying material. Stored and other exposed soil or spoil should be covered to minimise silt runoff. Imported material should be avoided as this may contain polluting substances or propagules of invasive plants. Seeding of landscaped areas may or may not be appropriate with suitable seed. Borrow pits should not be excavated in sites of wildlife or other value.

Compaction of soils - The use of boards and other temporary supporting structures and restricting the movement of vehicles and machinery in wet conditions will minimise compaction by heavy machinery.

Chemicals, fuel and oil - Suitably storage areas away from watercourses and drains should be used, with adequate bunding should spillage occur. Drip trays should also be utilised with pumps and other such machinery to catch leaking oil. Particular care should be taken when pouring concrete or handling cement near watercourses. The risk of pollution from vandalism and theft should be reduced by using tamper proof valves, adequate fencing and security. If pollution of any sort does occur, the NRA should be notified immediately and prompt action taken to minimise effects. Sewerage and waste disposal arrangements should be adequately considered.

Drainage - Temporary drainage during construction and more permanent drainage following completion should incorporate facilities such as storage tanks, oil separators (interceptors), silt traps and wet balancing ponds, as appropriate, to reduce water quality impacts of runoff and spillages. Field drains and ditches should be identified and carefully reinstated to prevent flooding and to maintain the character of the landscape. Flood compensation measures should be incorporated where the flood plain is affected; these should be designed in consultation with the NRA.

Site runoff - The use of permeable membranes, floating roads, pervious gabions, may reduced site runoff, although they should not be used if there is a high risk of contamination from through flow. The discharge of runoff may be regulated by passage through balancing ponds/retention basins. These may also act as a buffer against poor water quality from storm runoff, as sediment traps, and provide useful aquatic and wetland habitats. Other drainage facilities such as oil separators (interceptors) should be considered if oil is a likely pollutant. Isolation points designed into the drainage system may be useful to prevent pollution of watercourses where there are high risks of spillage. There will be a requirement for containment of fire-fighting water.

Dust - Dampening down of dust will reduce aerial transmission, but dampening water should not be washed into drains without sediment traps. Vehicle (wheel) wash facilities should be adequately constructed with containment of the effluent for proper treatment and disposal.

Noise and intrusion - Avoidance of work at sensitive times/locations, e.g. in the evenings where birds roost in adjacent sites, and the use of baffles etc. should reduce disturbance from noise and intrusion.

In-channel work - Peak periods of relevant seasonal activities (i.e. navigation. fish spawning) should be avoided. Interruption to recreational access and navigation should be minimised, although public safety should not compromised. Methods of working should be used that minimise the extent of disturbance to the banks and bed of the river.

Culverting - When unavoidable, culverts should be designed with the invert set below normal bed level to enable some bed features to reform and to allow the uninterrupted passage of fish. The headroom of the culvert should be maximised to enable light entry and permit the passage of birds and mammals. Adequate headroom and/or screening will also reduce flood risks.

Abstraction of water - Damage to aquatic ecosystems may be reduced by restricting abstraction to high flow conditions, or limiting the amount abstracted during low flow conditions. On-site storage reservoirs may also be useful to supplement the supply. Abstraction requirements may also be reduced by the use of recirculating or recycling systems and effective leakage controls.

Contingency plans - Plans to be used in the event of a major pollution incident should be set up. These should include emergency procedures on how to deal with the pollution. Where appropriate, booms should available. Such emergency equipment should be stored so that it is readily accessible and maintained in good condition. Staff should be trained regularly on deployment methods so that in the event of an emergency deployment is rapid and effective. Dispersants should only be used on spills only when absolutely necessary; and where possible, use should be restricted to those which are known to have the lowest toxicity. Fire fighting plans should be such that the risks of flushing contaminants into water systems are minimal.

Management systems - Operational impacts may be reduced by the formulation, adoption and adherence to environmental management systems (e.g. to comply with BS7750).

7. Baseline surveys

In order to ascertain the detailed impacts of a development, baseline surveys will generally be required, although some relevant information may be available from the NRA and other bodies. Surveys should be conducted at relevant times of year using recommended methods. The findings should highlight particularly sensitive sites, habitats or species.

In general, the NRA will require information on (from surveys or otherwise):

- river corridor survey (for wildlife conservation);
- fisheries;
- aquatic biology;
- water quality;
- water resources;
- hydrology and hydrogeology;
- landscape/amenity;
- recreation;
- river geomorphology; and
- archaeology.

8. Monitoring and audit

A relevant monitoring programme is recommended to assess the predicted impacts and the success mitigation works.

Audits of site management practices during construction may ensure that the construction techniques and practices proposed in the environmental assessment do not alter without due consideration for the environment. Audits should also be carried out on operational practices.

9. General guidance and references

Construction Industry Research and Information Association (1992) *Scope for the control of urban runoff*. Report R123/124. CIRIA, London.

Construction Industry Research and Information Association (1994) *Environmental Assessment*. Special Publication 96. CIRIA, London.

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to the procedures*. HMSO, London

Department of the Environment/Welsh Office (1991) *Integrated Pollution Control: A practical guide*. HMSO, London.

Harris, R. C. (1993) Groundwater pollution risks from underground storage tanks. *Land contamination & Reclamation*, **1** No. 4, 197-200.

Luker, M. and Montague, K. (1994) *Control of pollution from highway drainage discharges*. CIRIA Report 142. Construction Industry Research and Information Association, London.

National Rivers Authority (1994) *Discharge Consents and Compliance*. Water Quality Series Nº 17. HMSO, London.

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF GOLF COURSES

1. Introduction

This guidance note seeks to identify the potential impacts of golf courses upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for environmental studies carried out in connection with golf course proposals. The potential impacts of golf courses are of interest to the NRA because of the authority's responsibilities for flood defence, pollution control, fisheries, recreation and conservation management.

Although legislation does not formally require a formal Environmental Assessment (EA) to be carried out for proposed golf courses, EA is a useful process to gather and convey information to those individuals and organisations, including the NRA, who may have an interest in the environmental effects of the proposals. The NRA may require certain environmental information in order to respond to the planning application, and to applications to the NRA as a licensing body (Section 3).

The responsibility for EA lies with the developer, although the NRA will make available relevant related information that it holds. It is advantageous to consult with the NRA and initiate the EA in advance of the detailed designs to enable the proper consideration of alternatives and the identification of any environmental constraints which may be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage.

2. Development control

Golf courses are subject to planning controls within the Town and Country Planning framework.

3. NRA licences

Under the terms of the Water Resources Act 1991, the National Rivers Authority has a variety of licensing powers that may be relevant to golf courses.

i. **Land drainage consent** - required for any works on the bed and banks of a river or construction of any structure likely to impede the flow (e.g. surface water outfalls).

ii. **Abstraction licences** - for abstraction from ground or surface waters, e.g. for irrigation.

iii. **Impounding licences** - for impounding of watercourses

iv. **Discharge consent** - for discharges to inland surface waters, groundwaters and coastal waters.

Land drainage and impounding licences must be obtained in advance of any construction, regardless of whether planning permission has been granted.

4. Major/potential impacts upon the aquatic environment

4.1 Construction impacts

Preparation of the working area and construction of the golf course - This may result in damage to the site flora from direct damage and through compaction and other physical disruption of the soil. In addition, the temporary disposal of excavated soil may extend the area affected. There may be a loss of bank stability from bankside operations. Wildlife may be affected that are dependent on trees and other vegetation, e.g. birds and bats may utilise trees as nesting or roosting sites. The loss of shade provided by bankside trees may result in significantly increased river temperatures and plant or algal growth.

Increased runoff resulting from soil compaction, vegetation losses and buildings (e.g. clubhouses) may result in increased river flows and therefore flood risk. In addition, water resources may be affected by reduced infiltration of rainfall to aquifers. Runoff and soil disturbance may lead to soil erosion with subsequent pollution from raised levels of suspended solids, decreasing water quality. Pollution by suspended material may have effects on sensitive aquatic life from direct abrasion or from increased attenuation of light in turbid water. In addition, sedimentation in rivers may affect substrate characteristics for aquatic flora and fauna, and reduce the quality of gravels for fish spawning, particularly that of trout and salmon. Reduced fish stocks will affect angling opportunities for such stocks. Angling and recreation may also be impaired by bankside construction activities and changes to access. General construction activity may also disturb aquatic wildlife disrupting feeding and/or reproduction.

Archaeological interests may be damaged by soil excavation

Machinery and Vehicles - The general operation of machinery and vehicles may contribute to problems of soil compaction and soil instability. Leaking or spilled fuel and oil from stores, vehicles or machinery may contaminate both groundwater and surface waters.

Near river construction - Golf courses may be built adjacent to watercourses and artificial lakes may be constructed by excavating and/or impounding existing watercourses. The impacts caused by works carried out close to and within the watercourse, will include: direct damage to river banks, aquatic and riparian flora and fauna and their habitats; and impacts associated with pollution from high concentrations of disturbed sediments (with subsequent sedimentation) and from oil or fuel spills. Construction materials such as cement may also lead to pollution. Machinery and construction materials in the watercourse may also represent a barrier to migrating fish.

In addition, to the above impacts the watercourse river may become wider and deeper, altering the stream hydrology and geomorphology. This could have impacts on the riverine communities, including the loss of sensitive species. Algal blooms may potentially develop due to the increased retention time of stream water in ornamental lakes (and from the use of fertilisers).

4.2 End state/Operational impacts

Clubhouse - Disposal/treatment of sewage may have impacts on groundwater or surface water quality, particularly in rural locations distant from foul sewers.

Landscaping - Landscaping may result in the changes to flood plain storage area and flood flow routes, resulting in altered stream hydrography, increased runoff, localised erosion and an altered risk of flooding. Altered drainage characteristics, particularly in the vicinity of well-drained greens, will lead to associated changes to runoff, stream hydrology and infiltration of rainfall to groundwaters. The altered site drainage may cause an alteration in the grassland types and potentially could cause a loss in conservation value of the site.

Irrigation - Abstraction of surface waters for irrigation will cause a decrease in flow velocity, this may alter the sediment transportation and deposition regimes, thereby altering the nature of aquatic habitats. Lower flows also reduce a river's ability to dilute and flush out any contaminants that enter and affect downstream water users. Reduced river flows may present a barrier to fish migration and movement which may then affect breeding success and quality of fisheries. The temperature of rivers in low flow may rise more rapidly and, combined with other physicochemical changes such as reduced dissolved oxygen concentrations, may affect aquatic ecological communities, potentially killing sensitive species or causing them to migrate out of the area. Peak abstraction periods may often generally coincide with periods of low river flow. Abstraction from groundwaters will diminish groundwater resources and the flow of spring-fed streams.

Fertiliser and pesticide application - Fertilisers and pesticides applied to golf course will be carried in site runoff (particularly if rainfall occurs soon after application) and drainage. Chemical contamination of both groundwater and surface water may occur. Biological communities could be seriously affected by pesticides with a loss of sensitive species (both plants and animals). Fertilisers entering watercourses may increase the risk of algal blooms.

Addition of dye - The addition of dye to lakes may cause direct pollution. Where lakes are on line the dye will be transported into the river system.

Mowings - Grass mowings and other clippings may produce a polluting liquor when left to stand. Mowing itself and other maintenance activity may disturb sensitive wildlife.

5. Mitigation measures

Careful course design will minimise environmental impacts. The principal impacts of golf courses are generally short-lived and confined to the construction phase provided that adequate care is taken during the planning, construction and operation of courses. Alternative siting and designs of golf courses should be considered. Golf courses should avoid sensitive areas, or measures to protect such areas should be guaranteed. Sensitive areas include:

- river floodplains;
- lakes, wetlands and marshes;

- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable fisheries;
- vulnerable aquifers; and
- upland areas of catchments with particular sensitivities.

The siting of access roads, storage tanks and waste disposal facilities used during construction and in operations should also be considered.

Access roads - Roads should avoid riparian zones, and use appropriate construction materials. Culverts should be avoided, but where required these should be designed so as not to disrupt fish movement and be a flood hazard through their blockage. Drainage from car parks should have oil/fuel interception systems included.

Storage of fuel and equipment - On-site equipment and materials used in construction and operation should be carefully stored. Proper bunding should be provided for fuel tanks, away from water (preferably off-site) and locked when unattended. Bunds should be constructed such that all openings and fuel pipes are within the bund walls and that the bund itself has an adequate capacity. Chemical and fuel stores should be locked.

Drip trays - Drip trays should be placed under stationary machinery to collect oil and grease.

Waste disposal - Sewage and other waste water should be disposed of to foul sewer, where available. At locations remote from such sewerage, adequate treatment facilities should be installed.

Water features - Water features designed into the golf course should generally be off-line as algal growth, chemical treatments etc. in on-line features will have a direct effect on river water quality.

Storage of surplus winter water - Constructed lakes will limit the need for restrictions on abstraction licenses and result in a more reliable supply. By designing these to receive site drainage, these may also act as balancing lakes, thereby reducing the impacts of runoff and spillages. Recirculation or aeration devices may need to be installed in order to maintain water quality. Reclaimed waste water may be a further viable source of water for irrigation purposes.

Buffer strips - Areas of land around watercourses, unaffected directly by the development, may be used to intercept runoff and reduce the amounts of sediment and nutrients entering such watercourses. Strips of at least 10 m should be left adjacent to any watercourses to provide a natural undisturbed corridor in which herbicides and fertilisers etc. are not used. Larger buffer strips may be required if the natural land drainage situation requires it.

Pesticides and fertilisers - should be used in accordance with the relevant guidelines, such as MAFF (1985) and NRA (1995). These chemicals should only be applied to playing surface and used minimally. Drainage from areas with fertilisers applied should not enter water bodies within or adjacent to the course. Fertilisers, pesticides, dyes, fuel, oil and other potentially polluting materials should be properly stored, e.g. secure bunded areas.

Mowings - should be stored/composted away from watercourses.

Soil protection and restoration - Compaction of soils may be reduced by restricting traffic movement, especially during wet conditions, and the use of protective boarding and low ground pressure machinery. If necessary, soil should be carefully removed and stored with subsequent reinstatement. If necessary subsoil should be ripped prior to the spreading of topsoil. Mixing of unlike soil materials and importing soils should be avoided where possible.

Field drains and ditches - These should be identified and carefully reinstated where appropriate to prevent flooding and maintain the character of the landscape.

Habitat protection and creation - Where possible valuable existing habitat features should be incorporated into course design and protected from change. Mowing regimes may be used to avoid sensitive periods (e.g. flowering, breeding). Further habitats should be created to compensate for habitat losses and to improve the landscape and wildlife potential for the site. The former Nature Conservancy Council has issued relevant conservation guidance (NCC 1990).

Disturbance to wildlife - Appropriate phasing of construction work to avoid noise and disturbing activity at sensitive times will greatly reduce environmental impacts. Sensitive times for bird populations include breeding season and migratory concentrations.

Disturbance to recreation - Careful timing operations should minimise such disturbance.

Access - Where access restrictions result from the development, arrangements for alternative access should be made with the provision of gates, bridges or stiles.

Archaeological sites - Sites and other interest should be preserved *in situ* where feasible with the provision of facilities for visitors. Relocation should be considered, where damage is unavoidable.

6. Baseline surveys

Baseline field surveys should be carried out that are appropriate with respect to timing, timescale and methods used. Surveys should preferably include those conducted at the same time of the season as the proposed construction, in the year prior to the works.

Field surveys should be sufficient to:

- establish the pre-construction (baseline) state of the site;
- allow the determination of critical environmental factors upon which to give rapid on-site advice during construction;

- determine the best operational conditions for the aquatic environment during construction such as water level in wetlands, water flow in rivers and allowable sediment load or deoxygenation effects on river biota especially fish;

- optimise the reinstatement of channels or wetland areas by the appropriate choice or extent of use of a specific technique; and

- identify construction practices with a high environmental risk, economic liability or publicity factor.

The surveys required are site specific but is likely to include physical, chemical, and morphological data on water, soils and topographic features in addition to the species and numbers of the major organisms present. Important indicator species include flowering plants, dragonflies, amphibians, reptiles and native and migrant birds. Red Data Book species and those which are otherwise designated as rare (i.e. in legislation) must also be specifically searched for in surveys. Information on aquatic invertebrates, fisheries, recreational use and the river corridor as a whole will also need to be collected.

7. Monitoring and audit

Monitoring that is relevant to the predicted impacts and mitigation measures is recommended and should not only make use of baseline surveys but also consider further pre-scheme surveys. Post-scheme monitoring data should be regularly reviewed. The review or audit should also include compliance with agreed management practices.

8. General guidance and references

In general, there should be limit to the number of golf course developments in an area or type of area to reduce cumulative effects.

European Golf Association Ecology Unit (1995) *An environmental strategy for golf in Europe*. Pisces Publications. (Available from the Nature Conservation Bureau, 36 Kingfsher Court, Hambridge Road, Newbury, Berkshire, RG14 5SJ.)

Ministry of Agriculture, Fisheries and Food (1985) *Guidelines for the use of herbicides on weeds in or near to watercourses and lakes*. MAFF. (NB these guidelines are currently being updated).

NRA (1995) *The use of herbicides in or near water*. NRA (Anglian Region), Peterborough.

Nature Conservancy Council (1990) On course conservation: *Managing golf's natural heritage*. NCC, Peterborough.

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF POWER STATIONS

1. Introduction

This guidance note seeks to identify the potential impacts upon the water environment of power station developments. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of proposed power stations. The NRA has an interest in power stations due to its general environmental responsibilities and particularly with respect to the control of pollution of surface waters. Legislation requires that an EA should be carried out for most proposed power station developments with the production of an Environmental Statement (ES). The responsibility for this assessment lies with the developer. It is advantageous to conduct the EA in advance of the design phase to enable proper consideration of alternatives. Similarly, early contact with the NRA will enable identification of sensitive areas and other environmental constraints affecting proposals. The EA's conclusions require proper justification and raw data should be accessible to interested parties, such as the NRA.

Wind farms and hydropower schemes are subject to other guidance notes.

2. Development control

Under the Electricity Act 1989 the construction or extension of power stations with a capacity of 50 megawatts or more requires consent from the Secretary of State for Trade and Industry. Smaller power stations fall under planning legislation, i.e. the Town and Country Planning framework.

In addition to planning regulations, power stations may be subject to the requirements of the Environmental Protection Act 1990, e.g. the application of BATNEEC (Best Available Techniques Not Entailing Excessive Costs) for emission controls and the Duty of Care in the management of wastes.

3. Environmental Assessment

Under the Electricity and Pipe-line Works (Assessment of Environmental Effects) Regulations 1989 (SI 1989 Nº 167) an ES must be submitted to the Secretary of State for Trade and Industry in connection with applications which are made for:

i. the construction or extension of a nuclear power station;

ii. the construction or extension of a non-nuclear generating station with a heat output of 300 megawatts or more;

iii. the construction or extension of a non-nuclear generating station with a heat output of 300 megawatts or more where the Secretary of State is of the view that the development would be likely to have significant effects upon the environment; and

iv. the placement on land of an overhead line or the construction or diversion of a pipeline of 10 miles or more in length, where the Secretary of State takes the view that the project concerned would be likely to have significant environmental effects.

As such, EA may be required not only for power stations but also for the transmission of associated fuel supply (e.g. gas and oil) via pipelines and the transmission of generated power via overhead lines.

Local Planning Authorities may require EA for smaller schemes not subject to consent from the Department of Trade and Industry.

For those cases where an EA may not be formally required the EA process and ES may be a useful process to convey environmental information to interested or licensing bodies such as the NRA.

4. NRA licences

Power station developments may require a number of licences from the NRA, such as:

- **discharge consent** - for discharges to controlled waters (i.e. inland surface waters, coastal waters up to three miles offshore and groundwaters);
- **abstraction licence** - for abstraction from groundwater or surface waters;
- **impounding licence** - for impounding surface waters; and
- **land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

In addition, consent must be obtained for the introduction of fish into an inland water, e.g. for stocking fish into cooling water lagoons or into rivers as a mitigation measure.

In addition, Her Majesty's Inspectorate of Pollution (HMIP) is the competent authority for consenting discharges within integrated pollution control (IPC) arising from the EPA 1990.

5. Major potential impacts upon the aquatic environment

5.1 Construction impacts

Impacts are described primarily for fossil fuel and nuclear power stations. The principles of fossil fuel plants may be easily applied to smaller plants, such as municipal waste incinerators and biomass plants burning 'renewable' fuels such as straw and coppiced wood. Further detail on the general impacts of construction, may be found in other guidance.

Land take - Land take will result in the loss of wildlife habitats, species and possibly migration pathways.

Preparation of the working area and construction of roads and buildings - General construction activities may result in damage to the site fauna and flora from direct damage and physical disruption of soils. The temporary disposal of excavated materials may extend the affected area. Bankside operations are likely to cause bank instability. Fauna and flora may be affected by habitat loss from within water channels, from banksides and from other habitats such as wetlands. For example, bankside trees and vegetation may be used by birds and bats as nesting and roosting sites and by otters. Bankside trees may also provide shade to aquatic systems; tree loss may thus result in raised water temperatures and increased growth of plants and algae.

Increased runoff resulting from soil compaction and vegetation losses may result in reduced infiltration to groundwater and an altered hydrological response to rainfall, with increased short-term river flow. Infiltration loss may result in a lowered water table, affecting associated habitats (e.g. wetlands), water resources. River baseflows may also be reduced affecting aquatic life, water recreation and resources. Increased river flow in response to rainfall may result in erosion of river substrate, banks and associated aquatic life, changes to river geomorphology and the risk of flooding.

During a major construction of this type large quantities of fuel/oil and machinery may need to be stored on site. These may present a high risk to the aquatic environment from leakage and spillage.

Construction of inlet and discharge pipes - As much of the construction will inevitably have to take place within or near water channels, works may lead to the mobilisation of soils and sediments, and increased suspended solid loads. Erosion and runoff may add to these loads. Such deterioration in water quality may affect organisms which are sensitive to abrasion, siltation and to increased attenuation of light from water turbidity. Siltation may significantly alter substrate characteristics resulting in an increasing dominance of silt tolerant organisms and reduced egg-fry survival of fish using gravels for spawning, e.g. trout and salmon. Altered fish stocks will have implications for angling opportunities.

Access to watercourses or water bodies, for navigation, angling, other water-based activities may be disrupted. Maintenance of flood defences may also be prevented.

Associated development - Contractors parking, storage and accommodation areas may significantly extend the area of impacts, albeit temporarily. Transmission lines and the infrastructure for fuel supply and storage may similarly extend the area of impacts. The planting of crops for biomass production may result in a change of land use and associated impacts.

5.2 Operational impacts

Abstraction of water for cooling - The severity of impacts from abstraction will depend very much on the location and volumes abstracted, particularly in relation to river or tidal flows. Abstraction may cause reductions in river flows and changes to tidal regimes, dispersive characteristics and sediment transport; thereby significantly altering the nature of aquatic habitats. Reduced river and tidal flows also reduce the system's ability to flush, mix and dilute any contaminants. If too great a volume of water is abstracted the lack of water may present a significant barrier to fish migration and movement. The reduced volume and mixing of water in a system may also cause physicochemical changes such as increased temperature, and reduced dissolved oxygen, affecting sensitive aquatic communities. Secondary impacts may be exerted on other water users, e.g. fishermen.

At the point of abstraction, impingement of fish may occur at intake screens. Fish larvae and other smaller organism may also become entrained. Losses may be seasonal, particularly in relation to migration patterns and breeding cycles, such as the downstream migration of salmon smolts in rivers and the release of barnacle larvae in marine situations.

Further guidance notes on the impacts of abstraction are available.

Cooling Water Discharges - Cooling water discharges may have a thermal impact on the receiving water. Increased water temperature may alter growth, metabolism, food and feeding habits, reproduction, movements, migration and behaviour in aquatic organisms. Raised temperature may also alter the ability of organisms to deal with other stresses, such as diseases and other forms of pollution. These effects may be compounded by changes in water physicochemistry such as concentrations of dissolved gases. For example, the oxygen carrying capacity of water decreases with increasing temperature.

Cooling water may also contain significant concentrations of chemicals, some added, some concentrated by evaporative processes (particularly in recirculation systems). Chemicals in the cooling water may include salts, acids, biocides and antifoulants. These each may have impacts on the quality of receiving waters.

Other discharges - Effluents from processes such as flue gas desulphurization (FGD), may contain high concentrations of various contaminants, e.g. boron, fluoride, chloride and metals. These may have significant impacts on aquatic life and water resources.

Radioactivity releases from nuclear power stations into the aquatic environment is strictly controlled and are unlikely to cause acute toxicity problems under normal circumstances. However, long-term low level releases may result in chronic effects (e.g. reductions in fecundity, growth, and longevity) through bioaccumulation. Major spills or leaks of intermediate and high level wastes would have serious implications for aquatic life if surface waters were affected. Groundwater contamination would result in a long term loss of water resources.

Leakage from recirculating (cooling) systems may cause a significant drop in the water quality of receiving waters due to the concentrated nature of contaminants.

Further guidance notes on the impacts of abstraction are available.

Site runoff - The volume of site runoff will be increased by the increased paved area due to roads, car parks, buildings etc. As mentioned above, this may result in an altered stream hydrology and a lowered water table, affecting aquatic life, flood risk and water resources. Site runoff may also be acidic and contain various contaminants, including suspended solids, arising from particulates and leachate from dust, fly ash and coal stocks. Site runoff may also contain radioactive contamination. As a result, the receiving water may suffer a deterioration in quality, and in the loss of sensitive species. Bioaccumulation of contaminants may also occur in the food chain. Changes in the substrate characteristics and river bed morphology may also occur due to sedimentation.

Spills of fuel, chemical and wastes may cause pollution if these enter groundwater or surface waters.

Pulverised fly ash (PFA) - Disposal of PFA may extend the area of impact through and water quality effects. Aquatic habitats may be damaged or lost by dumping in aquatic or riparian sites, e.g. coastal lagoons. Leachate from PFA may contaminate groundwater and surface waters. Further contamination and suspended solids may arise from runoff and windblow. Damage to aquatic life may be via mechanisms of toxicity, smothering and habitat change or loss.

Other wastes - Other wastes from power stations may include boiler cleaning wastes, sludges from water treatment plant, ash from oil-fired boilers and gypsum from FGD. Further wastes may arise from the decommission of power stations. Impacts may arise from these other wastes.

Atmospheric emissions - Atmospheric emissions from combustion processes may lead to local deposition of contaminants derived from fuel sources and more remotely lead to the deposition of so-called "acid rain". Localised deposition of contaminants from municipal waste incinerators may be particularly significant (see separate guidance on waste management).

Acidification of freshwater systems may arise from acid rain in soft water areas, where the buffering capacity is low, causing damaging effects on the water quality of receiving waters and their communities. Low pH in itself can be acutely toxic to fish but effects are more usual through associated changes in aluminium toxicity. Acid-stressed streams may show reduced densities and diversity of aquatic fauna, including fish.

Atmospheric emissions from power stations may also contribute to alteration of the global climate.

Landscape - Power stations (and cooling towers in particular) will generally have a significant impact on landscape. The impact may be exacerbated by aerial emissions, including steam, and heaps of fuel and PFA.

Noise - Generators and site activity may disturb wildlife and nearby recreational users.

Associated developments - Transmission lines may be a significant cause of mortality of migratory birds through collisions. Extraction of fuel (or growth of biomass) will have impacts at source. Quarrying of limestone for FGD may have significant impacts at the point of extraction. Decommission of power stations may have a variety of impacts, depending on the power station type and mode of operation.

6. Mitigation Measures

Siting and design options - power stations and associated developments should avoid sensitive locations such as:

- river floodplains;
- lakes, wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;

- rivers supporting valuable fisheries;
- vulnerable aquifers; and
- acid sensitive areas.

Where space is limiting, gas or oil-powered generators may be preferable to coal-fired stations as these require less space, not requiring large areas for coal stockpiles and for PFA storage or disposal. More strategically, the power station should fit in with national energy policies and the consideration of alternatives such as energy conservation measures. Power station location should take into account the contribution to acid rain in sensitive areas.

Routing of transmission lines should also be considered at an early stage. In particular, locating lines underground may be a more environmentally acceptable (but costly) alternative in sensitive locations.

Preparation of the working area and construction of roads and buildings - The area of working should be minimised as far as possible. Measures should be taken to avoid valuable habitats and to reinstate semi-natural areas damaged by construction. To avoid damage to soils in construction, soils may be protected *in situ* or temporarily removed. To protect soils, compaction may be averted by restricting traffic movement, especially in wet conditions, and the use of protective boarding and low ground pressure machinery. If necessary, when removed soil is to be is reinstated, the subsoil should be ripped prior to the spreading of topsoil. Mixing of unlike soil materials should be avoided. Excavated soil should be carefully disposed of, away from more sensitive locations and possibly off-site. Stored and other exposed soil or spoil should be covered to minimise silt runoff.

Habitat creation - Opportunities of suitable habitat creation should be maximised, incorporating those types unavoidably lost. Such habitats should be installed at an early stage and translocation of sedentary species considered.

Drainage - Temporary drainage during construction and more permanent drainage on completion should incorporate facilities such as storage tanks, oil separators (interceptors), silt traps, wet balancing ponds, and reed bed treatment (as appropriate) to reduce water quality impacts of runoff and spillages. Field drains and ditches should be identified and carefully reinstated to prevent flooding and maintain the character of the landscape. Flood compensation measures should be incorporated where the flood plain is affected. These should be designed in consultation with the NRA.

Construction of inlet and discharge pipes - Inlet and discharge pipes should not be positioned where these may affect other intakes. Positions for discharge pipes should be chosen which have good mixing potential. Care should be taken using cement and other potentially toxic construction materials near water.

Abstraction - Damage to aquatic ecosystems may be reduced by primarily using water abstracted from lagoons rather than directly from rivers or estuaries. Abstraction will still also be required to replace losses from evaporation. However, abstraction needs to top-up lagoons will be reduced and may be done at times of high flow (or tide), where possible. At some sites direct abstraction for cooling may the only practicable option. Recirculation should be used where possible.

Loss of fish due to impingement can be reduced by employing 'warning stimuli' for example air bubbles, light, electricity, water velocity and pressure changes. Physical barriers such as fine screens or clinker bunds surrounding the area from which water is extracted may also be used to protect aquatic fauna. Carefully organised operating schedules may also reduce the risk of impingement and entrainment as may reducing the intake velocity. Solomon (1992) provides guidance on intake design and techniques that may be used to reduce impacts. It may be feasible to compensate for the loss of fish by the operation of a hatchery and stocking programme as agreed with the NRA.

Cooling water discharges - To minimise contamination of receiving waters cooling water should be passed through balancing lagoons or treated before it is returned. In freshwater systems it may be possible to dechlorinate effluents using sulphur dioxide injection.

Discharges should be made through dispersal mechanisms and/or at times of high flow to maximise dispersion and dilution of contaminants.

The need for antifoulants to prevent the growth of aquatic organisms in the cooling water circuit may be reduced by designing systems with smooth surfaces and by maintaining a high water velocity (>2.5 ms^{-1}) to create conditions unfavourable for attachment. Reversal of cooling water once every four weeks may achieve some degree of control, but requires some extra heating and is costly.

Atmospheric emissions - The quality of air emissions may be improved by fuel gasification, flue gas desulphurization, the use of low sulphur fuels, controlled combustion and NOx and other emission controls. Greater dispersion of emissions may be achieved from higher emission stacks.

Disposal of pulverised fly ash (PFA) - The incorporation of a settling system into the plant process will limit the amount of fly ash discharged into receiving waters. Damping down or covering of PFA may also reduce inputs from windblow. PFA disposal sites may be restored by covering of topsoil etc. and subsequently may be suitable for other land use.

Nuclear waste - Nuclear waste should be minimised and contained using stringent measures. Low level releases should consider cumulative effects from other discharges and background radiation.

Storage of fuel and equipment - On-site equipment and materials should be carefully stored both in construction and operations. Proper bunding should be provided for fuel tanks, away from water and locked when unattended. Bunds should be constructed such that all openings and fuel pipes are within the bund walls and that the bund itself has an adequate capacity. Drip trays should be placed under stationary machinery to collect oil and grease.

Noise impacts - Suitable screening will reduce noise impacts, as will having construction and operating procedures that avoid sensitive times or locations.

Visual impacts - Visual impacts may be reduced by screening with suitable native plants and bushes.

7. Baseline surveys

Pre-construction surveys should be appropriate with respect to timing, timescale and methods used and preferably include surveys at the same time of the season as the proposed construction, in the year prior to the works. Relevant surveys may be ascertained by consultation with interested parties, such as the NRA, but may include:

- hydrology;
- river/coastal geomorphology;
- water quality;
- water resources;
- river corridor surveys;
- aquatic biology;
- fisheries; and
- archaeology.

Predictive modelling of various factors such as dispersion of temperature plumes and other discharges and emissions will usually be required.

8. Monitoring and audit

Monitoring should be carried out that is relevant to the predicted impacts and mitigation measures. It should not only make use of baseline surveys but also consider further pre-scheme surveys. Post-scheme monitoring data should be regularly reviewed. The review or audit of data should also include an assessment of compliance with agreed management practices.

9. Further guidance and references

Construction Industry Research and Information Association (1994) *Environmental Assessment*. Special Publication 96. CIRIA, London.

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to procedures*. HMSO, London.

Department of the Environment/Welsh Office (1991) *Integrated Pollution Control: A practical guide*. HMSO, London.

Hawkes, F.B. (1974) Heated discharges from thermal power stations. *Effluent Water Treatment Journal*, **14** No.10, 549-559.

Langford, T.E. (1983) Electricity Generation and the Ecology of Natural Waters. Liverpool University Press.

National Rivers Authority (1994) Discharge Consents and Compliance - the NRA's approach to control of discharges to water. Water Quality Series No. 17. HMSO, London.

Solomon, D.J. (1992) *Diversion and Entrapment of Fish at Water Intakes and Outfalls.* R&D Report 1. National Rivers Authority, Bristol.

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF WIND FARMS

1. Introduction

This guidance note seeks to identify the potential impacts of wind farms upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of wind farm schemes. The potential impacts of wind farms are of interest to the NRA because of the authority's responsibilities for pollution control, fisheries, recreation and conservation management. Early consultation with the NRA will help to identify any environmental constraints and sensitive areas which may be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage. Consideration should not only be given to the impacts of generators alone, but also to associated development such as access and haul roads, buildings, substations, transformers and the installation of cables and overhead lines.

2. Development control and Environmental Assessment

Wind farm developments come under the Town and Country Planning framework. As such an EA may be required as wind farms are now listed under Schedule 2 of the 1988 Town and Country Planning (Assessment of Environmental Effects) Regulations as 'wind generators', following amendment to those regulations (which previously did not consider wind farms) by the introduction of the Town and Country Planning (Assessment of Environmental Effects) (Amendment) Regulations 1994. As Schedule 2 projects a formal EA may be required where the scheme is anticipated to have significant environmental effects. The following indicative criteria and thresholds are given by DoE Circular 7/94 (Welsh Office 20/94) to assist whether EA is required:

- the development is located within or is likely to have significant environmental effects on a National Park, the Broads or the New Forest, and Areas of Outstanding Natural Beauty, Sites of Special Scientific Interest or heritage coast; or
- the development consists of more than ten wind generators; or
- the total installed capacity of the development exceeds 5 megawatts.

Wind farms are given particular attention in Planning Policy Guidance on *Renewable energy* (PPG 22) issued by the Department of the Environment/Welsh Office 1993. This states that where an EA is not requested *per se*, applicants will be expected to have full regard to the environmental implications of proposals.

The installation of overhead power lines associated with wind farms may qualify for a separate EA under the Electricity and Pipe-line Works (Assessment of Environmental Effects) Regulations 1990 (SI 1990 No.442).

3. NRA licences

Authorisation will be required from the NRA for any works on the bed or banks of a river or construction of any structure likely to impede the flow (as a land drainage consent).

Other authorisations that may be required include discharge consent, abstraction and impounding licences. Authorisations must be obtained in advance of any construction, regardless of whether planning permission has been granted. In order to consider applications for authorisation, the NRA will require certain environmental information which would normally be included in an ES, if produced.

4. Major/potential impacts

Impacts upon the aquatic environment are expected particularly during the construction phase, and may not only arise from the erection of wind generators, but also from the construction (and use) of access and haul roads, substations, transformers and the installation of underground cables and overhead lines.

4.1 Construction impacts

Water hydrology - Runoff will increase due to the larger paved area and from soil compacted during construction and road use. Increased runoff will generally result in greater flow and flood risk downstream. Where roads and trenches need to cross a floodplain or river, impediment of groundwater or surface water flow may occur.

Water quality - High suspended solids, from the road and excavation works, may result in an increased bed load, possibly causing deoxygenation, and downstream sedimentation. The latter may be particularly unacceptable where salmon spawning areas are affected, as siltation reduces egg survival. Pollution from cement, concrete and leakage and/or spillage of fuels and oil from construction machinery and storage tanks may cause further deterioration of water quality. Contamination may also occur from litter, vehicle emissions, oil and grease, tyre wear, and the breakdown of road surfaces. Deterioration of water quality may adversely affect aquatic life and compromise downstream water supplies. Furthermore, reduced water quality may affect a watercourse's aesthetic quality and its recreational value. Groundwaters may be polluted by oil, fuel and other contaminants.

Channel morphology - Channel morphology may be altered by the downstream deposition of sediments, increased sediment and bed load.

Habitat disturbance - Disturbance of both aquatic and terrestrial habitats may occur from direct land take, deterioration of water quality, altered channel morphology, construction noise and vibration, and from the storage and disposal of excavated soil. Severance of migratory paths may occur from the site construction works or from the installation of associated cables or overhead lines which may have to cross a variety of habitats including river corridors, wetlands and other potentially sensitive areas. Damage may result in the loss of sensitive species.

Access - Access to the development and associated area may be impeded by construction activity.

Heritage, archaeology and landscape - Heritage/archaeological interest may be affected through the destruction of known and unknown features. Visual disturbance may occur during construction there are likely to be a significant number of lorry movements and the use of cranes for the erection of turbines may be particularly obtrusive.

4.2 End-state impacts

Water hydrology - Stream hydrology can be affected by increased runoff from the increased road surface area and compacted soils, which may remain to be a problem during the operational phase.

Water quality - The use on site of fuel, lubricants and chemicals, such as pesticides, may affect water quality. In general, contaminants from runoff should pose a lesser risk than during the construction phase due to the reduced volume of traffic and cessation of excavation activity.

Ecological disturbance - Disturbance may arise due to noise and vibration from the wind generators; sensitive species may be particularly affected. Also, bird fatalities may arise from direct collision with generator blades.

Landscape - The landscape may be particularly affected by wind farms.

5. Mitigation measures

Location/design - Alternative siting and design should be considered and the environmental acceptability of the options considered. In addition to the wind farm itself, the siting of access roads, substations, transformers, storage tanks and waste disposal facilities used during construction and thereafter should be considered along with the routing of underground cables and overhead lines. Wind farms and associated developments should avoid riparian zones and wetlands.

Storage of fuel and equipment - On-site equipment and materials should be carefully stored. Proper bunding should be provided for fuel tanks, away from water (preferably off-site) and locked when unattended. Bunds should be constructed such that all openings and fuel pipes are within the bund walls and that the bund itself has an adequate capacity.

Drip trays - Drip trays should be placed under stationary machinery to collect oil and grease.

Buffer areas - Areas of land around watercourses, unaffected directly by the development, may be used to intercept runoff and reduce the amounts of sediment and nutrients entering such watercourses.

Riparian management - Measures should be considered to protect or enhance the aquatic environment and the value of distinctive riparian habitats. It must be remembered that increased ecological diversity is not necessarily an improvement as a rare species may only exist where competition is low.

Road construction - Access/haul roads should avoid riparian zones, minimise erosion, use appropriate construction materials, have culverts designed so as not to disrupt fish movement, design roadside drains to drain road areas only and to discharge to buffer areas where drainage water is likely to contain high sediment loads.

Archaeological and other interest - Such interests should be preserved *in situ,* where feasible, with the provision of facilities for visitors. Relocation should be considered, where damage is unavoidable.

Access - Restrictions should be mitigated for by the construction of gates, bridges or stiles, or arrangements for alternative access to be made.

Compaction - Compaction and other soil damage may be reduced by restricting traffic movement and the use of protective boarding and low ground pressure machinery. If necessary, soil should be is reinstated, and subsoil should be ripped prior to the spreading of topsoil. Working on wet soils and mixing unlike soil materials should be avoided. Excavated soil should be carefully disposed of, possibly off-site.

Drainage - Field drainage should be reinstated. Header drains and water stops should be installed in cable trenches. Oil separators (interceptors), silt traps, wet balancing ponds, open ditches, soakaways and reed bed treatment should be used where appropriate to reduce water quality impacts.

Loss of habitats - The working width of roads, cable laying operations etc. should be restricted. Traffic should be restricted to suitable roads, which may often be temporary. Special provisions may be required where habitats need to be protected. For example, if a wetland needs to be crossed, bog mats could be employed. Damaged habitats should be restored to their former soil profiles with reseeding (using seeds from the original, disturbed vegetation or vegetative fragments). Grazing animals should be excluded during restoration.

Disturbance to wildlife - Operations should be carefully timed, e.g. to avoid breeding seasons, and sited to cause minimum disturbance.

Use of pesticides and fertilisers - Relevant guidance on the use of pesticides should be followed (e.g. MAFF (1985), FC (1989) and NRA (1995)). The NRA should be notified where appropriate and watercourses should be avoided.

Noise - should be minimised by careful selection of machinery and the use of baffles or screens, where appropriate. Timing of operations and rate of discharge should be restricted. The siting of operations should be chosen carefully.

6. Baseline surveys

The developer should ensure that the characteristics of the area of the development are ascertained and sensitive areas identified, such as:

- bird feeding and roosting areas and any migratory paths;
- rivers supporting valuable fisheries, e.g. salmon, and salmonid spawning areas;
- areas supporting rare species;
- saltmarshes and other wetlands;
- rivers and river corridors of high ecological or amenity value;

- contaminated land likely to lead to polluting runoff; and
- "vulnerable" aquifers as outlined in the NRA's *Policy and practice for the protection of groundwater* (NRA 1992).

The characterisation should be conducted by a review of information currently held by competent authorities and surveys conducted or commissioned by the developers. The surveys should be appropriate with respect to timing, timescale and methods used.

The surveys required are case specific but may include surveys of water quality, hydrology, river corridors, fisheries, recreational use, buildings, physiographic and geological features, sites and objects of archaeological or historic interest and the general landscape.

7. Monitoring and audit

Monitoring that is relevant to the predicted impacts and mitigation measures is strongly recommended and should not only make use of baseline surveys but also consider further prescheme surveys. Post-scheme monitoring data should be regularly reviewed. The review or audit should also include compliance with agreed management practices.

8. References and general guidance

British Wind Energy Association (1995) Best Practice Guidelines for Wind Energy Development.

English Nature have published nature conservation guidance for renewable energy projects (EN 1994) which concentrates on wind power. The Department of Trade and Industry have produced guidance (DTI 1992) on the EA of cross-country pipelines, which may be applicable to the laying of power cables.

Department of Trade and Industry (1992) Guidelines for the Environmental Assessment of Cross-Country Pipelines. HMSO, London.

English Nature (1994) Nature Conservation Guidelines for Renewable Energy Projects. English Nature, Peterborough.

Forestry Commission (1989) Provisional Code of practice for the use of pesticides in forestry. Occasional Paper 21. Forestry Commission, Edinburgh.

Ministry of Agriculture, Fisheries and Food (1985) Guidelines for the use of herbicides on weeds in or near watercourses and lakes. (NB these guidelines are currently being updated).

NRA (1995) *The use of herbicides in or near water*. NRA (Anglian Region), Peterborough.

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF HYDROPOWER PROJECTS

1. Introduction

This guidance note seeks to identify the potential impacts of hydropower upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of hydropower schemes. This note complements the NRA pamphlet *Hydropower Developments and the National Rivers Authority*. The NRA has an interest in hydropower developments primarily due to the potential impacts on water resources, fisheries, stream ecology and flood defence. Although formal EA may not be required for smaller schemes, the NRA will require certain environmental information as part of land drainage consent, and impounding and abstraction licensing procedures. The responsibility for such an assessment of environmental effects lies with the developer. Larger hydropower generating schemes such as major tidal schemes, hydroelectric dams and pumped storage reservoirs have not often been proposed in recent years, the main emphasis being on smaller non-tidal run-of-river schemes utilising subsidies available under the Non-Fossil Fuel Obligation schemes. This guidance note reflects that emphasis. The impacts of larger schemes are similar to those of smaller schemes, although they are likely to be more significant and are combined with the added impacts of reservoir or barrage development.

2. Development control

A hydropower development falls under Schedule 2 of The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No. 1199) as "an installation for hydroelectric energy production". As such, formal EA is only required for projects which are likely to have significant effects by virtue of factors such as their size, nature or location.

The following licences/consents may be required from the NRA:

- **impounding licence** for schemes involving the construction or alteration of impounding works such as dams and weirs;

- **abstraction licence** for schemes in which water is abstracted physically by leat or pipe; and

- **land drainage consent** for schemes which may affect land drainage and possibly flood risk.

3. Major/Potential impacts

3.1 Construction impacts

The main impacts of construction will arise from the installation of a weir or dam to provide the required head of water, the laying of pipelines and cables, and the construction of turbine houses. These impacts may be particularly significant where schemes are proposed in remote scenic areas.

3.1.1 Weir/dam construction

There will be direct disruption of rivers by in-channel works. Physical activity will disturb bankside and benthic sediments leading to raised levels of suspended solids, and potentially other contaminants. Dewatering of bunded areas may have similar effects. Other water quality effects may arise from the significant risk of oil, fuel and cement spills or leakage. On site activity and haul roads may impact upon riparian and aquatic flora and fauna either directly (e.g. through physical damage, noise) or indirectly (e.g. through soil compaction). Alterations to river flow during construction may affect aquatic life, particularly migratory fish. Settling of disturbed sediments may alter the quality of substrates, reducing their value to migratory fish and many invertebrate species.

3.1.2 Pipelines and cables

Pipelines, tunnels and leats may be installed to convey water with a sufficient head to turbines. Cables may be laid to convey generated electricity into the national grid. In general, the longer the length of river impacted, the longer the pipeline and the longer the electric cables, and the greater the potential environmental impact. Disturbance may directly affect riparian flora, but may also have indirect effects due to alterations in site drainage brought about by any channelling effect of underground pipeline/cable trenches. Such drainage may also lead to raised suspended solids in watercourses as may dewatering activities. Disturbance of contaminated soils may also result in pollution of watercourses. Mechanical activities may result in fuel or oil pollution. Other effects may be visual disturbance and damage to archaeological interests. Overground pipelines and overhead cables may be particularly intrusive in upland scenic areas. Where tunnels are required there may be impacts of noise during tunnelling and associated with the disposal of spoil.

3.1.3 Turbine houses

The construction of turbine houses and other buildings may have effects of habitat loss through land take, visual impacts during and after construction, associated sewerage and cement and oil pollution.

3.2 End state/Operational impacts

The main end state/operational impacts will arise from hydrological changes arising from the retention of water behind a dam, diversion of river flow through pipelines and from the discharge regime for power generation. Buildings, maintenance and generation activities may also have some effects. Although the generation of power is not a consumptive use, there may be water resource implications to upstream users.

3.2.1 Impoundment

For smaller hydropower schemes in rivers there are unlikely to be major changes in water quality brought about by prolonged retention time of water allowing siltation, the development of algal blooms and thermal stratification. However, raised water levels and reduced velocities may affect aquatic life. Riparian vegetation may be inundated or affected by a raised water table. Raised groundwater levels may also have implications for drainage patterns and buildings.

The impounding structure may present an obstacle to migrating fish, other wildlife and the passage of canoes and other craft.

3.2.2 Discharge Regime

The discharge regime may have major impacts on downstream water quality, flora and fauna. The extent of impacts will be dependent on the nature of the scheme, i.e. whether water is diverted away from the river and whether it is stored before discharge, the nature (hydrograph) of discharges if these occur and the extent of residual flow. For many schemes there will not be a discharge regime as such, with turbines utilising ambient flow only. Where water is stored, there will be periods of reduced flow followed by the high flows released during generation which may cause washout of banks, sediments and organisms. In addition, there may be the risk of flooding associated with the retention and discharge of water. Changes in flow may disturb downstream users (e.g. anglers, canoeists), have a visual impact, affect the behaviour of migratory fish and have safety implications.

The passage of water through turbines may oxygenate water, generally benefiting aquatic life, although supersaturated water may be damaging. Fish and other aquatic life may also be damaged by passage through turbines.

3.2.3 Abstraction of water

Where water is by-passed through turbines, there will be a reach dependent on the extent of residual flows and periodic low flows. The impacts of low flows will be a reduction in wetted width and water depth, a reduced dilution or flushing capacity and increased sedimentation, all potentially affecting aquatic life.

3.2.4 Other operational issues

The maintenance of turbines may involve the use of antifoulants, chemicals and lubricants, which would have an adverse effect on water quality if they were to enter the watercourse.

3.2.5 Water resources

The abstraction of water and discharge regime may affect holders of existing water rights, particularly downstream of impoundments and along the lengths of river where flow is diverted through pipelines to the turbines. In addition, the NRA will need to have regard for the use of water for hydropower and this may limit future upstream abstraction.

4. Mitigation measures

Alternative sites should be adequately considered where the expected environmental impacts are significant. Mitigation measures should include the following:

- taking care in construction to control site drainage and to minimise the disturbance of sediments and the risk of oil, fuel and cement pollution;
- covering exposed soil/spoil;
- effective on-site sewerage;

- using sympathetic building materials and/or underground construction;
- minimising disturbance caused by haul roads and pipeline construction;
- landscaping of blasting stone (from tunnelling) or use of stone in road or dam construction;
- avoidance of sensitive plants or areas;
- avoidance of sensitive periods, e.g. fish spawning and bird breeding times;
- burying of pipelines and cables with appropriate enhancement and reinstatement of overlying soils and vegetation;
- restriction of abstracted quantities, depending upon river flows;
- provision for residual flow to safeguard the river environment and other users, including provision for measurement and control of the flow;
- provision of adequate monitoring and control;
- provision of fish pass to allow fish migration (upstream and downstream);
- provision of screens at intake and discharge points to stop fish entering turbines; and
- having a water head and discharge regime as a compromise between ideal generation and environmental and other needs.

5. Baseline surveys

River corridor, macroinvertebrate, fish and bird surveys using approved techniques will be required along any river reach affected by impoundment, flow diversion or discharge. In addition, surveys will be required of areas affected by routes of haul roads, pipelines and cables. Landscape and archaeology interest should also be assessed. A detailed study of river hydrology should be made to assess not only generating capacity, but also the minimal acceptable flow and impact of the scheme on wetted area.

The NRA have produced a guidance leaflet on environmental information that may be required.

6. Monitoring and audit

Monitoring should be carried out using appropriate methods to assess impacts predicted and the success of remedial/mitigation works. Operational practice, such as abstraction rates and residual flows should also be recorded.

7. General guidance and references

There is likely to be a limit on the number of hydropower developments permitted within a particular catchment. Further details may be found in the relevant catchment management plan. The following may also be useful.

Department of the Environment/Welsh Office *Planning Policy Guidance Note on Renewable Energy*. PPG 22. HMSO. (A supplementary annex addresses hydropower in more detail).

National Rivers Authority *Hydropower Developments and the National Rivers Authority*.

National Rivers Authority Hydropower Developments. Guidance on Environmental Information Required

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF OIL REFINERIES AND OIL EXPLORATION

1. Introduction

This guidance note seeks to identify the potential impacts oil refineries and oil exploration upon the water environment. It is intended to act as a fairly detailed scoping brief to convey the concerns of the National Rivers Authority (NRA) with respect to the Environmental Assessment (EA) of such development. The NRA has an interest in oil refineries and oil exploration, particularly due to potential impacts on water quality, water resources, flood defence, fisheries and conservation.

EA may be required under planning legislation. However, even where EA is not formally required, it is a useful process by which to convey environmental information required by the NRA and others commenting on development proposals and related applications. The responsibility for obtaining information and/or EA lies with the developer. There are distinct advantages to contact the NRA and conduct environmental studies well in advance of proposed development, such that environmental constraints can be identified and avoided, where possible, and such that appropriate mitigation measures can be incorporated into the planned development. The developer should be able to demonstrate a reasonable consideration of alternatives for a scheme. There should also be the consideration of the wider implications of the development, such as impacts arising from associated infrastructure such as pipelines.

This note does not consider offshore oil exploration and extraction in detail as these are generally outside of the NRA's jurisdiction. However, some coverage is given as developments are occasionally sited in areas within the NRA's remit, i.e. within estuaries, embayments and the 3-mile limit.

2. Development control

Developments, other than those offshore, will generally fall under the Town and Country Planning Framework. These may include exploratory drilling operations. Under the recently consolidated General Development Order the NRA are statutory consultees for development for the purposes of refining or storing mineral oils and their derivatives. Offshore developments are subject to controls exercised by the Department of Trade and Industry (DTI).

3. Environmental Assessment

Under the terms of the Town and Country Planning (Assessment of Environmental Effects) Regulation 1988 (SI Nº 1199) an EA is mandatory for project types listed in Schedule 1 of the regulations, and would normally be required for those listed under Schedule 2 when significant impacts are expected. Relevant Schedule 1 projects include:

"a crude-oil refinery (excluding an undertaking manufacturing only lubricants from crude oil) or an installation for the gasifaction and liquefaction of 500 tonnes or more coal of coal or bituminous shale per day".

Relevant Schedule 2 projects include:

"extracting petroleum";

"a surface industrial installation for the extraction of coal, petroleum, ...";

"the surface storage of fossil fuels";

"the storage of petroleum or petrochemical or chemical products"; and

"the modification of a development which is carried out, where that development is within a description mentioned in Schedule 1".

Guidance on the significance of impacts for Schedule 2 projects has been produced by the Department of the Environment and Welsh Office (as DoE Circular 15/88 (WO Circular 23/88) and DoE/WO (1989)).

4. NRA authorisations

The following licences/consents may be required from the NRA in connection with the development.

i. **Discharge consent** - for discharges to groundwaters, inland surface waters and coastal waters up to three miles offshore.

ii. **Abstraction/impounding licence** - for abstraction or impounding of water.

iii. **Land drainage consent** - will be required for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

5. Major potential impacts

Primarily the NRA will be concerned about impacts relating to water quality, water resources and flood defence. In addition, there will be concern over impacts on fisheries, aquatic biology, conservation, recreation and amenity, archaeology, and stream hydrology and geomorphology. In general, it will be necessary to demonstrate that none of the water quality objectives applied to watercourses are adversely affected. Pollution of surface and groundwaters may result in criminal proceedings, as may any breaches of licence or consent conditions.

5.1 Construction phase

Many of the issues relating to the impacts of construction of oil refineries (and to a lesser extent exploration sites) are covered in more detail in separate guidance on the impacts of general construction.

Land take - Virtually all new developments involve some degree of land take. This results in the general destruction of habitats and displacement or loss of species. Often refineries are sited in coastal locations that may include sensitive habitats, e.g. saltmarshes, wetlands.

Preparation of the working area and construction activity - Site flora and fauna may be damaged through direct damage and through compaction and other physical disruption of the soil. In addition, the temporary disposal of excavated soil may extend the area affected. Excavations may damage archaeological interests. Bankside tree removal may affect certain associated flora and fauna, e.g. birds and bats may use trees as nesting or roosting sites. Bankside trees may also provide shade for rivers; tree loss may result significantly increased river temperatures and plant or algal growth.

Increased runoff resulting from soil compaction and vegetation losses may result in increased river flows and therefore flood risk. In addition, groundwater may be affected by reduced infiltration of precipitation to groundwater. Runoff and soil disturbance may lead to increased soil erosion with an associated increased sediment load in rivers. High suspended solid loadings reduce water quality with direct impacts on both aquatic life and the aesthetic appearance of a watercourse. Sedimentation of solids will in turn alter substrate quality for invertebrates and plants. Fish spawning areas may be particularly damaged by siltation, reducing egg survival. Dust generated on site may add to loads of suspended solids.

The general operation of machinery and vehicles may contribute to problems of soil compaction and stability. Leaking or spilled fuel and oil from vehicles, machinery or storage may contaminate both groundwater and surface waters.

The use of inadequate sewerage and waste disposal facilities may result in pollution of groundwater or surface waters.

The construction of buildings or other facilities in or near water channels may present a flood risk. Culverting or diversion of river channels will have impacts to both land drainage characteristics and aquatic life.

Noise and vibration may disturb wildlife and recreational users of waters.

Construction of a nearshore facility - Nearshore facilities may cause direct damage to aquatic habitats. Indirect impacts may stem from water pollution such as high concentrations of disturbed suspended sediments (with subsequent sedimentation) and from seepage, leaks and spills of oil, fuel, and construction materials (e.g. cement). Facilities, machinery and construction activity may represent a barrier to navigation and migrating fish. Tidal currents may be altered with knock-on effects on bottom substrates and associated life. Blasting may be necessary to penetrate hard rocks, this will cause direct destruction and disturbance of marine habitats, fauna and flora and will result in direct alteration of the bed morphology.

Pipelines may need to constructed and may have a variety of impacts, not least from leakage (see separate guidance on pipelines).

5.2 Operational impacts

Drilling - On land, drilling may lead to a variety of impacts, particularly due to direct or near contact with aquifers resulting in groundwater pollution. Pollution of groundwaters may occur by contamination from additives, drilling muds, lubricants, oil itself and the connection of isolated aquifers.

Drilling nearshore may also place coastal waters at risk. Noise and vibration from drilling operations may cause habitat disturbance resulting in the loss of sensitive species from the area. Drilling muds may contaminate sediments in the vicinity of drilling platforms and potentially over more extensive areas.

Refineries - Discharges from refineries may potentially have major impacts through the effects of heat, oil and other components of effluents. The effects may include the direct loss of species, gradual changes in the ecological communities, and contamination of fish stocks. Discharges to rivers may result in significantly increased river flows and velocities which may cause bank degradation and erosion.

Runoff from the refinery and associated area is likely to become contaminated with oil and fuel from operations and vehicles resulting in a deterioration of receiving water quality.

Major abstractions for cooling water or refinery processes may affect water resources, and river and tidal flows (with associated impacts on aquatic life). Direct impingement or entrainment of aquatic life may occur at the point of abstraction.

The siting of refineries in sensitive coastal areas may have implications for particular species or species groups, such as wading birds, and also for the coastal landscape. Noise and vibration from drilling and refinery operations may cause habitat disturbance resulting in the loss of sensitive species from the area.

Oil pollution - There is a strong risk of groundwater and surface water pollution through the loss of oil. Losses may range from comparatively small, frequent emissions resulting in chronic problems, e.g. seepage during drilling, or from the regular evacuation of ballast water from oil tankers, to major spillages resulting in acute pollution, e.g. from the sinking of a tanker or rupture of storage facilities or pipelines. The effects of oil pollution will depend not only on the quantity of oil lost but also on its quality, i.e. on the fractions involved. The lighter aromatic compounds tend to be volatile and may rapidly dissipate, but also tend to be very toxic to most living organisms, with the degree of toxicity increasing with degree of unsaturation; the heavier aliphatic fractions tend to be less toxic but sink (being heavier than water) and bind to sediments. Thus, the less toxic aliphatic fractions may remain in the sediment for a long time; degradation is slow and therefore can result in long term, low level chronic effects.

Oil can exert toxic effects at all levels of the food chain causing lethal and sublethal effects. The drastic smothering effects of oil on aquatic birds is well known, feathers may become saturated with oil affording the bird less buoyancy, waterproofing and heat insulation; death often follows. Animals may also be exposed to oil pollution through drinking contaminated water. In lower concentrations, oil can still have serious consequences, e.g. very low levels of oil can reduce the viability of fish eggs. Fish flesh may become tainted and therefore this may affect the value of a fishery.

Even small traces of oil in water may be noticeable as a surface film and may thus have an aesthetic impact. Oil on beaches can be a particular aesthetic nuisance.

Emulsifiers and dispersants which may be used to help clear an oil spill may themselves be very toxic and exacerbate the effects of the spill. Similarly, extinguishants used in the event of fire may have toxic effects.

Produced water - Produced water can exceed 50% of well output in a mature well. This contains various polluting and often toxic substances and may be a major source of pollution during the life of a well.

Increased shipping - Shipping activity will increase when a new oil refinery or extraction point is commissioned due to the import and export of oil. This increased activity may hinder existing shipping and will increase the risk of a major accident involving tankers. Pollution risk will also be increased due to ballast water, sewage and waste disposal. Ballast water may also introduce species that are not indigenous to the receiving water, causing ecological and other impacts through competition and the transmission of disease and parasites.

Subsea structures - Subsea structures and offshore wells may represent navigational hazards. However, they may also represent artificial reef structures benefiting fish and other marine life.

6. Mitigation measures

The location and size of developments will be key factors in determining impact significance. Where possible, construction activities (including laying of access roads, pipelines etc.) should avoid sensitive areas, such as:

- flood risk areas, e.g. floodplains;
- wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;
- rivers or coastal areas supporting valuable fisheries or nursery areas;
- areas of conservation importance;
- vulnerable aquifers; and
- upland areas of catchments with particular sensitivities.

The timing of construction and operation should consider disturbance to wildlife and other users. Impacts may be reduced by avoiding sensitive periods, e.g. bird nesting and fish spawning seasons, where possible.

Construction practice - Developers and their contractors should follow building regulations, codes of good practice etc., where these are applicable. Staff, including supervisors, should be made aware of risks of site activity to the environment. Dealing with the environmental impact of the site should be the responsibility of a designated manager, who should establish contact with local NRA staff at the earliest possible opportunity.

Ideally, an environmentally qualified and experienced site supervisor will be employed to ensure the protection and enhancement of the environment.

Permanent and temporary land take should be minimised and original habitat features maintained where possible.

The storage and handling of soil should be such that the area affected is minimised whilst the structure of soils to be restored is maintained as much as possible (i.e. avoid mixing topsoil with underlying material). Stored and other exposed soil or spoil should be covered to minimise silt runoff. Imported material should be avoided where this may contain polluting substances or propagules of invasive plants. Seeding of landscaped areas may or may not be appropriate with suitable seed. Borrow pits should not be excavated in sites of wildlife or other value. Opportunities to create wetland or other habitats should be considered.

Compaction of soils by heavy machinery should be minimised, particularly in sensitive sites, with the use of boards and other temporary supporting structures. Compaction may also be reduced by minimising activities in during wet weather conditions.

Habitats - Wetlands, trees and other important habitats should be retained, where possible. Where breeding/roosting/hibernating sites are inevitably going to be affected, access to these should be prevented prior to and during the relevant periods. Opportunities should be sought to create new habitats, particularly to simulate those lost due to the development.

Chemical storage - Suitably storage should be used for chemicals, fuel and oil in areas away from watercourses and drains with adequate bunding should spillage occur. Drip trays should be used with pumps and other such machinery to catch leaking oil. Paricular care should be taken when pouring concrete or handling cement near watercourses. The risk of pollution from vandalism and theft should be reduced by using tamper proof valves, adequate fencing and security. If pollution of any sort does occur, the NRA should be notified immediately and prompt action taken to minimise effects.

Adequate sewerage and waste disposal facilities and arrangements should be made such that there is a minimal risk of pollution.

Site runoff - The runoff from the site, including car parks and access roads should be routed through facilities to reduce the impacts of runoff itself. Oil separators (interceptors) may be generally appropriate and isolation points and/or underground storage tanks should be designed into the drainage system in loading, process and storage areas with a high risk of spillage. The discharge of cleaner runoff may be regulated by passage through balancing ponds/retention basins. These may also act as sediment traps, as a buffer against poor water quality from storm runoff, and provide useful aquatic and wetland habitats.

Noise - Noise and intrusion should be minimised and avoided at sensitive times, e.g. in the evenings where birds roost in adjacent sites.

Dust - Dust may be dampened down to reduce aerial transmission, but should not be washed into drains etc. Vehicle (wheel) wash facilities should be adequately constructed with containment of the effluent for proper treatment and disposal.

In-channel work - In-channel works should avoid periods of maximum disruption to relevant seasonal activities, i.e. navigation, fish spawning. Interruption to recreational access and navigation should be minimised, although public safety should not compromised. Methods of working should be used that minimise the extent of disturbance to the banks and bed of the river.

Culverting - Culverting should be avoided where possible. When it is unavoidable, the bottom should be continuous with that of the natural stream to allow the uninterrupted passage of fish, and headroom should be maximised to permit light entry and the passage of birds and mammals. Adequate headroom and/or screening will also reduce flood risks.

Waste disposal - Ballast water, sewage and other wastes - should be disposed of to reception facilities on land, where possible. Where disposal at sea is permitted, this should not occur inshore due to the risk of pollution and/or contamination of inshore waters.

Contingency plans - Contingency plans to be used in the event of a major pollution event should be established, including emergency procedures on how to deal with the pollution itself. Where appropriate, booms should available. They should be stored so that they are readily accessible and maintained in good condition. Their condition should be inspected regularly. Staff should be trained regularly on deployment methods so that in the event of an emergency they can be deployed properly, quickly and efficiently. Dispersants should only be used when necessary and where possible, use should be restricted to those which are known to have the lowest toxicity. Emergency procedures should consider the impacts of fire fighting from extinguishants and runoff.

Subsea structures - The decommissioning of an offshore rig should consider the relative merits of retention/removal of subsea structures (although removal may initially be stipulated by the DTI).

7. Baseline surveys

In order to ascertain the detailed impacts of a development, baseline surveys will generally be required, although some relevant information may be available from the NRA and other bodies. Surveys should be conducted at relevant times of year using recommended methods. The findings should highlight particularly sensitive sites, habitats or species.

In general, the NRA will require information (from surveys or otherwise) on:

- river corridor survey (for wildlife conservation);
- fisheries;
- aquatic biology;
- water quality;

- water resources;
- hydrology and hydrogeology;
- landscape/amenity;
- recreation;
- river/coastal geomorphology; and
- archaeology.

8. Monitoring and audit

A monitoring programme relevant to assessing predicted impacts and the success of mitigation works would be welcomed.

Audits of site management practices during construction may ensure that the construction techniques and practices proposed in the environmental assessment do not alter without due consideration for the environment.

9. General guidance and references

Construction Industry Research and Information Association (1994) *Environmental Assessment*. Special Publication 96. CIRIA, London.

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to the procedures*. HMSO, London.

Department of Trade and Industry (1992) *Guidelines for the Environmental Assessment of Cross-country Pipelines*. HMSO, London.

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NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF FORESTRY PROJECTS (to encompass clearfelling, replanting, mid-rotation work)

1. Introduction

This guidance note seeks to identify the potential impacts of forestry projects (to encompass clearfelling, replanting, mid-rotation work) upon the water environment. It is intended to form the basis for a scoping brief to cover the concerns of the National Rivers Authority (NRA) for both statutory and non-statutory Environmental Assessments (EAs). The NRA has an interest in forestry projects due to impacts on water resources, water quality, fisheries, recreation, conservation and flood defence. EA may be required for such projects depending on their scale, nature and expected impacts. The impacts of afforestation should at no time affect the river quality classification, statutory water quality objectives and other use- related environmental quality standards.

The NRA is not necessarily contacted formally about afforestation projects as it not a statutory consultees for these. In addition, the NRA are not specifically mentioned in the Forestry Commission leaflet guide *Consultation for Grant and Felling Applications* (FC 1993a). However, the location, scale, nature and timing of planting schemes are of prime interest to the NRA and the Forestry Commission booklet *Forests and Water Guidelines* (FC 1993b) encourages consultation with water regulatory authorities for all forestry operations and, in particular, for harvesting and pesticide, fertilizer and sewage sludge applications. Consultation with the NRA at an early planning stage will help identify environmental constraints and sensitive areas to be avoided, thus obviating the need for redesigning the scheme or mitigating avoidable impacts at a later stage.

2. Development control

Environmental Assessment of afforestation projects may be required under the Environmental Assessment (Afforestation) Regulations 1988[1] (SI 1988 Nº 1207). The need for EA is ascertained by the Forestry Authority on receipt of a grant application for a new planting proposal, EA not being required for replanting schemes (FC 1993c) or for felling itself. An EA is likely to be deemed necessary where the scheme is expected to have significant effects on the environment and may lead to harmful ecological change in terms of the physical, biological or cultural environment. Relatively little afforestation occurs outside of the Woodland Grant Scheme (1% in 1988).

It should be stressed that it would be desirable for EA to be carried out on a wider scale than is required under statutory procedures, thus including smaller planting schemes in less sensitive areas and also clearfelling and replanting operations.

3. NRA licences

Forestry projects may require NRA licences or consents, most notably land drainage consents will be required for any works on the bed and banks of a river or construction of any structure likely to impede the flow. Examples of such works include access roads, river

[1] Reported to be revised soon in Department of the Environment Circular 3/95 (Welsh Office 12/95).

crossings and diversions. A consent requires the consideration of the consequences to all other NRA functions to be made.

4. Major/Potential impacts

In addition to the location and scale of the project, and the tree species to be planted, the potential impacts of forestry projects vary depending on the stage of the development of the forest and associated activities. Generally, at each stage there will be a risk of oil, fuel or chemical spillage from inadequate storage facilities, leading to surface or groundwater pollution. Vehicle and machinery movements and other activities may disturb sensitive wildlife and lead to soil compaction and erosion. The design of the riparian zone and activities within it are critical to the establishment and protection of good quality terrestrial and riverine habitats.

Ground preparation

Ploughing and other ground preparation may destroy ground flora and fauna and possibly damage archaeological interests. The use of ploughing to install site drainage may cause major impacts on stream hydrology, generally with a more rapid hydrograph response to rainfall with an increased flood risk downstream. The lowering of the water table as a result of drainage will also have hydrological and ecological implications. Rapid drainage from forestry sites may lead to severe erosion of drainage channels, high suspended solid loads and siltation of receiving streams. This will have significant negative effects on the quality of spawning gravels of salmonid fish. High suspended solids may also have more direct effects on water quality, aquatic life and visual amenity. In addition, disturbance and drainage of soils may lead to raised colour, manganese and iron levels in receiving waters with implications for stream ecology and water treatment. General vehicle movements may add to concentrations of suspended solids in runoff; oil or fuel leaks may cause further contamination of surface or groundwaters. The aesthetic appearance of recently ploughed sites may have a visual impact. Planting itself should not have major impacts.

Road construction

The development of access routes may lead to siltation of streams due to changed runoff patterns and high loads of suspended solids from the new road surface and from the construction of bridges and culverts. Cement and raw concrete entering watercourses may be toxic to aquatic life. Culverts may restrict the upstream migration of fish. Road construction may eventually lead to improved recreational access to the site, but initially access would be disrupted by site activity.

Tree Maturation

There will be an increasing acidification potential arising from the action of the developing forestry canopy, filtering out atmospheric pollution (dry and wet deposition). Soft surface waters may be acidified causing the loss of plants, fish, invertebrates and associated species (e.g. dipper), principally due to the mechanism of acidity and aluminium toxicity. The developing canopy will also cause increased shading of riparian and stream plant communities. The thermal characteristics of streams will be influenced by the degree of shade, with more constant, less extreme temperatures featuring in wooded streams. As the trees mature there may be a decreasing water yield from the site and catchment through interception and evapotranspiration losses, with possible low flow impacts and a reduced water resource downstream. Low flow impacts include reduced habitat for fish and other aquatic life, increased temperature and algal growth and a decreased dilution capacity.

Harvesting

General harvesting and associated vehicle movements may lead to raised suspended solids in site drainage and runoff, with associated water quality and siltation problems. Further road building (with associated impacts) may be required to facilitate access for timber haulage. The use of vehicles, chain saws and other machinery may lead to oil pollution. With the felling of trees, streamflow and water yield may change, depending on land use pre- and post-planting, and modifications to site drainage. Trash dams, consisting of woodland debris may obstruct fish movements and change river habitat features. Access will generally be disrupted during harvesting, but may be generally improved with the construction of haulage roads. Aesthetically, the appearance of the site will deteriorate post harvest. Ecologically, the site will initially be colonised by pioneer species rather than by the pre-afforestation flora. Tree debris remaining on site and soil leaching will continue to contribute nutrients to receiving waters. In base-poor catchments nitrate loss may enhance surface water acidity and aluminium concentrations for the first few years after clearfelling.

Pesticide, fertiliser and sewage sludge application

Pesticides applied in the establishment phase may contaminate surface and groundwaters. Eutrophication may arise from the seepage of fertiliser (e.g. phosphate) into surface waters. The use of organic fertilisers such as sewage sludge may also result in organic and other forms of pollution (i.e. raised BOD, lowered dissolved oxygen, raised heavy metals). Fertilisation of the soil will also affect plant communities in both terrestrial and aquatic habitats.

Replanting

Replanting or restocking will lead to impacts similar to initial site preparation from ploughing and drainage activity, and from the application of fertilisers and pesticides. Acidification may be further enhanced. The opportunity to redesign according to current best practice should allow some impacts to be ameliorated.

5. Mitigation measures

Primary considerations should be the location and size of proposed forestry projects. Where possible, the proposed siting of forestry projects should avoid sensitive areas such as: groundwater source protection zones; potable supply catchments; catchments with limited water resources; acid sensitive catchments; flood risk areas, and areas of other importance (e.g. for conservation, fisheries, or recreation). Cumulative impacts may be reduced by a scaling down the extent of forestry proposals.

Foresters should follow the *Forests & Water Guidelines* (FMC 1993b) for good practice with respect to NRA concerns. In these guidelines, the concept of critical load of atmospherically-derived acidity is explained in the context of strategic considerations of the catchment capacity for new planting. The guidelines also include detailed recommendations with respect to ground preparation. the use of buffer strips or areas, management of riparian vegetation, road construction, harvesting, the storage of fuel and chemicals and the use of pesticides and fertilisers. Liaison with the NRA is the rule to ensure appropriate implementation of these guidelines. Some key recommendations are outlined below.

Ground preparation - Minimise cultivation, do not plough deeper than necessary, align drains near parallel to contours, end drains away from watercourses and install silt traps, maintain silt traps and drains outside of sensitive periods (October to May for salmonid fish).

Use of buffer areas - Design uncultivated areas of land around watercourses to reduce the amounts of sediment and nutrient runoff.

Riparian management - Manage such that the aquatic environment is protected or enhanced and the value of distinctive riparian habitats is maintained or enhanced, follow *Forest Nature Conservation Guidelines* (FC 1990).

Road construction - Avoid riparian zones, minimise erosion, use appropriate construction materials, design culverts so as not to obstruct fish movements, design roadside drains to drain road areas only and to discharge to buffer areas where drains are likely to carry high sediment loads.

Harvesting - Liaise with NRA and consider phased felling in sensitive catchments, stack timber away from watercourses, plan to minimise stream and drain crossings in felling and extraction.

Storage of fuel and chemicals - Use bunded tanks or stores away from watercourses (preferably off-site) and lock when unattended. Avoid fuel spillages.

Use of pesticides and fertilisers - follow guidance such as *the Provisional code of practice for the use of pesticides in forestry* (FC 1989) and those on the use of herbicides on weeds in or near watercourses and lakes (MAFF 1985, NRA 1995a). Consult the NRA before the use of any pesticide in or near water or aerial applications on land adjacent to water.

6. Baseline surveys

Assessments should be made of various aspects of environmental quality from studies of existing data (NRA, conservation bodies etc.) and from desk and field surveys using approved techniques. The NRA should identify which data they hold that are relevant and highlight particularly sensitive sites.

Key factors to be considered are:

- site geology, soils and vulnerability to acidification;
- water quality of surface and groundwaters;
- water resources, flood defence and hydrology; fisheries;
- other fauna and flora, river corridor surveys;

- landscape;
- recreation and other uses.

7. Monitoring and audit

Monitoring that is relevant to predicted impacts and mitigation measures is desirable and should not only make use of baseline surveys but also consider further pre-scheme surveys. Post-scheme monitoring data should be regularly reviewed. The review or audit should also include compliance with agreed management practices. Further guidance on monitoring and best practice are being developed as part of the NRA Forestry Business Plan (NRA 1995b).

8. General guidance and references

A variety of literature and guidance is available as listed below. *The Forests and Water Guidelines* (FC 1993b) should be used as a key reference.

Forestry Commission (1989) *Provisional Code of Practice for the Use of Pesticides in Forestry*. Occasional Paper 21. Forestry Commission, Edinburgh.

Forestry Commission (1990) *Forest Nature Conservation Guidelines*. Forestry Commission.

Forestry Commission (1993a) *Consultation for Grant and Felling Applications*. Forestry Commission, Edinburgh.

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Forestry Commission (1993c) *Environmental Assessment of New Woodlands*. Forestry Commission, Edinburgh.

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NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF THE REDEVELOPMENT OF CONTAMINATED LAND

1. Introduction

This guidance note seeks to identify the potential impacts of the redevelopment of contaminated land upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for environmental impact studies at redevelopment sites. The NRA has an interest in the redevelopment of contaminated land due to its general environmental duties and in particular due to its responsibilities for water quality and water resources. There is often a significant risk of pollution of groundwater and surface waters from such developments, amongst other impacts.

Contaminated land is defined in the Environment Bill as "any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that significant harm or pollution of controlled waters is being, or is likely to be, caused". Examples of contaminated land include: former waste disposal facilities, such as completed landfill sites, waste tips, sewage sludge dumping areas etc.; former industrial sites, such as gas works, manufacturing and engineering works etc.; the sites of former mines; and land previously used for agriculture or horticulture. Contaminated land may be derelict or in operational use; the contamination is often contained, until redevelopment. (The Department of the Environment (DoE) has recently issued draft guidance for local authorities in determining whether land is contaminated for the purposes of the Environmental Protection Act 1990, the existing legislation relevant to such land).

In order for the NRA to comment on planning applications and/or issue relevant licences or consents (Section 4), the Authority will require certain environmental information. As such environmental studies may be required, even if there is not a legal requirement for formal Environmental Assessment (EA) with the production of an environmental statement (ES). The responsibility for environmental studies/assessment lies with developer. There are distinct advantages to contact the NRA at an early stage of proposals and conduct studies/EA in advance of detailed planning so that a proper consideration of alternatives (siting, construction techniques, design etc.) and mitigation measures can be considered.

Relevant information on the policy of the NRA on contaminated land are set out in the NRA document *Contaminated Land and the Water Environment* (NRA 1994a) and in *National guidelines on redevelopment of contaminated land* (NRA 1994b). In addition, a further policy document *Policy and Protection of Groundwater* (NRA 1992) may be relevant with respect to constraints on the redevelopment of contaminated land arising from the risk of pollution of groundwaters. Relevant Government guidance includes DoE Circular 21/87 (now somewhat dated), the more recent Planning Policy Guidance, PPG 23 *Planning and Pollution Control*, and that from the Interdepartmental Committee on the Redevelopment of Contaminated Land (e.g. ICRCL 1987). The DoE and Welsh Office have recently published *Framework for Contaminated Land: Outcome of the Government's Policy Review and Conclusions from the Consultation Paper - Paying for our Past* (DoE/WO 1994). Whilst the Government encourages the development of contaminated land, thereby minimising avoidable pressures for new development on greenfield sites, remedial action may be required where there are unacceptable actual or potential risks to the environment. The DoE Contaminated Land Report series (DoE 1994a, 1994b, 1994c, 1994d, 1994e) may be relevant to developers.

New government guidance will be forthcoming in 1995; the NRA guidance is provided for interim use until this has been published.

2. Development control

Development controls applicable to redevelopment of contaminated land will vary according to the nature of the proposal. Typically, projects may fall under the Town and Country Planning framework.

3. Environmental Assessment

The redevelopment of contaminated land *per se* does not require EA. The relevant regulations, e.g. the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No. 1199), refer to specific project types such as industrial estates and power stations which may require an EA and be constructed on contaminated sites. Also, the need for an EA is often assessed on the basis of significance of expected impacts. Potentially, significant impacts from the disturbance of contaminated land may thus trigger the need for EA.

Regardless of any statutory requirement for a full EA, the NRA will require a site investigation as a condition or prerequisite of any planning permission at contaminated sites posing a threat to water resources. Such an investigation will include hydrogeological assessment and a risk-based impact assessment of the effect of the development on groundwater and surface waters. In general, the "source-pathway-receptor" philosophy should be employed as set out in DoE (1994a).

4. NRA licences

The NRA are responsible for issuing the following licences/consents that may be required in the redevelopment of contaminated land.

i. **Discharge consent** - for discharges to groundwater or surface waters (e.g. from dewatering operations). Prohibition Notices may be used to control discharges from clean up (pump and treat) operations.

ii. **Abstraction licence** - for abstractions from surface or groundwaters, including testing boreholes.

iii. **Impounding licence** - for the impoundment of surface water.

iv. **Land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

Land drainage and impounding licences must be obtained in advance of any construction, regardless of whether planning permission has been granted. Permission to discharge must be obtained prior to any discharges.

5. Major Potential Impacts

In general, the key impact of concern to the NRA in the redevelopment of contaminated land will be pollution of groundwater or surface waters, which may occur to a major degree. Contamination of waters will be regarded as pollution when either of the following factors occur (NRA 1994a):

- there is a breach of a water quality standard (WQS) or other internationally agreed standard/action, e.g. North Sea Conference 1987 (Reduction of Red List substances); or

- there is evidence of poor water quality or harm to the systems the water supports.

Typical substances in contaminated land include heavy metals, acids/alkalis, ammonia, phenols and other organic compounds, especially halogenated solvents (Beckett *et al.* 1992). Microbial contamination may also be at significant levels. Leaching of these substances may affect water quality affecting uses of the water (e.g. for abstraction) and aquatic life. Factors potentially causing pollution and other impacts are indicated below.

5.1 Site investigation

Although an essential element of successful redevelopment work, investigation boreholes may disturb both natural and man-made impermeable layers below contaminated sites leading to the release of contaminants and hence groundwater pollution. Such layers may include concrete foundations and basement floors, and clay layers.

5.2 Site preparation

Site demolition and stripping can cause the release of contaminants by damaging impermeable layers both above and below contaminated sites and exposing contaminated layers to rainfall resulting in the generation of noxious leachate. Exposure of contaminated soils may add to leachate problems through oxidative processes. Excavations may lead to the further release of contaminants from damage to pockets of concentrated contamination (e.g. in underground tanks, drums and pipes) and may damage underground services, sewers, culverts and drains with direct contamination of these. Also, excavation activity may lead to high levels of suspended solids and other contamination of runoff, causing pollution of receiving waters. Settlement of solids may affect the substrate as a habitat from both siltation and contamination of sediments. The dust and windblow may be further sources of solids entering watercourses.

Dewatering of construction areas within or adjacent to contaminated land may draw contaminated water out of containment. Disposal of pumped water may cause pollution of receiving waters. General flooding of sites during redevelopment may lead to the dispersal of contamination and pollution.

During the preparation and development of sites, access to or through the site may be restricted, potentially affecting public recreation and maintenance of flood defences etc.

5.3 Foundations

Piling may puncture impermeable layers containing contamination, thus providing a route for leachate to enter groundwater (or surface waters). Some piling techniques (e.g. vibro replacement piling) are likely to enhance the downward migration of contaminants.

5.4 Development

The development itself may give rise to particular impacts related to the development itself rather than due to the prior contamination of the site. These development specific impacts may be covered by other NRA guidance. However, some of the impacts of development relate more specifically to the fact that the site is contaminated.

Where development results in a rise in groundwater levels, e.g. from the creation of water bodies or the cessation of abstraction, the rise in water table may lead to mobilisation of contaminants and subsequent pollution.

Measures to minimise infiltration and the laying of impermeable surfaces (roads, car parks and buildings) may result in increased runoff potentially causing flow-related problems impacts (e.g. flooding, erosion) in receiving waters.

6. Mitigation measures

Mitigation measures are described briefly below - for detailed guidance see NRA (1994b). The NRA may object fundamentally to a development unless there are adequate environmental safeguards.

6.1 Site decontamination

Mitigation options will be very much case specific, depending on factors including the nature of contamination and the intended use of the land once redeveloped. The government advocates a "suitable for use" approach to remediating contaminated land, a view supported by the NRA.

Permanent clean-up of contaminated sites using physical, chemical or biological techniques are available. In addition, chemical treatment may not restore a soil to an uncontaminated state, but merely 'lock-up' contaminants that may be released at a later date. The use of microbial degradation may present a risk, albeit short term, to groundwater quality unless adequate precautions are taken, such as lining the site. Removal of the contaminated ground for disposal elsewhere may be a viable option and is certainly the most common practice today, but merely transfers the problem to the receiving site. (Such disposal is subject to the same waste disposal regulations as apply to other 'controlled wastes'). Often the pragmatic approach, where the nature of the development is not seriously compromised by the contamination, is to redevelop the land with contamination *in situ*, incorporating various measures to contain or encapsulate the contaminants. Examples of such possible measures are considered below.

6.2 Containment

6.2.1 Site investigation

Investigative boreholes should be drilled using methods which minimise the risk of spreading contamination deeper into the ground. Temporary drilling casings should closely follow the base of the hole as it is drilled, and all perched water tables should be sealed out as effectively as possible. Wherever possible clay layers below the site should be left intact. Special precautions may be necessary when it is necessary to penetrate an underlying aquifer (see Naylor *et al.* (1978) for guidance). Temporary boreholes should be sealed up using appropriate methods, e.g. bentonite/cement grouts or plugs.

6.2.2 Site preparation and development

Methods of stripping and preparing the site should be chosen that minimise the risk of disturbing containment of the contaminated land.

Where surface soils may carry contamination, wheel washing facilities should be installed and utilised for vehicles leaving the site.

Alternative choices of piling techniques may be used to reduce the likelihood of damage to impermeable layers and the release of contaminants.

Dewatering operations should only be done with prior consultation with the NRA. Waters with a high pollution potential may need to be discharged to sewer with the appropriate consent of the relevant water utility. Tankering off site may also be an option.

Covering over of contaminated land with impermeable surface such as hot-rolled asphalt will reduce the risk of infiltration of rainfall and leachate generation. The risk of leachate production will increase with permeability of cover material. However, the overground flow of runoff should not be blocked by demolished, excavated or other material.

The construction and use of balancing lagoons may reduce the impacts of runoff or leachate from a site which may be inevitable at various stages of redevelopment, particularly following heavy rainfall.

Containment of horizontal underground flow may be achieved by the insertion of cut-off walls and/or by the installation of leachate collection systems. Upward movement of contaminants may be prevented by the installation of capillary breaks.

6.3 Restoration of access

Rights of way and other prior uses of sites should be restored as part of site redevelopment.

7. Baseline survey

Surveys should be designed in consultation with the NRA. The following may generally apply.

Site investigation - Following a review to ascertain historical uses of the site (and hence probable contaminants), an extensive site investigation should be carried out, incorporating carefully drilled investigation boreholes and trial pits to study groundwater levels, groundwater quality and the nature of contamination. Site investigations may be reduced in scale or targeted where the results of any previous investigations are available.

Water quality analysis - Analyses should be conducted relevant to the contamination anticipated from the previous use of the site. For example, analysis for ammonia, polynuclear aromatic hydrocarbons (PAHs) phenols, tars and other organics would be appropriate for the site of former gas works.

Leaching tests - Tests should be conducted using NRA recommended methodologies (NRA 1994c) to assess the potential of the contaminated land for groundwater pollution from leaching. (Note that although the ICRCL provides guideline figures for contaminated land, known as trigger values, these relate primarily to the impact on people or plants of direct contact with the contaminated material, and do not indicate the danger to water resources. Leaching tests provide a better indicator of such risks.)

Hydrogeological and hydrological studies - Studies should be carried out on a wide scale to ascertain the drainage flow patterns. The water quality, uses and ecological status of receiving (or potentially receiving) waters should also be ascertained; the NRA may hold relevant data. The studies should be designed to enable an impact assessment to be undertaken to predict effects on underlying groundwater, nearby surface water systems and any target receptors such as abstraction boreholes in the area (DoE 1994a).

On-site ecology should be studied; often contaminated sites may develop a unique flora. River corridor surveys may be appropriate.

8. Monitoring and audit

Monitoring programmes should be established that are relevant to predicted impacts and remedial/mitigation works. Generally, permanent groundwater quality monitoring boreholes may be required to detect changes to, and the movement of, contamination.

9. Further guidance and references

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DoE (1994d) *Sampling strategies for contaminated land* Contaminated Land Research Report 4.

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NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF WASTE DISPOSAL FACILITIES

1. Introduction

This guidance note seeks to identify the potential impacts upon the water environment of developments for the purposes of waste disposal. It is intended to act as a fairly detailed general scoping brief to cover the concerns of the National Rivers Authority (NRA) for the assessment of the environmental effects of such developments. The NRA has an interest in waste disposal sites due to its general environmental responsibilities and particularly with respect to the control of pollution of groundwater and surface waters. Legislation may require a formal Environmental Assessment (EA) of the proposed development. Otherwise, an EA may still represent a useful process to gather and convey any environmental information required by those commenting on such development proposals.

The responsibility for the assessment lies with developer. Conclusions made in the assessment will require proper justification and the raw data upon which conclusions are based should be accessible, if required. There are distinct advantages to both contact the NRA and to conduct an EA at an early stage such that any environmental constraints (e.g. the proximity of vulnerable aquifers) can be identified in advance of detailed planning and so that there can be the proper consideration of alternatives and mitigation measures.

Under the Environmental Protection Act 1990 (EPA 1990), types of waste are divided into two major categories:

- **controlled waste** - household, industrial and commercial waste or any such waste; and
- **special waste** - controlled waste of any kind that is dangerous or difficult to treat, keep or dispose of.

Certain other wastes, namely radioactive waste, some wastes from mines and quarries, explosives and some agricultural wastes are subject to separate regulatory provisions. Guidance on which mine and agricultural wastes should be treated as controlled waste is given in DoE Circular 11/94 (Welsh Office Circular 26/94).

The general definitions of waste and particular waste types are given in more detail in the Environmental Protection Act 1990, the Control of Pollution (Special Waste) Regulations (SI 1980 Nº 1709) and discussed in the Department of the Environment Circular 24/92 (Welsh Office Circular 30/92) on controlled waste. There are currently proposals (*The hazardous waste Directive, the special waste regulations 1995*) to change the definitions of waste categories, which are due to be implemented in 1995.

This briefing note includes consideration of the following as waste disposal sites: waste transfer stations; scrap yards; bailing plants; recycling plants; solvent recovery plants; waste treatment plants; incinerators; and disposal of sludge to land.

Although sewage sludge is not technically defined as controlled waste when disposed of in a beneficial manner to agricultural land, it is considered briefly in this note to complement disposal by incineration. (Disposal at sea is no longer a long-term option). Landfill sites are not discussed in detail as relevant guidance exists on landfills in the context of the restoration of mineral extraction sites. The latter guidance does not consider landfill development on green field sites; the general impacts of development on such sites are covered by other guidance on general construction activity. In addition, this note does not specifically address the disposal of radioactive waste.

The EA of waste treatment and disposal sites is discussed in some detail by Petts and Edujee (1994) and CIRIA (1994). Waste Management Papers may be relevant to specific types and waste and to facilities. The NRA policy with respect to the protection of groundwaters is available (NRA 1992).

2. Development control

The development control of waste disposal sites is within the Town and Country Planning framework. Under the recently consolidated General Development Order the NRA is a statutory consultee for "development involving the use of land for the deposit of refuse or waste" and "development relating to the retention, treatment or disposal of sewage, trade waste, slurry or sludge..". Planning Policy Guidance PPG 23 on *Planning and Pollution Control* provides further relevant information.

3. Environmental Assessment

Environmental Assessment may be required for waste disposal sites under the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No. 1199). Developments on Schedule 1 of the Regulations for which EA is mandatory include:

- "a waste-disposal installation for the incineration or chemical treatment of special waste";
- "the carrying out of operations whereby land is filled with special waste, or the change of use of land (where a material change) to use for the deposit of such waste"; and
- "an installation designed solely for the permanent storage or final disposal of radioactive waste".

Waste disposal related development listed under Schedule 2, i.e. those requiring EA where significant impacts are expected, include:

- "an installation for the disposal of controlled waste or waste from mines and quarries, not being an installation falling within Schedule 1";
- "a waste water treatment plant";
- "a site for depositing sludge",
- "the storage of scrap"; and
- "modification of development listed under Schedule 1".

Government guidance on the Regulations (DoE Circular 15/88 and DoE 1989a) with respect to identifying which Schedule 2 projects do require EA suggest a threshold capacity of 75,000 tonnes a year for installations, including landfill sites, for the transfer, treatment or disposal of household, industrial and commercial wastes. The guidance also suggests that "Except in the most sensitive locations, sites taking smaller tonnages of these wastes, Civil Amenity sites, and sites seeking only to accept inert wastes (demolition, rubble, etc.) are unlikely to be candidates for EA". However, significant impacts may occur from developments not meeting the suggested criteria and EA should still be considered.

HMIP may be able to provide relevant guidance on the need for EA and EA methodologies.

4. NRA licences

Waste management developments may require a number of licences from the NRA, such as:

- **discharge consent** - for a discharge to groundwaters, inland and coastal surface waters;
- **abstraction licence** - for abstraction from groundwater or surface waters;
- **impounding licence** - for impounding surface waters; and
- **land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

5. Major potential impacts

Waste management sites will have many general impacts common to a variety of types of operation, and a number of process-specific impacts. In this context depots, waste transfer stations, scrap yards, bailing and recycling plants are combined under the heading of waste handling. Solvent recovery plants, waste treatment plants, incinerators and sludge to land are considered more specifically and may have impacts additional to those from waste handling. The impacts of operations are discussed below; impacts arising from the construction of waste management sites (e.g. from land take, site preparation etc.) is discussed in other guidance.

5.1 Waste handling

A major potential impact is that of the pollution of surface (or ground) waters arising from runoff and spillages, leading to reduced water quality and associated impacts on fish, other aquatic life and water resources. The aesthetic (and chemical) quality of watercourses may also be affected by solid wastes (e.g. litter) entering watercourses via windblow or runoff. Fine particulates and poorly (water) soluble contaminants may contaminate stream sediments. Both major spillages and gradual leakages from sites may result in the long-term contamination of the both land and groundwaters. The lining of sites, e.g. by the laying of an impermeable base of concrete, will protect groundwater resources from such damage but there may be a loss of infiltration to underlying aquifers.

Site activity, machinery, vehicle movements, and the sound of vehicle reversing warning sirens, may disturb wildlife and recreational users of watercourses.

Waste handling sites may detract from landscape quality.

Infrastructure associated with waste handling sites, e.g. sewers, power and water supplies, may have impacts beyond the site boundaries and should also be considered.

5.2 Solvent recovery plants

Spillages of solvents may be particularly damaging to surface water quality ecosystems. In addition, groundwaters may be particularly vulnerable to solvent contamination, causing long term damage to water resources.

5.3 Waste treatment plants

The potential impacts of waste treatment plants will vary according to the waste treated and treatment methods. Surface or groundwater pollution are likely potential impacts.

5.4 Incinerators

Thermal discharges, e.g. of cooling water, may cause temperature stress on aquatic ecosystems and alter fish and other ecological communities. Temperature increases may also have secondary effects such as altering concentrations of dissolved oxygen, unionised ammonia and other ecologically relevant substances. Discharges of cooling water may contain biocides and other potentially polluting contaminants.

Abstraction of surface waters for cooling may cause problems of low flow, damaging ecological systems, and mortalities of fish and other life by impingement at intakes.

Aqueous discharges may arise (other than cooling water) from processes such as the dewatering of waste with a high moisture content (e.g. sewage sludge) and aqueous scrubbing of air emissions. Such discharges may contain highly polluting contaminants, depending on the nature of wastes and incineration processes. Discharges may have both impacts on surfaces waters from direct discharge or indirectly via sewage treatment.

Incinerators, particularly emission stacks and gaseous emissions themselves may have particularly significant impacts on landscape quality.

Gaseous emissions may also ultimately damage aquatic and other ecosystems from the settling of contaminants and from effects of acidification. Certain organic contaminants, such as PCBs, may be liable to bioaccumulate within ecosystems, thus placing predators at particular risk.

Solid wastes such as ash may have impacts on water quality, e.g. from leachate or runoff in handling, storage or disposal. Depending on the nature of the waste incinerated, ash may contain high concentrations of certain contaminants, such as heavy metals. The content of metals in sewage sludge will generally vary according to the proportion of industrial discharges in the sewage collection catchment.

5.5 Sludge to land

The impacts of sludge disposal include contamination of groundwater and surface waters arising from leaching from the sludge. The content of sludge (and its suitability to apply to land) may be very much dependent on the proportion and quality of industrial sewage treated. Direct contamination of surface waters may occur from runoff of sludge, e.g.

following heavy rainfall, causing damage to fish and other aquatic life and associated recreation such as angling. Change in plant communities may occur where sludge or runoff comes into contact with such communities. Recreational use of nearby watercourses may also be affected by strong odours.

6. Mitigation measures

Strategically, measures to minimise waste production should be adopted including recycling, composting and the use of digesters. Energy generation or heat recovery should occur when wastes are incinerated or digested.

Individual proposals should consider alternative sites and processes (the consideration of Best Practicable Environmental Option (BPEO) may be a requirement for certain development proposals under the EPA 1990).

The proposed location of waste management operations should avoid sensitive areas such as:

- vulnerable aquifers;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable fisheries;
- river floodplains, lakes, wetlands and marshes; and
- upland areas of catchments with particular sensitivities.

6.1 Waste handling

With suitable precautions, the risks to the aquatic environment may be minimised.

Sites should be distant from receiving rivers or aquifers at risk from pollution; buffer zones should be used if available.

Sites should be constructed on low gradients (i.e. less than 5%) to reduce severity of runoff and drainage requirements.

Sites should be lined with an impermeable layer, e.g. concrete, with carefully designed drainage systems incorporating sediment traps, grease separators (interceptors), and drainage storage tanks with sufficient volume for runoff, spillage and fire water.

On site, covered bays should be installed in transfer stations and in storage areas etc. to reduce rainfall-induced generation of leachate from wastes.

Adequate bunding should be installed around liquid waste tanks, fuel and other stores. Bund walls should be protected from collision damage.

Vehicles loaded with liquids should not be left overnight in areas without bunds or similar protection.

Vehicle and container wash down areas should have suitable drainage and collection systems. Drainage water should subsequently be treated.

The risks of spillage should be reduced by the adoption of safe operating procedures. There should be verification of incoming waste types and appropriate separation of wastes to avoid unstable mixtures of incompatible chemicals.

6.2 Solvent recovery plants

Storage tanks should be subject to particularly stringent containment, incorporating double lining, leak detection equipment and below ground interception facilities. Also, particular measures should be taken to prevent damage to surface water systems in the event of spillages.

6.3 Waste treatment plants

Mitigation options will depend on the types of waste and treatment processes.

6.4 Incinerators

Recycling of flue gas scrubber and other effluents and the use of storage/balancing lagoons will reduce or prevent discharges to surface waters. Such storage should be of sufficient capacity for complete containment and lined if necessary to prevent contamination of groundwaters. Effluent may be best disposed of via a specific or general treatment works, e.g. effluent from sewage sludge incinerators may conveniently be treated at the sewage treatment works generating the sludge.

Measures should be adopted to ensure complete combustion, thereby reducing risks of pollution from air emissions, effluents and leaching of solid residues.

6.5 Sludge to land

Sludge disposal should follow guidance (e.g. WRc/Silsoe College 1985, DoE 1989b, MAFF 1991) to avoid contamination of groundwaters, surface waters and damage to sensitive sites of conservation interest. Unsuitable weather conditions, e.g. frozen ground or heavy rainfall, should be avoided. Sludge injection may be have a lesser associated risk of problems of surface water pollution and odour.

7. Baseline surveys

The surveys required will vary to some extent depending on the nature of the proposed development and site. In each case the methods used should be relevant with respect to timing, methods used and the nature of the development. In general, the following survey types should be regarded as a minimum:

- hydrogeology - location of aquifers;
- water quality of groundwater and surface waters;
- hydrology and drainage; and

- landscape/amenity.

Where rivers are at risk from runoff or other discharges the following surveys should be considered:

- river corridor survey (of wildlife and habitats);
- aquatic ecology, including fisheries; and
- recreational use.

Baseline surveys with respect to incinerators should also consider the where fall-out of air emissions is expected (i.e. on the basis of wind direction etc.).

8. Monitoring and audit

Monitoring relevant to the predicted impacts and mitigation works should be carried out. Monitoring data should be periodically reviewed and measures taken should unexpected impacts occur.

9. References and further guidance

Construction Industry Research and Information Association (1994) *Environmental Assessment*. Special Publication 96. CIRIA, London.

Department of the Environment/Welsh Office (1989a) *Environmental Assessment: a guide to the procedures*. HMSO, London.

Department of the Environment (1989b) *Code of Practice for Agricultural Use of Sewage Sludge*. HMSO, London.

National Rivers Authority (1992) Policy and Practice for the Protection of Groundwater. HMSO, London.

NRA (1994a) *Abandoned mines and the water environment*. Water Quality Series Nº14. HMSO, London.

National Rivers Authority (1994b) Contaminated Land and the Water Environment. Water Quality Series Nº15. HMSO, London.

Petts, J. and Edujee, G. (1994) Environmental Impact Assessment for Waste Treatment and Disposal Facilities. John Wiley & Sons Ltd., Chichester.

Ministry of Agriculture, Fisheries and Food (1991) *A Code of Good Agricultural Practice for the Protection of Water*. MAFF, London.

WRc/Silsoe College (1985) Soil Injection of Sewage Sludge: A code of practice.

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF MINING AND QUARRYING OPERATIONS

1. Introduction

This guidance note seeks to identify the potential impacts of mining and quarrying operations upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of mineral extraction schemes. The NRA has a interest in such projects due to its environmental responsibilities and particularly with respect to those for water quality, water resources and conservation. Formal EA may be required under planning legislation. Where an EA is not required, environmental information may still be required by the planning authority and other interested parties, including the NRA. The NRA are statutory consultees for developments involving or including mining operations and are also the licensing authority for water abstraction and other relevant issues. An EA is often a useful way of presenting the environmental information required to process planning and licence applications.

The responsibility for carrying out an EA lies with the developer. The conclusions reached in an assessment require proper justification and the raw data upon which such conclusions are based should be accessible to interested parties. It is a distinct advantage to consult with the NRA and initiate the EA process in advance of detailed plans, such that environmental constraints and mitigation opportunities are recognised at an early stage and there is the proper consideration of alternatives.

Mining and quarrying proposals should have due regard to Mineral Plans produced by Mineral Planning Authorities and Mineral Planning Guidance issued by the DoE. In this document, both mining and quarrying are implied by the use of the term of mineral extraction.

Mineral extraction is often a precursor for other schemes relating to the after use of sites, e.g. for landfill. Such further development is considered by other NRA guidance.

2. Development control

Mineral extraction falls under the Town and Country Planning framework. Planning permission may include conditions with respect to the restoration and aftercare of mineral workings. Boreholes drilled in connection with proposed mineral extraction may also require planning permission.

3. Environmental Assessment

The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No. 1199) cover various types of extractive industry as Schedule 2 projects, i.e. for which a formal EA is required where significant environmental impacts are expected. The types of industry listed in Government guidance on these regulations (DoE/WO 1989) are presented as Appendix 1 of this note. The guidance indicates the scale or location of operations expected to have significant impacts.

This note concentrates on the extraction of solid minerals and includes underground and opencast mining. Quarries can in many respects be regarded as open-cast mines for non-energy producing minerals. Extraction of aggregates on large scale from coastal sites, the so-called "super quarries", are not specifically considered here as proposals for these have concentrated on Scottish sites. Also, excluded from this guidance is consideration of the dredging of aggregates from marine sites.

EAs may also be required for installations for the disposal of wastes from mines and quarries.

4. NRA licences

The NRA is the licensing authority for the following:

- **discharge consents** - for discharges to all controlled waters (i.e. groundwaters, inland and coastal surface waters);
- **abstraction licences** - for water abstraction from groundwater or surface waters;
- **impounding licences** - for impoundment of surface waters; and
- **land drainage consents** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

Land drainage and impounding licences must be obtained in advance of any construction, regardless of whether planning permission has been granted. Permission to discharge must be obtained prior to operation

5. Major Potential Impacts

Impacts are presented largely for the operation of mines and quarries. Site investigation or prospecting activity may have some minor impacts from the transportation and access of drilling machinery and operators, and site works such as borehole drilling itself. These are not discussed further, but may need to be considered. Construction activity such as to prepare the site are considered briefly. For more information on the impacts arising from the general construction of access roads, site buildings etc., refer to other NRA guidance. Similarly, the restoration of mineral extraction sites, e.g. for landfill or recreational use, is covered in detail by separate guidance. The processing of materials from quarries or mines may be performed on site and may have a variety of impacts. NRA guidance on general industry may be applicable, as may guidance from the DoE on specific processes subject to the Environmental Protection Act 1990.

5.1 Construction

Site works may include clearance of the ground surface for access roads, vehicle parks, buildings, process works or for mining itself. Ground clearance will extend to the removal of soils and overburden in areas to be mined/quarried. The principal impacts of ground clearance will be ecological and hydrological. In addition, clearance may disturb or destroy items of archaeological interest.

Ecological impacts from ground clearance will arise from the direct destruction and removal of vegetation and soil structure. The storage and disposal of soil and overburden may also smother habitats. Indirect impacts may arise from hydrological changes and pollution. Soil compaction from vehicle movements and storage of overburden may also affect the long-term recovery of sites.

Hydrological impacts will arise from the loss of the moisture holding capacity of overlying soils and vegetation, and runoff resulting from cleared ground. Runoff may carry high sediment loads into receiving watercourses, affecting water quality and stream ecology. Sediment may damage stream life by direct abrasion and smothering or indirectly from the turbidity cutting out light and settlement of sediment altering substrate composition. Of particular concern to the NRA may be the siltation of gravel areas used by spawning salmon and trout.

Mounds of soils and overburden may be further sources of particulates. In addition, due to exposure of mineral layers to air, leachate from overburden may pollute receiving streams with chemicals such as acids and metals. Disturbed soils may also be significant sources of nitrates released by mineralisation. Nitrates entering watercourses may have impacts on water resources (via drinking water quality) and cause eutrophication, i.e. excessive plant or algal growth

Increased stream flow from runoff may cause stream habitats to become unsuitable for some organisms and may cause erosion of streambed and banks. Stream flows may be reduced in dry periods due to the loss of seepage from the formerly overlying soils and alterations to the water table (see below). Where sites of mineral extraction are extensive, e.g. opencast sites, streams may need to be diverted and site drainage installed. This will destroy or damage established communities and river geomorphology. New channels will have an altered ecology, hydrology, geomorphology and stability. Receiving watercourses may be impacted by siltation and/or pollution.

The site of operations may restrict public access and also affect the local landscape.

5.2 Operation

The extraction process will generally involve wholesale removal of the ground surface or overburden (e.g. in opencast mining or quarrying) with the loss of conservation and/or archaeological interest, or more selective extraction of mineral and ores from deep mines. Both processes will generally involve dewatering of working areas. Water pumped from the mine or quarry may be polluted by various contaminants, dependent on the geology of the site and mining operation and may affect the water quality of receiving watercourses and subsequent uses of such watercourses (e.g. for livestock watering). Common constituents of minewater discharges include: suspended solids, iron, ammonia, oxygen demand, acidity and alkalinity. The very quantities of water, regardless of quality, may have significant impacts on the hydrology of receiving streams, with implications to channel geomorphology and flood defence. Dewatering may affect groundwater flows and level, affecting water resources. Physical extraction of water-bearing material and any damage to aquifers from the extended lowering of water table and replacement with alternative materials may result in a permanent loss of aquifer capacity and correspondingly reduced water resources. Temporary or permanent lowering of the water table may have severe implications to the flora and fauna of wetlands and spring-fed streams. In addition, adjacent land use (e.g. agriculture) may be affected by changes to water table levels and/or drainage.

General site activity, the movement of vehicles and use of explosives for blasting may generate dust and other particulates that may directly smother flora and fauna, contribute sediment to receiving watercourses and reduce water quality due to suspended solid loads. Such activities may also generate noise and vibration, disturbing sensitive wildlife. Lighting may also disturb wildlife and the landscape. Spills of fuel and oil from vehicles, machinery and on-site storage may affect the water quality of watercourses and groundwater. The latter may be particularly vulnerable to such pollution as a result of mineral extraction, e.g. limestone quarrying, often occurring in areas of important aquifers. The transport of extracted material may also have more distant impacts, e.g. from lorry traffic and spillages in transit.

The storage of extracted minerals and spoil and disposal of the latter may cause further land take and habitat destruction. Runoff and leachate may be particularly polluting of watercourses. For example, exposure to air of pyrite (FeS_2) rich materials may lead to the formation of sulphuric acid and iron rich runoff with subsequent deposition of ochreous hydrated ferric oxide in receiving streams.

Spoil heaps may become a significant and usually undesirable feature on the landscape. In addition, the collapse of improperly designed spoil tips can have catastrophic consequences for both human and natural environments. Spoil heaps themselves may be subject to mineral extraction itself where new technologies make reprocessing economically feasible, with impacts similar to extraction from green field sites.

The disposal of spoil to sea may have severe smothering effects at the locality of dumping and in areas of dispersal. The coastal landscape may also be severely affected by such practices.

5.3 Processing

The processing of mined or quarried material may cause a variety of impacts, depending on the process. More significant processes will almost certainly be subject to Integrated Pollution Control. Physical grading processes such as pulverizing and sorting of aggregates, and flotation techniques such as used in coal washeries, may result in effluents with high concentrations of suspended solids and other contaminants. Uncontrolled discharges of these to watercourses may cause significant pollution and smothering of aquatic life.

5.4 Post operation

Following cessation of mine or quarrying activities, sites may be subject to a variety of treatments with associated impacts. These are discussed in greater detail in other guidance.

Abandonment - Abandonment should seldom occur, due to the usual imposition of restoration, i.e. infilling, and aftercare provisions of planning permission. However, abandoned quarries may or may not fill with water on cessation of dewatering activities, depending on surrounding water table levels. The main impact may continue to be the vulnerability of exposed aquifers to pollution from illegal dumping activities, and the loss of water resource from pollution or the removal of aquifer material. Access routes may also be permanently interrupted by excavations. Quarries and gravel pits may be deliberately allowed to flood to create lakes for conservation and recreation purposes.

The cessation of pumping from mine workings upon decommission or abandonment may result in the seepage of minewater into watercourses as the mine fills, with similar pollution as that from spoil tips. Although this is more likely to be a problem in deep mines, it may occur upon cessation of the dewatering of open cast or quarry sites and is discussed more fully in NRA (1994). The quality of water in abandoned mines will general decrease with increasing duration of contact with exposed minerals and the initial discharge of water from flooded mines may be of very poor quality, with serious affects on receiving water quality. Over time the level of contaminants in discharges will decrease due to flushing effects. The discharge point of water from dewatering may be different than that of seepage from flooded workings. As a result, the cessation of pumping from active mines may affect not only the water quality of receiving streams, but also their hydrology. Leachate from mineworkings may also originate from material tipped in abandoned shafts.

Restoration - Sites, including spoilheaps, may be restored. Mine shafts and excavations may be infilled with or without imported material, e.g. waste for landfill. Impacts may arise due to the nature of infill material, e.g. from leachate from landfill or mineral-rich spoil. The runoff/infiltration characteristics will affect supplies to receiving streams or groundwaters, and subsequently influence stream hydrology, water quality and water resources. Infill material may alter groundwater flow. The ecology of the restored site will depend on the methods of restoration, e.g. storage and replacement of overburden and topsoil, drainage characteristics and seeding. Landscaping practices will influence visual impact and also site ecology. Some sites, e.g. opencast mines, may be progressively backfilled and restored during operations.

6. Mitigation measures

Alternative sites should be considered, although the choice of sites may be determined by the nature of mineral deposits. In general, there should be avoidance of sensitive locations, e.g. important and/or vulnerable aquifers, SSSIs and wetlands. The location of processing, storage and disposal areas should all be considered.

Site-activity should be phased to avoid seasonally sensitive areas. Also, certain mining activities, e.g. opencast mining, should be limited during heavy rainfall. Where appropriate, extraction techniques should be used that reduce the volume of waste generated and also the proportion of fine particulates. Secondary uses for waste materials should be considered, e.g. as infill for large engineering projects.

Mine design should consider the long-term future of the site, where possible.

There should be the safe storage of fuel, chemicals and explosives, with adequate bunding for stored liquids.

The on-site use of pesticides should be minimal due to the vulnerability of aquifers and watercourses to pollution. Also, the use of herbicides on soil mounds may affect the long-term viability of seed in restoration.

Dust production on-site may be reduced by dampening down roads, provided there is an adequate water supply and drainage incorporating silt traps, if appropriate.

Dust and dirt production off-site may be reduced by washing down lorries, subject to provisos above, and using sheeting over loads. Haul roads may also be paved.

Lagoons or tanks with adequate storage volume should be incorporated (and maintained) to allow sufficient settling of suspended solids in slurries, process water and runoff. Also, settling devices (e.g. cyclones and thickeners) may be useful to dewater slurries. Even at the construction stage, measures should be installed to collect, treat and discharge runoff and other surface water under agreed consent conditions. Similarly, there should be suitable provision for sewage and other waste water disposal. Site drainage should incorporate oil separators (interceptors), silt traps, wet balancing ponds, reed bed treatment etc., as appropriate.

Discharges from dewatering activities will require consent and treatment if necessary.

Process waters should be recycled to minimise both abstraction and discharges.

The siting and design of tailings/spoil disposal should consider risks of subsidence and collapse. Mounds, including stored material, should be covered or revegetated encouraged to reduce erosion, windblow, and, in the case of revegetation, to improve aesthetic appearance.

Newly created channels from stream diversions, if unavoidable, should be designed to maximise conservation opportunities and should be 'seeded' with material from former channels as appropriate to encourage colonisation by similar communities.

There should be advance provision of physical, chemical or biological treatment systems for minewaters. These may not be required until the cessation of mining (and pumping). The forthcoming closure of mines should be discussed with the NRA well in advance.

Sites should be restored to former or other suitable land use. Opportunities should be sought for environmental and recreational enhancement. This may follow an intermediate use (e.g. landfill). Successful restoration often involves careful long-term storage of topsoil and overburden etc. Public footpaths and other rights of way should be re-established and site drainage reinstated. Flooding of sites may provide recreational opportunities and create aquatic habitats.

Mine shafts should be capped to prevent fly-tipping of unknown waste and reduce safety hazards. However, openings for the access for bats should be included at appropriate sites.

7. Baseline surveys

A variety of surveys may be required in the EA of a mineral extraction proposal. Of particular interest to the NRA are the following.

Hydrogeology - to identify impacts on groundwaters, such as the groundwater flows, the loss of aquifer and recharge capacity and "vulnerable" aquifers as outlined in NRA's *Policy and practice for the protection of groundwater* (NRA 1992).

Hydrology - to identify impacts on river flow and implications for flood defence and stream ecology.

Water quality - to ascertain current water quality and predict impacts of pollution on water quality and the ecology of receiving waters.

Ecology - to identify valuable habitats (e.g. wetlands), communities and species.

Landscape - to ascertain the implications of the mine in operation and in restoration.

Archaeology - to identify archaeological interests.

8. Monitoring and audit

Monitoring of parameters relevant to the predicted impacts and remedial/mitigation works is recommended and may be required . Parameters may include groundwater and surface water quality, river flow, water table level and the rate of plant and animal colonisation of restored areas.

9. General guidance and references

Due to cumulative environmental impacts, there may be a limit to the number or extent of such developments permissible in an area or catchment.

Construction Industry Research and Information Association (1994) *Environmental Assessment*. Special Publication 96. CIRIA, London.

Department of the Environment (1985) Circular 25/85. *Restoration of Sites with a High Water Table*. HMSO, London.

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to procedures*. HMSO, London.

Department of the Environment (1995) *Coal Mining and Colliery Spoil Disposal*. DoE, London.

Hester, R. E. and Harrison, R.M. (1994) *Mining and its Environmental Impact*. Issues in Environmental Science and Technology, Volume 1. Royal Society of Chemistry.

National Rivers Authority (1992) Policy and Practice for the Protection of Groundwater. HMSO, London.

National Rivers Authority (1994) *Abandoned Mines and the Water Environment*. Water Quality Series №14. HMSO, London.

Walsh, F., Lee, N. and Wood, C.M. (1991) *The Environmental Assessment of Opencast Coal Mines*. Occasional Paper 28. Department of Planning and Landscape, University of Manchester, Manchester.

Appendix 1 Types of Extractive Industry Listed as Schedule 2 Projects (after DoE/WO 1989)

a) extracting peat

b) deep drilling, including in particular -

   i. geothermal drilling

   ii. drilling for the storage of nuclear waste material

   iii. drilling for water supplies but excluding drilling to investigate the stability of the soil extracting minerals (other than metalliferous and energy-producing minerals) such as marble, sand, gravel, shale, salt, phosphates and potash

(d) extracting coal or lignite by underground or opencast mining

(e) extracting petroleum

(f) extracting natural gas

(g) extracting ores

(h) extracting bituminous shale

(i) extracting minerals (other than metalliferous and energy-producing minerals) by opencast mining

(j) a surface industrial installation for the extraction of coal, petroleum, natural gas or ores or bituminous shale

(k) a coke oven (dry distillation of coal)

(l) an installation for the manufacture of cement

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF RESTORATION OF MINERAL EXTRACTION SITES

1. Introduction

This guidance note seeks to identify the potential impacts arising from the restoration of mineral extraction sites upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of restoration schemes for former mineral extraction sites.

The restoration of mineral workings may be for a variety of purposes including landfill, recreation and nature conservation purposes. In addition, workings may simply be restored systematically to pre-mining conditions as an essential element of the extraction scheme without any intermediate use. This note largely considers secondary uses of mineral workings (e.g. for waste disposal or for recreational purposes) as mineral extraction with systematic restoration is covered by other guidance.

It is the responsibility of the developer to carry out the EA and to present the results in an appropriate manner to address the questions raised by the NRA. Proper justification will be required for any conclusions and access may be required to the raw data to examine particular issues in more detail.

2. Development control

The restoration of mineral extraction sites will generally be subject to development control under the Town and Country Planning (T&CP) framework.

The use of sites for landfill will also require a Waste Disposal Licence under the Environmental Protection Act (EPA). The NRA is a statutory consultee of the Waste Regulation Authority at the licensing stage. It has the power to object at this stage. More detailed information on NRA policy with respect to landfill applications are outlined in the NRA's *Policy and practice for the protection of groundwater* (NRA 1992).

3. Environmental Assessment

An EA may formally be requested under the terms of the Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199) for the after-use of mineral workings for waste disposal. For general recreation use an EA may not be formally required, but may be requested. An Environmental Statement (ES) arising from EA may be a suitable means of conveying environmental information to the NRA, which may be required before the issues of licences or consents.

Under the Regulations, landfill projects are divided into two types:

- those dealing with "special" waste; and
- those dealing with "controlled" waste or waste from mines and quarries

An EA is mandatory for all landfill applications dealing with special waste, as these projects fall under Schedule 1 of the above Regulations.

For all other landfill projects, EA may be required if they are likely to give rise to significant effects. A threshold of 75,000 tonnes of waste per year is suggested in government guidance (DoE/WO 1989a). If the proposed site is in a sensitive area, then an EA may be requested for smaller projects.

A draft EC Landfill Directive proposes to subject all landfills to EA. The DoE criteria, therefore, should be considered a minimum for future requirements.

4. NRA Licences

Development schemes may require the following licences and consents from the NRA.

i. **discharge consent** - for the disposal of runoff, either directly, or after treatment, into any controlled water (i.e. groundwaters, inland and coastal surface waters).

ii. **land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow. Examples include proposals to divert or culvert watercourses. NRA consent is also required for obstruction to or infilling of the floodplain under local bylaws.

iii. **abstraction licence** - for pumping or lowering of the water table. Consent is required for test and monitoring boreholes.

iv. **impounding licence** - to impound water.

v. **fisheries consent** - for the introduction or stocking of fish into an inland water (required under Section 30 of the Salmon and Freshwater Fisheries Act 1975).

The NRA will object to proposed landfill projects unless it can be shown that uncontrolled migration of leachate and deterioration in the quality of local water resources will not occur. Applications will generally be unacceptable in the vicinity of vulnerable and important aquifers. Reference should be made to the NRA 's *Policy and practice for the protection of groundwater* (NRA 1992) and the NRA Position Statement *Landfill and the Water Environment* (NRA 1995).

5. Potential Impacts

Impacts are divided into construction and operational impacts for both landfill and water recreation developments. General principles from these should be drawn for other schemes.

5.1 Landfill

5.1.1 Landfill construction

The construction of a landfill will generally involve the laying of a synthetic membrane and/or an engineered clay or bentonite amended soil, in order to contain leachate and landfill gas within the installation. Prior to laying, the void created by mineral extraction will generally need to be landscaped with soft material to a substrate upon which the liner system is constructed. A drainage and collection system will generally be laid within the lined void to control leachate. Vents for the discharge of methane and other landfill gas also may need to be installed. As such, the impacts of landfill construction at recently abandoned mine workings may be minimal, the main impacts of excavation, construction of access roads and other infrastructure having occurred in mineral extraction itself. Where sites have been abandoned for longer periods and ecological communities and recreational use of a site have become established, the preparation of the site for construction may have a variety of impacts including the following.

Loss of habitats - In most instances, all habitats within the former workings may be destroyed by landfill construction and operations.

Drop in water table level - Dewatering of flooded sites will destroy aquatic communities, and may lower surrounding groundwater levels, affecting wetland sites and drainage. Water resources may be affected and the rights of other licensed abstractors compromised.

Pollution - Water pumped from the site may have water quality impacts upon receiving watercourses. There may also be hydrological effects from the water flow.

Loss of recreational use - Recreational use of the site, e.g. for walking or water sports, will end.

Loss of floodplain capacity - the isolation of sites by undersealing and subsequent infill could result in a loss of floodplain capacity.

5.1.2 Landfill operation

The potential environmental impacts from landfill operation are dependent on:

- locational factors (principally hydrogeology);
- waste composition (this may vary over time);
- rate at which the waste is to be deposited; and
- other operational/management factors.

Of primary concern is the contamination of groundwater and/or surface water by leachate. Other impacts relate to the quantity and quality of surface waters, ponds and streams and effects on groundwater flow. Impacts due to the generation and migration of landfill gas, although important, are usually only indirectly relevant to NRA responsibilities. However, gas build-up in sewers receiving leachate may present an unacceptable risks of explosions with consequences for the environment.

a) Leachate pollution

Leachate production may be unavoidable. The composition of leachate will vary according with the composition of waste itself, the age of landfill, the extent to which rainfall is permitted to enter the landfill and a number of other factors. Leachate is usually a noxious substance, with significant concentrations of ammonia, organic compounds, chloride and earth metals.

Groundwaters - Where a landfill is ineffectively contained, leachate may pollute groundwaters. Depending on the type and extent of contamination, this may lead to long-term sterilisation of both current and future potable supplies. Other users of groundwater or spring abstracted waters may also be affected. Failure or rupture of liners may cause serious groundwater and surface water pollution.

Surface waters - Effects on surface waters receiving untreated leachate via contaminated baseflow or runoff may include organic enrichment with oxygen depletion, causing mortalities of fish and other aquatic life, and unaesthetic growths of sewage fungus. Suspended solids, sewage fungus and deposits of iron hydroxide may cause smothering of the substrate, affecting plants, invertebrates, fish and fish spawning. Other contaminants (ammonia, metals and pesticides) may also contribute to significant effects.

The NRA will specify the range of parameters permitted in the discharge of leachate and timing of the discharge as part of the consent conditions.

b) Other pollution

Pollution of water bodies, aquifers and drains may also result from spillage of inappropriately stored site fuel, lubricating oils and chemicals. Litter from landfill operations can cause obstructions in watercourses resulting in an increased risk of flooding and aesthetic deterioration.

c) Effects on groundwater flow

A contained landfill extending below the water table may present an impermeable barrier to groundwater and may modify the direction of natural flow. This may cause springs and wells to dry up, resulting in a derogation of existing rights.

d) Recreation and amenity

Noise, odour and visual disturbance may have effects upon the recreational uses of adjacent watercourses. Any visible forms of pollution such as litter and suspended solids will detract from visual amenity. Public rights of way may need to be diverted.

e) Conservation and wildlife

Aquatic fauna may be directly disrupted due to landfill activities. However, the primary cause for concern are secondary impacts as a result of leachate percolation into groundwater and surface waters and alterations in flow as a result of any abstractions. Landfill gas may affect plant life. Gulls, crows and vermin populations may benefit from the landfill; their increased populations may have impacts on other wildlife. Gull faecal production may adversely affect the water quality of (aquatic) roosting sites. Litter blown from landfills may be a hazard to wildlife and have a visual impact.

5.1.3 Landfill restoration

Impacts associated with restoration and aftercare could be a major issue. If not properly sealed, old sites may continue to pose a threat to groundwater and surface waters, and cause long-term quality problems. Under the EPA 1990, monitoring and control of landfills remains the responsibility of the landfill operator after disposal operations have ceased, the site has been restored, and until such time as the wastes no longer pose an environmental threat.

Landfills are generally capped with an impervious clay layer to reduce infiltration of rainfall, percolation and leachate production. Surface runoff from such capping may alter the hydrological characteristics of receiving streams, with potential implications for stream ecology and flood defence. Runoff effects may be exacerbated where landraise occurs. Landraise and surface structures, e.g. gas flares or recovery equipment may also significantly alter the landscape.

The contaminated nature of restored landfill sites may restrict future uses of the land. Sites may also be subject to subsidence.

5.2 Water recreation sites

5.2.1 Construction

Sites for water recreation will generally require landscaping of the site of the lake or lakes and surrounds, and the construction of access ramps, mooring facilities and buildings etc., depending on proposed activities. Lining of lakes may be required to guarantee water levels, or to isolate sites from the water table and/or underlying minerals and mineral waste. Dewatering of sites prior to lining may have implications on the water quality and flow of receiving waters.

a) Landscaping

Soil excavation may destroy established communities. The planting of sites with seeds, shrubs and trees may lead to the introduction of unsuitable, often non-native species that may alter the ecology of the site. Where dewatering of lakes is required to access submerged areas, aquatic life may be adversely affected. The discharge of water may have impacts on receiving streams. Drawdown of the surrounding water table may occur with impacts on wetlands, drainage and water resources.

b) Lake filling

The flooding of mineral workings may have a number of impacts.

Water resources - water used to fill the lake will be unavailable elsewhere, and may be subject to competing demands.

Water quality - the quality of lake water may be adversely affected by underlying minerals and mineral and other wastes. Nutrient-rich water may be subject to algal blooms. Oil residues may produce unsightly films on the water surface. Visiting gulls from nearby colonies may add to the concentrations of nutrients and bacteria. Watercourses and groundwater may be affected by drainage from filled lakes.

Habitat loss - terrestrial and riparian habitats may be destroyed by immersion. However, new habitats will be created.

Loss of flood storage - the filling of the lake may represent a loss of flood storage.

5.2.2 Operations - recreational activity

Recreational activities may themselves have a variety of impacts, depending on activity types, which may include windsurfing, sailing, rowing, scuba diving, jet skiing, water skiing, and angling.

Recreation - Conflicts between recreational users may occur, e.g. speed boats may disturb anglers, wind surfers etc. Patterns of recreational use in the surrounding area may also change with the development of new facilities, thus affecting other sites.

Water quality - Water quality may be affected by pollution from fuel spillages from powered craft, fuel stores and car parks. Inadequate sewerage provisions at clubhouses, public conveniences etc. may result in sewage pollution. Water quality of the lakes may determine suitable uses, i.e. water contact sports may not be permitted.

Conservation - Wildlife may be affected by general activity and noise from speedboats, jet skis etc. Disturbance may be particularly significant at certain times of year, e.g. breeding or wintering birds. However, lakes will also represent new areas of aquatic habitats.

Fisheries - Fish introduced from lakes may escape into nearby watercourses, potentially altering fishery quality and ecosystem functioning. The transfer of fish diseases may also occur.

5.3 Nature reserves

Abandoned mineral working may be colonised by a variety of wildlife and warrant conservation measures. Impacts from the restoration of sites as nature reserves will generally be minor but may include the following.

Conservation - Disturbance of sensitive species, from noise, general activity, trampling and vandalism. Loss of species from land take for paths, buildings and car parks.

Water quality - Oil pollution from car park areas, sewage pollution from inadequate toilet facilities. Fly tipping and the deposition of litter may cause water quality and aesthetic problems.

6. Mitigation measures

6.1 Landfills

Developers should follow advice given in Waste Management papers (e.g. DoE 1986, 1993, 1994).

a) **Location and design** - Landfill may not be a viable option where sensitive aquifers or watercourses are at risk. The distance between the landfill and the receiving water should be sufficient to allow any leakage from containment systems to be diluted, dispersed or attenuated. Landfill design should be modified to avoid sensitive habitats in quarries, although translocation of important species may also be a possibility.

b) **Waste type** - Inert waste will be less likely to generate noxious leachate.

c) **Waste minimisation** - The minimisation of waste production, e.g. by recycling, will reduce the need for landfills and resulting environmental impacts.

d) **Sealing the site** - The site should be adequately sealed.

e) **Good management practice** - Methods of working should consider implications for leachate production and other impacts. It is recommended that one cell is filled at a time to minimise the areas open for leachate generation, and that waste is compacted to prevent infiltration of water. Completed areas should be covered with impermeable materials. Rainfall on virgin areas should be directed from the site without contact with the waste. Perimeter fences will reduce litter contamination from windblow.

Lubricating oil, site fuel and other potential pollutants should be stored in sealed tanks or containers with secure, impervious bunds. The volume of the bund should be in excess of that required to contain the contents in the event of an entire spillage. All valves and taps should be positioned within the bund.

Wheel washing facilities should be utilised (with suitable treatment of washings).

g) **Capping** - Landfills should be capped after operations cease in order to prevent ingress of surface water.

h) **Treatment of leachate and surface runoff** - Leachate should be contained and collected prior to disposal to sewer. Surface runoff treatment may incorporate a combination perimeter drainage, balancing lagoons, silt traps and reed bed treatment.

I) **Floodplain impacts** - Compensatory work may be required to mitigate loss of floodplain storage.

j) **Vermin control** - may be required.

6.2 Water recreation

In general, guidance in Planning Policy Guidance (PPG) 17 *Sport and Recreation* may be applicable. The following deals with specific issues.

Lake design - Lakes should be designed to incorporate or replicate important habitats in the abandoned mineral workings, if these had become valuable aquatic habitat. Islands created by mounds of topsoil/overburden may be useful additions to lake design, providing nesting and roosting habitats for birds. Submerged islands may also be useful aquatic habitat. Translocation of species between similar habitats may be an option.

Water quality - If appropriate, lakes should be lined to prevent continuation with groundwater or surface water, e.g. where lake water may adversely affect nearby rivers and {vice versa}.

Zoning of activities - Conservation interests may be protected by the zoning of disturbing activities both temporally and spatially. Certain activities may best be banned altogether.

Selective stocking/planting - The choice of fish stocked should consider compatibility with nearby watercourses. It may be appropriate to design lakes such that they actually contribute to river fisheries, e.g. by providing spawning and nursery areas out of the main river flow. Planting and seeding should consider the impact on existing ecology.

Flood storage - There may be opportunities to manage the water levels of the lakes such that they may be used as flood storage areas - reducing flooding downstream.

6.3 Nature reserves

Measures will depending on the importance, location of species and their sensitivity, and may include access restrictions, the installation of paths and hides. In sites of relatively low conservation but high scenic value, public access may be actively encouraged, and facilities such as public conveniences and children's play areas installed. Safety provisions may be required where visitors may be at risk from rockfalls, path subsidence etc.

7. Baseline surveys

The surveys required will depend to some extent on particular restoration plans and availability of information gathered in the planning and monitoring of mineral workings. In general, the NRA will require a thorough hydrogeological survey of the site and surrounds with an assessment of impacts on water resources of any stretch of river likely to be affected. In addition, the following surveys may be required, where appropriate, using recommended techniques:

- catchment drainage pattern and hydrology (including flood patterns and levels);
- details of the floodplain flow and storage pattern;
- soils;
- groundwater and surface water quality;

- aquatic flora and fauna;
- river corridor survey;
- downstream water uses and recreation;
- landscape;
- fisheries;
- archaeology; and
- climatic conditions (e.g. rainfall, wind strength and direction).

8. Monitoring and Audit

An appropriate monitoring strategy should be developed, based upon initial findings and the predicted impacts of the project. Monitoring may determine if steps are necessary to contain, reduce or avoid unanticipated impacts. Detailed monitoring is likely to be required for landfill sites.

Landfill sites

For landfill sites, the NRA wish to see the following incorporated into any monitoring programme:

- the amount and composition of runoff;
- the quality and levels of leachate;
- any discharges into watercourses; and
- the quality of the receiving groundwater.

Current practice is for the placement of boreholes to indicate water levels:

- in the tipping cell;
- on site (but not in the cell); and
- adjacent to the site.

The NRA will make recommendations as to the design and placement of monitoring boreholes within the site and its surrounds, to monitor groundwater composition and flow.

Boreholes should be inspected regularly as part of an agreed monitoring strategy. This should continue after operations have ceased as leachate generation may continue for many years.

Water recreation sites

For water recreation sites, suggested monitoring may include water quality, and surveys of both breeding and wintering birds.

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NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF ROAD AND ROAD WIDENING SCHEMES

1. Introduction

This guidance seeks to identify the potential impacts of road and road widening schemes upon the water environment. It is intended to form the basis of a fairly detailed general scoping brief to cover the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of road schemes.

It is the responsibility of the developer to carry out the EA and to present the results in an appropriate manner to address the questions raised by the NRA. Reference should be made to the *Design Manual for Roads and Bridge - Volume 11* (DoT 1993). In addition, Volume 10 of the design manual provides advice on sympathetic environmental design, particularly documents making up the so-called "Good Roads Guide".

Proper justification will be required for any conclusions and access to the raw data may be required to examine particular issues in more detail.

2. Development control

For the purposes of development control, road schemes fall into two separate categories. The Secretary of State for Transport and the Secretary of State for Wales are the highway authorities for trunk roads and motorways. These are approved under procedures set out in the Highways Act 1980. Statutory orders are published which are usually subject to a public inquiry. Other roads developed by local authorities and private developers require planning permission and follow the normal planning procedures within the Town and Country Planning framework.

3. Environmental Assessment

Roads appear on both Annexes of the EC Directive on the assessment of the effects of certain public and private projects on the environment (85/337/EEC). Annex I includes "motorways and express roads" and Annex II includes roads as "roads (not listed in Annex I)" and widening schemes etc. ("modifications to development projects included in Annex I).

Translated into UK law, an EA should be undertaken by the Department of Transport under Statutory Instrument 1988 No 1241 for any trunk road or motorway encompassed by certain threshold criteria of size. These are where the road is either over 10 km in length or is longer than 1 km, where the route passes through a "sensitive area" (DoE/WO 1990). Trunk road improvements will also require an EA where they are likely to give rise to "significant effects", having regard to the criteria set out in DoE Circular 15/88 (WO 23/88).

Roads developed by local authorities and private developers may require an EA as these are listed as Schedule II projects under Statutory Instrument 1988 № 1199, again based upon criteria of significance outlined set out in DoE Circular 15/88 (WO 23/88). Private toll roads and other "special roads" require an EA as Schedule I projects under these Regulations.

4. Interpretation of the Regulations

The thresholds are widely accepted as being very high. Developments below the size criteria can still have a serious environmental impact. Such is the detrimental nature of some road projects on the aquatic environment that the NRA wish to be involved in the screening of projects and would indicate whether an EA is required. Location is an important factor and, in line with its general environmental duties, the NRA are likely to require an EA under the following circumstances:

- where valuable river, wetland or lakeland habitats are likely to be destroyed or impoverished or where there are major modifications to a river channel or corridor;

- where pollution arising from construction activity or as a consequence of increased risk and vulnerability might have a significant impact on water quality or cause a breach in water quality objectives;

- for developments likely to have a significant impact upon the availability of water resources or upon groundwater quality or quantity; and

- for developments in the headwaters or for developments likely to cause a significant increase in flood risk.

5. Road routing and the assessment of alternatives

The NRA wish to be involved in the assessment of any proposed road projects from the initial "scoping" stage, prior to the selection of the proposed alignment. Early involvement will enable environmental constraints to be identified and sensitive areas to be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage. The NRA can also indicate opportunities for environmental improvements at an early stage.

Examples of sensitive areas include:

- river floodplains;

- lakes, wetlands and marshes;

- rivers and river corridors of high ecological, recreational or amenity value;

- rivers supporting valuable fisheries;

- contaminated land likely to lead to polluting runoff;

- important aquifers;

- river abstraction points; and

- upland areas of catchments with particular sensitivities.

6. NRA Licences

Road schemes are likely to require the following licences and consents from the NRA.

i. **Land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow. Examples include the construction of bridges, outfall structures and culverts or river diversion. Local bylaws may also forbid obstruction or infilling the floodplain without consent.

ii. **Abstraction licence** - for water abstraction, including dewatering.

iii. **Impounding licence** - for any impounding of water, e.g. creation of artificial ponds and lakes.

Land drainage and impounding licences must be obtained in advance of any construction, regardless of whether planning permission has been granted. Land drainage consents are issued under Section 109 and 110 of the Water Resources Act 1991 for designated main rivers. For non-main rivers, this is covered under Section 23 and 24 of the Land Drainage Act 1991. Local authorities and Internal Drainage Boards (IDBs) also have responsibilities for the latter.

Although discharges of drainage from highways are generally not subject to **discharge consents**, a highway drain may become subject to a prohibition notice under Section 86 of the Water Resources Act 1991 if the NRA and road developer cannot reach an agreement on appropriate pollution prevention measures. If an effluent is discharged in contravention of the prohibition, and a similar contravention is likely, the NRA may serve a discharge consent upon the person who has caused or permitted the contravention (Luker and Montague 1994).

7. Major Impacts

Impacts on the aquatic environment may arise as a result of construction activities or due to the operational end state of the development.

7.1 Construction impacts

The main impacts of construction will arise from primary engineering works e.g. embankments, cuttings, bridges and tunnels. Alignment of roads through valuable river corridors, stream diversions, and the insensitive design of bridges and embankments can result in the destruction or impoverishment of river corridors with consequent impacts upon conservation, recreation and amenity. Other associated construction works, such as slip roads, new junctions, temporary haul or access roads, service areas, filling stations, temporary accommodation for workers and the installation of electricity supplies will add to the impacts, if only through added land take. Brookes and Hills (in press) discuss some of the impacts of road developments on river corridors.

7.1.1 Embankments and cuttings

The excavation and disposal of soils will result in the direct destruction of habitats with resultant effects on flora and fauna. Even with reinstatement measures, secondary adverse ecological effects may arise from the severance of habitats, the spread of weeds and opportunist species with spoil, and from water table and micro-climate changes arising from embankments and other structures. Construction noise and lighting may disturb wildlife. Dust may damage vegetation.

Embankments and other structures in floodplain areas may result in the loss of flood storage. The installation of embankments, cuttings and drainage may alter the drainage to groundwater and surface watercourses. Drawdown of groundwater may also arise from dewatering operations and from cuttings severing shallow aquifers. Changes to water table levels may have secondary effects on wildlife, water supplies and the integrity of the foundations of buildings. Significant alterations to river flow may lead to ecological impacts, altered sediment quality, and other geomorphological changes.

The water quality of runoff and site drainage may be affected by suspended solids, oil and construction materials. Additional pollution of surface or groundwaters may occur where contaminated land is disturbed or from contaminated groundwater drawn into the site by dewatering operations. Leachate from imported or excavated material may pollute groundwater or surface waters.

Excavation in river floodplains or river diversion may uncover archaeological remains. It is important that arrangements are made to contact the County Archaeologist to establish any risk of damage and need for the removal or preservation of any findings.

The construction and use of the road will have impacts on the landscape, with embankments and flyovers being particularly noticeable features. It is likely that such a linear development may interfere with established rights of way.

7.1.2 Bridges

The construction of river bridges and other in or near channel works (e.g. culverts) may lead to a variety of impacts. Water quality may be affected by disturbance of instream or riparian sediments, dewatering operations and spillages of oil, cement and other construction materials. Raised suspended solids and sedimentation may be particularly damaging to downstream salmonid spawning gravels. The bridge structure and its construction may block the passage of fish, birds and mammals. Navigation may also be disrupted. Culverts should be avoided as they may compromise various functions of a river and its corridor. The flow characteristics of the river may be altered leading to sediment quality and other geomorphological changes. Shading due to bridges or culverts may destroy plant communities.

7.1.3 Tunnels

Tunnel construction may impact upon water quality from solids, oil, lubricant and grouting materials entering watercourses. The presence of an impervious tunnel structure may alter groundwater flows. Groundwater quality may be affected by pollution and the mixing of groundwaters at the interface of different strata penetrated by tunnelling. The noise and vibration from tunnelling activities may disturb wildlife.

7.1.4 Other works

Stream diversions - Stream diversions should generally be avoided as they have serious impacts. These include the loss of established aquatic and riparian habitat and stable river geomorphology, with resulting effects on a wide variety of aquatic and riparian wildlife and altered river flow and sedimentation patterns.

Accommodation works - Any temporary accommodation works required for construction workers may lead to water quality problems arising from sewerage and disturbance of wildlife in the locality, both from temporary land take by buildings and noise and light from site activities.

Installation of electricity supplies - The installation of cabling for power supplies for lighting overhead and telephone lines may have affects similar to those for pipelines (see relevant guidance note). Other infrastructure requirements such as for water or sewage may have similar effects.

Vehicle use and storage - The storage and use of construction vehicles may result in oil contamination of surface or groundwaters. Vehicle movements may also disturb sensitive fauna, particularly nesting birds.

Aggregates - The extraction and transport of aggregates will have impacts off-site.

7.2 Operation impacts

Major pollution impacts may occur if surface water drainage is not adequately disposed of or as a result of spillages. River flow may be constricted by structures, leading to reduced standards of flood defence and the potential for future flood alleviation to be prejudiced financially. The highway structure may also have an effect upon the catchment runoff response.

7.2.1 Drainage and pollution of watercourses

Increases in traffic flow and the associated road construction programme is placing an increasing pressure on the aquatic environment in terms of drainage facilities required. Motorways, in particular, provide long stretches of impermeable surface draining to a single point. Where such points are located at major intersections, there is an increased risk of accidents, spillages and pollution.

Surface runoff is discharged either directly to a watercourse or some form of balancing or soakaway system. There is a significant risk of pollution as a result of the following.

i. **Routine runoff** - Enhancement of background levels of contaminants due to tyre wear, vehicular emissions, oil, litter etc. In particular, runoff may contain significant quantities of suspended solids, polynuclear aromatic hydrocarbons (PAHs), oil, lead, cadmium, zinc and other heavy metals.

ii. Accidental spillage - Oil and/or chemicals may be spilt directly as a result of accidents, particularly at major intersections. Indirect pollution may subsequently occur due to the use of fire fighting or clean-up materials.

iii. Operations and maintenance - Weedkillers, de-icing agents, clearance and maintenance of ditches and ponds.

iv. Other - Atmospheric deposition, vehicle maintenance, illegal disposal and agricultural activities.

Pollution may also continue to arise from leachate from construction fill material, e.g. slag.

Lowering of the water quality, whether gradual or as a result of a specific accident will have direct effects upon the river wildlife, fisheries and general amenity.

Sewerage requirements of buildings associated with the road may overload the existing infrastructure, resulting in reduced surface water quality.

7.2.2 Effects on groundwaters

In order to avoid pollution of groundwater, all soakaways and settling ponds must conform to the NRA 's *Policy and practice for the protection of groundwater* (NRA 1992). If road cuttings and tunnels are below the water table, then localised flooding of the road may occur.

The catchment response to rainfall will be altered due to the creation of a large impermeable surface which will reduce infiltration. Large earth movements associated with tunnelling may affect the direction and quantity of groundwater flow. Linking up previously discrete aquifers will cause the water to follow from one to another, thus affecting groundwater levels.

7.2.3 Other impacts

Culverts may present a flood risk if these become blocked.

The road may act as barrier to migration of certain wildlife, be it due to the road itself, traffic or embankments etc. Some animals, e.g. amphibians and badgers, may try to cross the road but incur significant mortalities. The course of the road may itself become a wildlife corridor. Land use changes resulting from the presence of the road may bring about further impacts.

Vegetation control may damage nesting birds and other habitats at certain times of year. This and other maintenance activities may disturb wildlife.

The noise and vibration from road traffic may damage historic buildings and may also disturb wildlife.

Sewerage requirements associated with buildings may overload the existing infrastructure, resulting in reduced surface water quality.

The road may lead to consequential development associated with it which may add to the total impact.

8. Mitigation measures

Measures which should be taken to mitigate adverse effects will have to be discussed with reference to the project in question, but some of general principles are discussed below. The Highways Agency (1994) has produced useful guidance for developers that sets out practices that should be adopted to meet NRA concerns. These guidelines should be followed, where possible, for all road developments.

8.1 Drainage

Luker and Montague (1994) provide detailed guidance on the control of pollution from highway drainage, which should be followed. The design of drainage systems should incorporate the risk of spillages which may increase at certain points, e.g. major motorway intersections. In general, a number of measures may be adopted to minimise the risk of pollution incidents, including the following.

i. **Oil separators (interceptors) with cut-off valves** - These may be specifically required on roundabout and interchange junction areas and straight carriageways where the receiving waters are particularly susceptible to pollution.

ii. **Silt traps** - Where it is anticipated that large quantities of silt may jeopardise the efficient operation of an interceptor, an upstream silt trap should be provided.

iii. **Wet balancing ponds** - If suitably designed and maintained, these may form a local environmental feature, particularly if vegetated, as well as providing a degree of treatment for polluted runoff.

iv. **Open ditches** - Open ditches may be used in combination with sand bag and wooden booms to intercept a pollutant.

v. **Soakaways** - The depth of soakaways must be restricted in line with the NRA's Groundwater Protection Policy.

vi. **Reed beds** - For treatment of runoff using existing or artificially constructed wetlands. The wetland may provide useful habitat, although the vulnerability of wildlife to pollution and road traffic should be considered.

vii. **Grass swales** - These and other types of buffer zones can provide areas in which the various impacts of roads may be absorbed before reaching watercourses.

It is important to maintain good access and operating instructions in the event of a spillage and for maintenance purposes. Operating instructions/signs should be provided at shut-off valves etc.

8.2 Conservation of river corridors

The NRA wishes to promote river corridors as conservation and amenity areas. As such, it is opposed to developments likely to have a detrimental effect on river corridors. Where development does occur, appropriate mitigation measures may be required, such as the following.

i. An adequate river corridor width between the road and existing or proposed river channels. A figure of 50 m from either bank has been widely quoted as appropriate to preserve the continuity of the wildlife habitat. However, this may not be possible in valley situations.

ii. A 9 m minimum (depending upon local land drainage bylaws) width on each bank should be provided beneath bridges and river crossings. Local stone, brickwork or concrete finishing should be selected to blend in with the local environment. Provision for relevant nest and/or bat boxes in bridge structure should be considered. Where appropriate, sufficient headroom under bridges should be allowed for to ensure navigational access not compromised.

iii. If culverting is unavoidable, the length should be kept to a minimum; a freeboard above the top water level should be maintained to allow the free passage of debris unless a trash-grid is installed. Culvert design should be to specific flood return periods and capacities. Reinstatement of the river bed should be carried out with a suitable substrate. A ledge above normal water level should be installed for utilisation by mammals.

iv. Careful design of diverted river channels considering both river stability, maximising nature conservation interests and appropriateness in the landscape.

8.3 Other measures

Other mitigation measures that should be considered include:

- using alternative routes to minimise impacts;
- timing of construction to reduce disturbance of wildlife;
- using fencing to stop both the increase of working area and parking outside of that area;
- using bridges and tunnels, rather than cuttings and embankments;
- reinstating cuttings and embankments with appropriate vegetation;
- adopting sympathetic spoil disposal management;
- covering soil/spoil mounds to reduce silt runoff;
- remedial action at contaminated sites;
- habitat creation;
- translocation of species (and soil) from destroyed habitats to suitable sites;

- ensure invasive/alien plant species are not transferred to the site and eliminate transferals if they occur;

- installing appropriately designed tunnels for the safe passage of amphibians, badgers etc. at known crossing points;

- fuel and other stores should be adequately bunded or lined to protect groundwater and surface waters;

- using drip trays for pumps and other machinery;

- fitting design of embankments and cuttings to achieve natural profiles and vegetation cover;

- providing acoustic and visual barriers to protect and shelter sensitive sites;

- providing bridges etc. to maintain footpaths and other rights of way, including access to a river and recreational activities; and

- formulation and adoption of a sensitive management plan.

9. Baseline surveys

In addition to a river corridor survey for any channel affected by the development, the following surveys may be required:

- water quality;
- hydrology;
- hydrogeology;
- fisheries;
- botanical/ecological/bird;
- aquatic biology;
- recreation and amenity;
- landscape;
- archaeology; and
- geomorphology

Details of proposed baseline survey work should be discussed with the NRA as soon as possible as parameters are likely to be diurnally and seasonally variable.

10. Maintenance

Facilities should be provided for access, and provisions made for regular maintenance of the road and associated developments, and particularly of silt traps and other pollution control devices. The details of these will have to be discussed with the NRA. Maintenance and vegetation control should be conducted at appropriate times of year (i.e. outside of nesting periods). Mechanical methods of control should be used in favour of chemical controls. In the latter case only approved pesticides should be used, particularly near watercourses (in which case NRA consent is required). Appropriate guidance should be followed, e.g. NRA (1995)

11. Monitoring and audit

An appropriate monitoring and remedial management strategy should be devised, based upon initial findings and the predicted impacts of the project. Audit may be required in certain cases.

12. Further guidance and references

English Nature have produced a report-*Roads and Nature Conservation* which includes guidance on impacts, mitigation and enhancement works. The Welsh Office have produced a landscape design guide, *Roads in Upland Areas: Design Guide* (WO 1990). Further Welsh Office guides, *Roads in Lowland Areas: Design Guide* and *Rock Profiling and Vegetation Re-establishment* are in press. The Institute of Environmental Assessment (IEA, 1993) have produced guidelines for the assessment of road traffic.

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NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF RAILWAYS

1. Introduction

This guidance note seeks to identify the potential impacts of railways upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of railway schemes. Railways may affect a variety of NRA interests and particularly water quality and flood defence. Railway projects will generally be subject to formal environmental assessment procedures and the responsibility for the assessment lies with developer.

There are distinct advantages for the developer to contact the NRA, and also to conduct some of the environmental assessment in advance of detailed planning such that there is a proper consideration of the need for the scheme, alternatives, particularly with respect to routing, and general environmental implications.

2. Development Control

Railways are listed in both Annexes I and II of the EC Directive 85/337/EEC and also are on the corresponding Schedules of the Town and Country Planning (Assessment of Environmental Effects) Regulations SI 1988 No. 1199 as "a line for long-distance railway traffic" (Schedule 1) and "a tramway, elevated or underground railway, suspended line, exclusively or mainly for passenger transport" (Schedule 2). However, the planning of most major railway developments would now fall under the Transport and Works Act 1992. Under the Application Rules of this Act an Environmental Statement is generally required, the EC Directive rules applying similarly as for Town and Country Planning Regulations.

3. NRA Licences

The NRA may require a variety of licences or consents for operations affecting surface or groundwaters (e.g. for abstraction, discharge, impoundment and land drainage operations). For railway developments the main requirement is likely to be for **land drainage consent** for any works on the bed and banks of a river or construction of any structure (e.g. embankments, bridges) likely to impede the flow. Land drainage licences must be obtained in advance of any construction, regardless of whether planning permission has been granted.

Discharge consents may be required for the disposal of runoff to a sensitive watercourse or soakaway system.

4. Major/Potential Impacts

4.1 Construction impacts

The main impacts of construction will arise from primary engineering works (e.g. embankments, cuttings, bridges and tunnels) and other works such as access roads, station and stabling yard construction, stream and road diversions, accommodation works, and the installation of electricity supplies (where required). The necessity of a relatively straight route of low gradient results in some lack of flexibility in the choice of routes. As a result, the avoidance of meandering river corridors may not be possible and frequent river crossings may be required. he NRA will be particularly concerned about consultation activity in close proximity to watercourses.

4.1.1 Embankments and cuttings

The preparation of a rail route would usually entail major earthworks in the creation of raised embankments and sunk cuttings along with levelling before the installation of ballast and the track itself.

The excavation, storage and disposal of soils will result in the destruction of habitats with resultant effects on flora and fauna. Secondary adverse ecological effects may arise from: severance; the deposition of dust; the spread of weeds and opportunist species with spoil; and micro-climate changes arising from embankments and other structures. Construction noise (e.g. blasting) and lighting may disturb wildlife. Excavations may damage archaeological interests.

The raising of embankments may result in the loss of floodplain area and associated flood storage. The installation of embankments, cuttings and drainage may alter the drainage patterns and flow of adjacent watercourses and groundwater. Where significant changes to river flow occur there may be ecological impacts of low flows, altered sediment quality and other geomorphological changes. Changes to water table levels may have impacts on water supplies, building foundations, and wetlands and other habitats affected by groundwater levels.

The quality of receiving watercourses may be affected by runoff and site drainage which may carry raised concentrations of suspended solids, oil and construction materials. Where contaminated land is disturbed further contamination may occur. Aquatic ecosystems including fisheries may be damaged as a result.

The landscape may be affected by both construction and operation of the railway, with embankments being particularly noticeable features. The course of the track may interfere with established rights of way.

4.1.2 Bridges

The construction of bridges and other in-channel works (e.g. culverts) may lead to a variety of effects. Temporary measures to accommodate watercourses diverted around bridges or culverts during construction may lead to a raised flood risk over this period (and localised ecological effects). Completed structures may also lead to increased flood risk. Water quality may be affected by disturbance of instream or riparian sediments, dewatering operations and spillages of oil, cement and other construction materials. Raised suspended solids and sedimentation may be particularly damaging to downstream salmonid spawning gravels. Instream structures may block the passage of fish, whilst the more terrestrial elements of the bridge structure may block the passage of birds or mammals. Navigation may also be affected. The flow characteristics of the river may be altered leading to sediment quality and other geomorphological changes. For instance, scour may occur around bridge piers.

4.1.3 Tunnels

The construction of tunnels may affect water quality through the entry of suspended solids, oil and lubricant from tunnelling and grouting. Groundwater flows may be affected by presence of an impervious tunnel structure, and quality altered by mixing of groundwaters at the interface of different strata penetrated by tunnelling. The noise and vibration from blasting and tunnelling may disturb wildlife.

4.1.4 Other works

Access roads - The creation of temporary access or haul roads will result in soil disturbance and compaction along the route. There will be a loss of, and damage to, plant (and animal) communities. Runoff and culverting activities may result in raised suspended solids levels and siltation in watercourses, affecting water and substrate quality. The storage and use of vehicles and fuel may result in oil contamination of surface or groundwaters. Vehicle movements may also disturb sensitive fauna, particularly nesting birds.

The creation of permanent access routes will result in more permanent habitat damage and loss. There may also be drainage effects.

Stations and stabling yard construction - Stations, signal box and stabling construction will involve impacts of land take for these and associated car parks and access roads - see general construction guidance note.

Stream diversions - Stream diversions may be necessary. The impacts of these are the loss of established aquatic habitat and stable river geomorphology with likely effects on a wide variety of aquatic and riparian wildlife, and altered river flow and sedimentation patterns.

Road diversions - Road diversions may be necessary as part of a scheme. (Refer to guidance note on roads and road widening for likely impacts).

Accommodation works - Any temporary accommodation works required for construction workers may lead to water quality problems arising from sewerage and disturbance of wildlife in the locality, both from temporary land take by buildings and noise and light from site activities.

Installation of electricity supplies - The installation of underground cabling (and overhead wiring) will have effects similar to those for pipelines (see relevant guidance note). Other infrastructure requirements such as for water, telephone or sewage may have similar effects.

Remote impacts - The extraction and transportation of aggregates (e.g. for ballast and concrete) and manufacture of track and other construction materials will have impacts off-site.

4.2 End state/Operational impacts

In operation, the main general impact of the railway will be from drainage from the track and its corridor. Localised impacts may also occur in association with stations, stabling areas etc.

In general, there will not be a great deal of runoff from a railway itself due to the generally permeable nature of track ballast. Through drainage, however, may be contaminated by oil, spills of cargo, sewage and other train waste, herbicides used for vegetation control and other pesticides. The ballast itself may be a direct source of pollution if it is a waste material. Depending on drainage arrangements, receiving surface or groundwaters may be affected and resources compromised.

Surface water quality may also be affected by pumped (ground) water from cuttings or tunnels, where this occurs.

Through flow of drainage may be rapid and may affect river hydrology with implications for flood defence and sediment transport. Culverts may present a flood risk if these become blocked.

A railway may act as barrier to migration of certain wildlife across it, be it due to the track, railway traffic or embankments. However, the course of the railway may itself become an important wildlife corridor. Vegetation control may also damage nesting birds and other habitats at certain times of year. This and other maintenance activity may disturb wildlife.

The noise and vibration from railway traffic may damage historic buildings and may also disturb wildlife and amenity use of nearby rivers.

Train station, maintenance and stabling areas may cause localised problems. Runoff from buildings will affect the flow characteristics of receiving streams. Drainage of track areas may be at particular risk from oil and other general contamination from trains, and from spills and leaks from refuelling and loading areas. Sewerage requirements associated with buildings may overload the existing infrastructure, resulting in reduced surface water quality.

The railway may lead to consequential development associated with it which may add to the total impact.

4.3 Decommissioning

The decommissioning of railways is relatively straightforward. Track, ballast and other components may be removed, but embankments and cuttings are usually retained. Line closure often results in an attractive rural byway with a valuable wildlife corridor.

5. Mitigation Measures

Mitigation measures that should be considered include:

- using alternative routes to minimise impacts;
- timing of construction to reduce disturbance of wildlife;

- covering exposed soil/spoil too reduce silt runoff;
- protecting ground on access roads to reduce disturbance of soils;
- transporting materials to site by rail where possible;
- rehabilitating access roads to restore flora and fauna;
- maintaining river corridors by having a minimum width of corridor under bridges, and a minimum free height beneath bridges;
- using sympathetic bridge material and design, including provision for relevant nest boxes;
- installing culverts with sufficient freeboard (to allow the passage of debris) or with trash-grids, to reduce flood risks;
- making provisions for adequate passage of flood flows in both construction and operational states;
- adequate bunding or lining of fuels, chemicals and other stores to protect groundwater and surface waters;
- installing pollution prevention devices for site drainage (e.g. oil separators, silt traps, balancing ponds), particularly in high risk areas (e.g. loading areas, major junctions);
- establishing emergency arrangements for spills, including drainage isolation, notification and access arrangements;
- careful siting and storage of soils;
- reinstating cuttings and embankments with appropriate vegetation;
- conducting maintenance and controlling vegetation at an appropriate time of year (i.e. outside of nesting periods) and using approved pesticides, particularly near watercourses;
- fitting landscaping of embankments and cuttings;
- provision of acoustic and visual barriers to protect sensitive sites;
- careful design of diverted river channels (including replanting) considering both stability and nature conservation interests;
- retaining abandoned river sections as ponds or other aquatic habitats; and
- provision of bridges etc. to maintain footpaths and other rights of way.

6. Baseline Surveys

Information should be gathered on a variety of subjects from archive data and field surveys. Surveys should be conducted using appropriate methods and timing. Of particular interest may be surveys in the following:

- river corridor (conservation);
- botanical and other wildlife;
- aquatic biology;
- fisheries;
- landscape/amenity;
- recreation;
- hydrogeology;
- water quality;
- hydrology and drainage; and
- geomorphology.

The NRA will normally provide details as to what relevant information the Authority may hold.

7. Monitoring And Audit

Monitoring that is relevant to predicted impacts and mitigation measures is recommended and should not only make use of baseline surveys but also consider further pre-scheme surveys. Post-scheme monitoring data should be regularly reviewed. The review or audit should also include compliance with agreed management practices.

8. General guidance

Carpenter, T.G. (1994) The Environmental Impact of Railways. John Wiley & Sons Ltd.

Construction Industry Research and Information Association (1994) *Environmental Assessment*. Special Publication 96. CIRIA, London.

Countryside Commission (1995) *Roads in the Countryside*. Countryside Commission.

Harris, R. C. (1993) Groundwater pollution risks from underground storage tanks. *Land Contamination & Reclamation*, 1 No. 4, 197-200.

Nelson, P. (1992) EA of a rail link terminal and associated development. In proceedings of *Advances in Environmental Assessment* conference, 29-30 October 1992. IBC Technical Services.

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF AIRPORTS

1. Introduction

This guidance note seeks to identify the potential impacts of airports upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of airport schemes. The potential impacts of airports are of interest to the NRA because of the authority's responsibilities for flood defences, pollution control, water resources, fisheries, recreation and conservation management. Early consultation with the NRA will help to identify any environmental constraints and sensitive areas which may be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage. Consultation with the NRA will also be required as a licensing body for discharge and other consents.

Legislation requires that an EA is carried out for proposed airports and airport extensions. The responsibility for this assessment lies with the developer. It is advantageous to conduct the EA in advance of the design phase to enable proper consideration of alternatives. The EA's conclusions require proper justification and raw data should be accessible in the event of such a request.

2. Development control

Development control of airports is within the Town and Country Planning (T&CP) framework.

3. Environmental Assessment

Airports are listed under The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No 1199) under both Schedules 1 and 2. "Aerodromes with a basic runway length of 2,100m or more" are projects listed under Schedule 1, for which EA is mandatory. Smaller airport projects are classified as Schedule 2 projects for which EA is required when significant impacts are expected. Similarly, extensions to existing airports may require EA as a modification of a Schedule 1 project. Further guidance on the need for EA for such infrastructure projects may be found DoE Circular 15/88 (WO 23/88) and DoE/WO (1989).

4. NRA authorisations

Different licences or consents may be required with respect to the development, such as:

- **discharge consent** - for discharges to controlled waters (i.e. groundwaters, inland surface waters, and coastal waters);
- **abstraction licence** - for abstraction from groundwater or surface waters;
- **impounding licence** - for impounding of water;

- **land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

Authorisation from the NRA will also be required for the movement of fish (e.g. from ponds to be destroyed or to newly created ones) and for the use of herbicides in or near water.

5. Major/potential impacts upon the aquatic environment

The impacts of airport projects will occur in both construction and operation.

5.1 Construction impacts

The construction of airports will generally involve the clearance and levelling of the site for runways, car parks and buildings with the permanent loss of the habitats affected. Land take for level grassy areas, e.g. between runways, and subsequent management may result in altered habitats. Site drainage, including the diversion or culverting of existing watercourses will be of particular interest to the NRA.

Site clearance - The stripping of topsoil, levelling of ground surface and other excavation will result in the direct destruction of habitats and loss or displacement of associated organisms. Runoff from exposed and compacted soil may be rapid, leading to contamination of watercourses by high levels of suspended sediments, directly reducing water quality and indirectly reducing habitat quality through siltation. Siltation may be particularly significant where gravels in receiving streams are used by salmonid fish (salmon and trout) for spawning. Soil compaction and increased runoff from sites will also lead to increased flood risk downstream and decreased infiltration to groundwaters, the latter having implications for water resources and water table levels. Reductions in water table level will affect adjacent wetland sites. Compaction of soils and altered soil profiles may also determine subsequent flora and other associated wildlife.

Disposal of spoil - The disposal of spoil from levelling and excavation works, and also of topsoil set aside, will affect the ecology of the site of disposal. Spoil heaps may increase or reduce runoff and infiltration with corresponding impacts on surface or groundwaters. Runoff is likely to contain high sediment loads. In addition, exposure of both natural and contaminated soils to air and rain may produce a contaminated runoff from chemical processes and leaching.

Demolition works - Demolition works will result in the destruction of buildings and may cause damage to areas of cultural/archaeological interest. Associated habitats, e.g. bat roosts, will be lost. Debris from demolition works may enter watercourses causing pollution and increasing the risk of blockage and flooding.

Dewatering - Dewatering will have a direct effect on water table levels, with impacts on water resources and ecosystems dependent on water table levels, e.g. wetlands. Discharges from dewatering may potentially pollute receive waters, particularly if water is "drawn in" from contaminated land.

Redirecting/culverting streams - The redirecting of streams will result in the loss of established aquatic habitats and their ecological communities. In addition, changes to channel geomorphology arising from diversion may lead to further habitat changes beyond the area directly affected.

The culverting of channels will result in a loss of access to the river for both human (e.g. recreation) and wildlife use. The passage of migratory fish may be hampered where culverts discharge to rivers above the level of the water surface. Culverts may also present a flood risk should blockage occur from site and other debris.

Culverting, stream diversion and other channel or near-channel works may result in the disturbance of associated wildlife (e.g. feeding or breeding birds). Compaction of river banks by heavy machinery will lead to the loss in bank stability, and the destruction of soil structure and bankside flora. The disturbance of bank and river substrate may cause erosion and sediment resuspension leading to water quality deterioration. The loss of river substrate and disturbance to bed form (pools, riffles etc.) may represent a major loss of habitat. Damage from habitat loss and deterioration of water quality may lead to reduced species diversity (particularly of aquatic invertebrates and plants) and the loss of sensitive species. Angling quality may be affected by changes to access, fish populations, their food and habitat.

General site activities - General site activities may disturb wildlife and the outward migration of sensitive species. Vehicle movements may add to the erosion of soils and solid loads in runoff. Careless handling, storage and disposal of chemicals and fuel may result in pollution of groundwater and surface waters from spillages. Inadequate on-site sewerage, damage to existing sewerage or the disturbance of contaminated land may also cause pollution.

Infrastructure - The laying of cables, sewers, pipelines, roads and other associated infrastructure associated with the airport will also have impacts. The site may cause overloading of water supplies and wastewater treatment capacities. Other relevant guidance notes may be available from the NRA.

5.2 End state/Operational impacts

Paved surfaces - The extensive impermeable area presented by paved surfaces (runways, car parks) and buildings will result in greatly increased runoff from the airport, causing increased flow velocities, erosion and flood risk in receiving waters and decreased infiltration to groundwaters. Reduced groundwater levels may adversely affect water resources, wetland sites and river base flows. Changes to stream hydrology or flow regime are likely to affect aquatic life and recreation use of watercourses.

Fuel/oil - Spillages of fuel or oil in emergency or routine situations may cause surface water pollution with the loss of invertebrates, plants and fish etc. and may restrict downstream uses, including abstraction for public supply. Groundwaters may also be affected by such spillages. High pressure pipelines conveying fuel oil may represent a significant potential source of groundwater and surface water pollution.

Other chemicals - The use (or spillage) of chemical dispersant on oil/fuel spillages and extinguishants used in fire fighting may exacerbate pollution impacts. Similarly the use or spillage of de-icing agents (e.g. glycol, urea) and pesticides may cause pollution of surface and groundwaters, including deoxygenation. Surface water pollution from oil, fuel, chemicals and other substances may be a particular problem in runoff following dry weather or from snowmelt. Other potential sources of pollution are chemicals and other substances carried as freight, and those used in the maintenance and servicing of aircraft.

Noise - The movement of aircraft and other airport activity may disturb wildlife. In general, birdlife in the vicinity of the airport will be discouraged due to the risk of birdstrikes. Active measures to keep birds away may disturb bird and other wildlife.

Noise and vibration from aircraft take-off may affect buildings and other areas of archaeological/cultural interest. Also, recreational use of watercourses or water bodies may be disturbed by aircraft noise.

Maintenance and support services - Impacts, particularly pollution, may arise from maintenance and support services, such as inflight catering, aircraft services and freight handling. Impacts may arise from site sewerage; sewage from terminal buildings, associated businesses and aircraft may potentially overload the existing system and cause surface water pollution. The use of pesticides (particularly herbicides on runways, taxiways, roads and footways) may cause contamination of surface and ground waters.

6. Mitigation measures

Careful design of airports will minimise their environmental impacts. Alternative siting and designs should be considered, taking into account their environmental acceptability. Land-use mapping should be carried out at an early stage in the planning process, including the identification of sensitive sites such as:

- river flood plains;
- lakes, wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable fisheries;
- vulnerable aquifers as outlined in the NRA's *Policy and practice for the protection of groundwater* (NRA 1992);
- architectural, SSSI and other nature conservation sites.

This will enable re-designing or implementation of adequate mitigation measures to occur while the project is a desk study, avoiding costly alterations and/or delays at a later stage. Appropriate surveys carried out in the EA will enable the identification of habitats and/or species which will be affected by the development, thus enabling further avoidance or mitigation measures to be undertaken.

Mitigation measures will be case-specific but may include those described below.

General construction - Riparian zones should be avoided and appropriate construction materials used. Operations close to rivers should be properly engineered to avoid problems with the stability and long term performance of river banks and flood defences.

Storage of fuel and equipment - On-site equipment and materials should be carefully stored during construction and operation. Proper bunding should be provided for fuel tanks, away from water (preferably off-site) and locked when unattended. Bunds should be constructed such that all openings and fuel pipes are within the bund walls and that the bund itself has an adequate capacity. Drip trays should be placed under stationary machinery to collect oil and grease. The NRA will be able to advise on bund design.

Drainage - To reduce the risk of pollution of surface waters, a drainage system which collects the first flush of runoff (the first 10 mm of rainfall) into a containment lagoon should be installed. The collected discharge should be carried to a sewage treatment works for treatment. A reservoir to hold the maximum possible contaminated flow from a major pollution incident should also be incorporated into the design. For example, the crash of a Boeing 747 could spill up to 180 000 litres of fuel and an equal amount of expanded foam could be applied, therefore the total capacity needs to exceed 360 000 litres. All discharge points should be fitted with an oil/water separator.

In addition, the installation of booms on major watercourses at risk from a major pollution from the airport will enable the spillage to be contained and recovered, thereby providing a high degree of protection.

Balancing ponds and artificial wetlands may provide a useful buffer/treatment system for routine drainage discharges. Lagoons may require surface aerators to counter deoxygenating effects of deicing agents in the water and algal blooms in the summer.

Sewerage - Sewage pumping stations may be required for the collection and distribution of sewage from the terminal building, related businesses or aircraft. The potential failure and overflow of such systems should be taken into account in sewerage/drainage design.

Drainage should also take into account pollution from maintenance and support services.

Landscaping - Careful landscaping of the site and its surrounds may reduce visual, noise and ecological impacts. Advance tree and shrub planting, if appropriate, will provide screening of construction works and may also act as a refuge for disturbed species.

Noise - Noise during construction should be minimised by careful selection of machinery and the use of baffles or screens. The timing and siting of operations should be chosen carefully to minimise disturbance to wildlife and recreational users. Timing of operations including aircraft flight times should be restricted.

Access - Alternative access should be made to watercourses for recreational use and maintenance if the present arrangements are affected by the development.

Site restoration - Non-paved areas affected by construction should be restored to a semi-natural state. To reduce damage to the physical properties of soils during site preparation and construction, it may be appropriate to carefully remove topsoil and subsoil and store it separately so that proper reinstatement can be carried out. If necessary, subsoil should be ripped prior to the spreading of topsoil. Mixing unlike soil materials should be avoided. Certain soil damage, e.g. compaction, may be reduced by restricting traffic movement and the use of protective boarding and low ground pressure machinery, especially during wet conditions. Sufficient care taken during the construction and reinstatement may minimise any long term residual effects on soils drainage or vegetation. Excavated soil should be carefully disposed of, possibly off-site.

Habitats - Loss of habitats can be minimised by restricting the working width during construction of runways, roads, cable laying operations etc. Reinstatement of affected habitats should be undertaken wherever possible, although for some (e.g. wetlands) this may be complex and specific consultation with the NRA is recommended so that the best available and practical methods are employed. Where a habitat will inevitably be destroyed by the development, habitat/species rescue and habitat creation should be undertaken, e.g. the creation of new and restoration existing ponds and wetlands, through the translocation of soils, sediments, fauna and flora.

River diversions - Material should be translated from the existing to the newly created river channels in instances of river diversions. In such instances, remnants of the old channels should be retained as wetlands, ponds or blind-ending channels.

Culverts - Where unavoidable, culverts should be designed so as not to disrupt fish movement, and should have adequate clearance to allow the passage of both wildlife and debris. The incorporation of trash screens may be useful to prevent the build-up of debris in inaccessible areas, but these should be regularly maintained (with maintenance agreements made in advance of installation). Culverts should be designed to take highest predicted flows.

Pesticides and fertilisers - The use of pesticides and fertilisers should be minimised and used in accordance with the relevant guidelines, such as MAFF (1985) and NRA (1995). Watercourses should generally be avoided; approval from the NRA will be required for the use of herbicides in or near watercourses. Buffer areas (areas of land around watercourses, unaffected directly by the applications) may be used to intercept runoff and reduce the amounts of these chemicals entering watercourses. The use of herbicides should be minimal in the vicinity of important aquifers.

7. Baseline surveys

Field surveys should be appropriate with respect to timing, timescale and methods used and preferably include surveys conducted at a similar time of the year to the proposed construction, in the year (or years) prior to the works.

Field surveys should be sufficient to:

- establish the pre-construction (baseline) state of the site;
- allow the determination of critical environmental factors upon which to give rapid on site advice during construction;
- determine the best operational conditions for the aquatic environment during construction such as water level in wetlands, water flow in rivers and allowable sediment load or deoxygenation effects on river biota including fish;

- optimise the reinstatement of channels or wetland areas by the appropriate choice or extent of use of a specific technique; and
- identify construction practices with a high environmental risk, economic liability or publicity factor

The surveys required are site specific but is likely to include:

- river corridor surveys;
- aquatic, riparian and wetland ecology;
- water quality;
- water resources;
- hydrology;
- hydrogeology;
- landscape/amenity;
- recreational use;
- archaeology; and
- river geomorphology.

8. Monitoring and audit

Monitoring that is relevant to the predicted impacts and mitigation measures is recommended and should not only make use of the baseline surveys but also consider further pre-scheme surveys. Post-scheme monitoring data should be regularly reviewed. The review or audit should also include compliance with agreed management practices.

9. References and guidance

Department of the Environment/Welsh Office (1989) *Environmental Assessment - A guide to procedures*. HMSO.

Harris, R. C. (1993) Groundwater pollution risks from underground storage tanks. *Land Contamination & Reclamation*, **1** No. 4, 197-200.

Maeda, M. (1991) The Kansai International Airport Project and Environmental Impact Assessment. *Marine Pollution Bulletin*, 23, 349-353.

Ministry of Agriculture, Fisheries and Food (1985) *Guidelines for the Use of Herbicides on Weeds in or near Watercourses and Lakes*. MAFF. (NB these guidelines are currently being updated).

National Rivers Authority (1992) *Policy and practice for the protection of groundwater.* HMSO, London.

National Rivers Authority (1994) *Guidance notes for Local Planning Authorities on the methods of protecting the water environment through development plans.* NRA, Bristol.

National Rivers Authority (1995) *The use of herbicides in or near water.* NRA (Anglian Region), Peterborough.

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF CEMETERIES

1. Introduction

This guidance note seeks to identify the potential impacts of cemeteries upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) with respect to the environmental impacts of cemeteries. The potential impacts of cemeteries are of interest to the NRA because of the authority's responsibilities for pollution control, fisheries, recreation and conservation management. Early consultation with the NRA will help to identify any environmental constraints and sensitive areas which may be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage.

Although planning legislation does not require a formal Environmental Assessment (EA) to be carried out in connection with proposed cemeteries, environmental studies of some form will usually be required by consultees, such as the NRA, who are commenting on the proposals. The responsibility for such studies, which may take the form of an EA, lies with the developer. It is advantageous to both contact the NRA and conduct the studies or EA in advance of detailed designs to enable the identification of environmental constraints and the proper consideration of alternatives.

2. Development control

Cemeteries are covered by the Town and Country Planning framework. Under the recently consolidated General Development Order the NRA are statutory consultees for development relating to the use of land as a cemetery.

3. NRA licences

Under the Water Resources Act 1991 the NRA is the licensing body for abstraction and impounding licences and discharge and land drainage consents. Of these the most applicable would be land drainage consents, required for any works on the bed and banks of a river or construction of any structure likely to impede the flow. Such a consent must be obtained in advance of any construction, regardless of whether planning permission has been granted.

4. Potential impacts upon the aquatic environment

The main impact of cemeteries is groundwater contamination from corporeal decomposition products. This and other generally less significant impacts caused during both the construction and operation of cemeteries are discussed below.

4.1 Construction impacts

Preparation of the working area for new roads, chapels, toilets - This may result in damage to the site flora from land take, direct damage and through compaction and other physical disruption of the soil. In addition, the temporary disposal of excavated soil may extend the area affected. There may be a loss of bank stability from bankside operations.

Fauna may be affected that are dependent on trees and other vegetation, e.g. birds and bats may utilise trees as nesting or roosting sites.

Increased runoff resulting from soil compaction and vegetation losses and may result in increased river flows and therefore flood risk. In addition, groundwater resources may be affected by reduced infiltration of precipitation. Runoff and soil disturbance may lead to soil erosion with subsequent pollution from raised levels of suspended solids, decreasing water quality. Pollution by suspended material may have a direct effect on sensitive aquatic life from abrasion or from the attenuation of light in turbid water. In addition, sedimentation in rivers may affect substrate characteristics for aquatic flora and fauna, and reduce the quality of gravels for fish spawning, particularly trout and salmon. Reduced fish stocks will affect angling opportunities for such stocks. Angling and recreation may also be impaired by construction activities, e.g. at river banksides and crossings.

Archaeological interests may be unearthed or damaged by excavations.

Machinery and Vehicles - The general operation of machinery and vehicles may contribute to problems of soil compaction and soil stability. Leaking or spilled fuel and oil from stores, vehicles or machinery may contaminate both groundwater and surface waters.

5.2 End state/Operational impacts

Contamination of ground/surface water from decomposing bodies - Leachate from decomposing bodies may enter groundwater or surface water causing a deterioration in quality and potential health risks from microbial contamination. Deterioration of water quality from leachate with a high biological oxygen demand may result in the loss of fish and other aquatic life. The amenity value of watercourses may also be decreased by odour and other aesthetic problems. Polluted groundwater and surface waters may affect other users and water resources. Leachate may be more problematic in poorly drained sites with a high water table.

Fertiliser and pesticide application - Fertilisers and pesticides applied to cemetery in site maintenance may be carried into site runoff (particularly if rainfall occurs soon after application) and drainage. Chemical contamination of both groundwater and surface water may occur. Biological communities could be affected with a loss of sensitive species (both plants and animals).

Grave digging - Mechanical or manual excavation of graves may result in damage to the site flora from direct damage and through compaction and other physical disruption of the soil. Increased erosion from the disturbed soils may lead to pollution from raised levels of suspended solids, decreasing receiving water quality.

Graveyard mowing/strimming - Spills of oil and/or fuel from lawnmowers, strimmers or excavators may enter the groundwater or surface water causing a decrease in water quality; having a negative impact on the fauna, flora and amenity value of watercourses. The noise of mowers, strimmers and excavators may disturb wildlife and recreational users.

6. Mitigation measures

In general, cemeteries proposals should avoid sensitive areas such as:

- vulnerable aquifers;
- rivers, river corridors and other areas of high ecological or amenity value;
- river floodplains;
- lakes, wetlands and marshes;
- rivers supporting valuable fisheries;
- contaminated land likely to lead to polluting runoff if disturbed (without remediation); and
- upland areas of catchments with particular sensitivities.

Careful siting, design and operation should minimise the environmental impacts of cemeteries.

Site drainage - Where groundwater or surface waters may be at risk there should be an adequate drainage system to collect site drainage, including leachate, for appropriate treatment, e.g. by connection to a sewage treatment works.

Buffer areas - Strips of undeveloped land around watercourses may be used to intercept runoff and reduce the amounts of sediment and nutrients entering such watercourses.

On-site activity - If possible, maintenance activity should avoid sensitive locations or times of the year. Noise may be minimised by careful selection of machinery. Mowing regimes for border areas may be adopted to enhance conservation value.

On-site equipment - including fuel and oil, should be should be stored carefully in secure dry conditions, possibly off-site. Stores containing significant volumes of fuel or chemicals should be bunded to contain the liquids in the event of vandalism or spillage.

Drip trays - should be placed under stationary machinery to collect oil and grease.

Pesticides and fertilisers - should be used in accordance with the relevant guidelines (e.g. MAFF (1985), NRA (1995)) and avoid watercourses, buffer strips and other semi-natural areas. The NRA must be notified of there intended use near watercourses.

7. Baseline surveys

Surveys should be appropriate with respect to timing, timescale and methods used. The surveys programme should preferably include those at the same time of the season as the proposed construction, in the year prior to the works.

Relevant surveys may include:

- hydrogeology;
- groundwater and surface water quality;
- river corridor/ecological surveys;
- aquatic biology;
- fisheries;
- recreational and other use; and
- archaeology.

8. Monitoring and audit

Monitoring that is relevant to the predicted impacts and mitigation measures should be considered.

9. General guidance and references

Ministry of Agriculture, Fisheries and Food (1985) Guidelines for the use of herbicides on weeds in or near watercourses and lakes. MAFF. (NB these guidelines are currently being updated).

NRA (1995) *The use of herbicides in or near water.* NRA (Anglian Region), Peterborough.

Pacheco, A., Mendes, J., Martins, T., Hassuda, S. and Kimmelmann, A. (1991) Cemeteries - a potential risk to groundwater. *Water Science and Technology*, **24** No. 11, 97-104.

Van der Honing, H., Brinkmann, F.J.J. van der Ende, P.J. and Hooimeijer, A. (1988) The quality of surface water, drainage water and groundwater in the neighbourhood of cemeteries. *H_2O*, **21** No. 12, 327-331. (In Dutch, English summary p319).

NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF NAVIGATION ISSUES

1. Introduction

This guidance note seeks to identify the potential impacts of issues relating to navigation upon the water environment. It is intended to form the basis for a scoping brief to cover the concerns of the National Rivers Authority (NRA). The potential impacts of navigation issues are of interest to the NRA because of the authority's responsibilities for navigation, water quality, water resources, fisheries and conservation.

In general, small-scale navigation issues as discussed in this note will not require formal Environmental Assessment (EA) under the relevant regulations. However, the principles of EA may apply to ascertain the impacts of navigation issues as described. Larger scale development such as marinas are described in separate guidance.

2. Development control

Some relevant issues with respect to navigation may be subject to planning controls under the Town and Country Planning framework. In general, the NRA should be contacted with respect to navigation developments. Under the recently consolidated General Development Order, the NRA are statutory consultees for development involving the carrying out of works or operations in the bed of or on the banks of a river or stream.

3. NRA authorisations

The NRA are the competent navigation authority on certain rivers (e.g. Thames, Medway, Dee Estuary) and as such may issue boat and other relevant licences and introduce various bylaws etc. A **navigation consent** or licence will be required to undertake works in, on or over a navigable river where the NRA is the navigation authority.

4. Major potential impacts upon the aquatic environment

4.1 Construction issues

Construction impacts that may arise include those from the installation or modification of locks, moorings, slips, pilings etc. The impacts of even small developments are potentially very significant due to the essential proximity of watercourses or water bodies.

Preparation of the working area - This may result in damage to the site fauna and flora from direct damage and physical disruption of bankside soils and riverine sediments. Excavation may unearth and damage sites of archaeological interest. The temporary disposal of excavated materials may extend the affected area. Bankside operations may also cause bank instability.

Fauna may be affected by habitat loss both within the water channel and on the bankside, e.g. bankside trees and vegetation may be used by birds and bats as nesting or roosting sites. In addition, bankside trees may be used by otters and also provide shade; tree loss may result in raised water temperatures, and problematic plant and algal growth.

Construction - The construction of within water structures works will inevitably lead to disturbance of sediments and increased suspended solids. Further suspended solids may enter the river as runoff from disturbed bankside soils. This deterioration in water quality may affect organisms which are sensitive to abrasion or the attenuation of light from turbidity. Substrate characteristics may also be affected and this could result in changes in aquatic ecology, organisms favouring a more silty sediment becoming more dominant. Siltation may seriously affect gravels used for spawning by salmon and trout, with reduced egg-to-fry survival. Reduced fish stocks or a shift in species will affect angling quality.

Major works on locks may necessitate temporary cessation of use, for both boat and other users (e.g. pedestrian river crossings).

River works may result in an altered channel morphology with respect to channel width, depth, shape, gradient and bedform (riffles, pools etc.) and will lead to the deposition of suspended solids upstream with an associated loss of sediments deposited downstream. Changes in the riverine environment will have an impact on the aquatic fauna and flora.

Within or near river works may also disrupt access to the river, navigation, angling and other water-based activities. The installation of rigid concrete and metal bankside structures will prevent use of the bank as habitat. e.g. for voles, kingfishers etc., and access points for wildlife may also be affected. There will also be an aesthetic loss of "naturalness".

4.2 Operational issues

There is a variety of operational issues that may have environmental implications, ranging from boat movements on the waterway to dredging to maintain its use for navigation.

Boat movement - Waves and so-called "boat-wash" may cause erosion of the banks and/or riverbed and result in high levels of solids maintained in suspension. Erosion and boat-wash may damage bankside habitats and wildlife, and increase channel width. Waves and boat-wash may disturb nesting birds and damage nests. Increased sediment loads may lead to increased turbidity and sedimentation downstream. Boat-wash and movements may disturb anglers and other users, resulting in conflicts between user groups. Moored boats may block access to the river for anglers and other users.

Pollution - Pollution may be caused by the resuspension of contaminated sediments or directly from the boats themselves through the release of oil/fuel, chemical or organic materials to the waterway. Rubbish may also be released from boats either accidentally or carelessly.

Flow regulation - The use of locks generally improves access to the river for boats and can also be used to prevent flooding defence. Locks and weirs may also provide pedestrian crossing points and amenity areas. Altered flows through flow regulation and from locks may alter aquatic communities and affect recreational activities, such as angling. Stagnation of flow in the lock cut at time of low usage may result in deterioration of water quality thereby affecting aquatic life and decreasing the resource value for other users.

Water releases - Releases or artificial freshets may be made on rivers for canoeing purposes, improving the recreational value with respect to this pursuit. However, the increased water velocities may cause erosion of the bed and banks, high levels of suspended solids, washout of aquatic life, and a localised rise in the water table (if sustained). Alternation between high and low flows may have major impacts on the aquatic invertebrate and plant communities with species adapted to low flow, silty conditions not tolerating the high flow conditions and *vice versa*. The fish community, its distribution, behaviour, migration and spawning may be affected both directly and indirectly by freshets. Angling and other recreational use may be affected by flow changes (and fish distribution).

Dredging - From time to time navigation channels may need to be dredged, resulting in a myriad of impacts. Navigation may be disrupted whilst the dredging operations are underway. Dredging operations will increase the suspended solids loading through the remobilisation of sediments back into the water column. A variety of contaminants including oil, pesticides, and other chemicals, may be associated with the sediment particles. Thus, the net effect may be a reduction in water quality and which may seriously impact on aquatic fauna and flora and other water use, e.g. abstraction. Bankside users will also be affected as access to the banks may be limited by the temporary deposition of dredged materials along the river edges. The material will have a physical impact on underlying soils and associated flora and fauna, and may have amenity impacts from its appearance, odour and attracted flies. Dredged sediments may also pollute soils and water from leaching and runoff of associated contaminants.

5. Mitigation measures

Bankside construction - Sensitive and important habitats should be avoided and protected, where possible. General disturbance to wildlife, plants and habitats can be reduced by restricting the width of operations and the appropriate phasing of construction work to avoid sensitive times, e.g. sensitive times for bird populations include the breeding season, roosting and migratory concentrations. Similarly, disturbance to recreation caused by construction works can be minimised by timing operations carefully. For example, construction work on locks should be executed outside of the main boating season. Where possible alternative access and crossing arrangements should be made. The duration of construction and other works should be minimised.

Boat movements - The imposition of mandatory speed limits on vessels will reduce wave action and the impacts of boat-wash on bank and bed sediments and the aquatic communities. Mooring areas should avoid key angling pegs and other recreational access points.

Flow regulation - Freshets for canoeing should be carefully planned with respect to duration and flow. Advance notification of freshets to other user groups may reduce impacts on members of such groups. Stagnation within locks may be prevented by periodic or continuous (trickle) flushing.

Dredging - Dredged material should be disposed with consideration of the sensitivity of receiving site and the level of sediment contamination in mind. Disposal to landfill may be required for particularly contaminated material.

Disturbance to recreational users from dredging activities may be minimised by timing operations carefully.

6. Baseline surveys

Surveys may be required to ascertain the value and sensitivity of sites to navigation developments. Surveys should be appropriate with respect to timing, timescale and methods used.

The surveys required are case-specific but are likely to include:

- water quality;
- aquatic ecology, e.g. river corridor surveys;
- fisheries;
- recreational use;
- archaeology;
- geomorphology; and
- hydrology;

7. Monitoring and audit

Monitoring that is relevant to the predicted impacts and mitigation measures is recommended. Monitoring data should be regularly reviewed, such that action may be taken to resolve issues arising.

APPENDIX H LITERATURE SEARCHES ON DEVELOPMENT TYPES

APPENDIX H LITERATURE SEARCHES ON DEVELOPMENT TYPES

General assessment guidelines

Genium Publishing Corporation, Schenetlady, NY, 1993. (193)pp.
Handbook of environmental analysis.
R. K. SMITH (Apichemical Consultants).
This volume is designed to assist those responsible for the preparation of environmental studies and analyses in the task of obtaining all relevant data and the compilation of the results in a form which meets the requirements of the U.S. EPA guidelines for such studies in the U.S.A.. It discusses the methods employed in the sampling and analysis of environmental materials, the quality control and assurance procedures, nature of the determinands and organic parameters relevant to an impact assessment, and considers the specific problems of hazardous waste evaluation, groundwater monitoring and air pollution monitoring, in more detail. Appendices containing additional data, including inventories of suppliers and equipment are included. The procedures described are based on those of the U.S. EPA and the Standard Methods (17th Edition) and are strongly biased towards the demands of environmental legislation currently in force and the conduct of assessments in the U.S.A..
-U.S.A.- ; -Book- ; -Application-

Public Works, 1991, 122, No.9, 99-103 and 132.
Minimizing the $[1menvironmental$[0m obstacles of new projects.
R. ZYMA (STV Environmental, Inc., Pottstown, Pa.).
Practical suggestions, specifically applicable to the U.S.A., are offered as to how to smooth the passage through the regulatory structure of any project that would have $[1menvironmental$[0m implications; the suggestions are also intended to placate public opinion. The key to success was preparedness and willingness to cooperate, seen in such matters as the identification of all affected regulatory agencies, awareness of their permit systems and of their timetables for award of permits, the collection and comprehension of any literature relating to the site of the proposed development, and assimilation of any legislation (federal, state or local) already binding on the site. Early meetings with representatives of regulatory agencies and local interest groups, to find out what anxieties had been raised, and to concentrate any environmental impact $[1massessment$[0m that might be required onto the most sensitive areas, were strongly recommended. Cooperation with utility departments in such matters as transport arrangements to and from the site, the disposal of $[1mwastes$[0m generated, the provision of electricity and telephone connections, the reinstatement of disturbed land (and possibly the clean-up of any contaminants left by a previous developer who might have been operating under a more lax regime) was also strongly recommended. Preparedness to indicate compliance with all permit conditions, once the development had been completed, was also essential, and might entail the submission of plans to combat an emergency (fire, hazardous waste spillages, accidents to staff), and the maintenance of records showing safe operation of the site. -U.S.A.- ;
-Journal Paper- ; -Review-

Journal of Air & Waste Management Association, 1990, 40, No.7, 976-978.
Identifying ecological indicators: an $[1menvironmental$[0m monitoring and $[1massessment$[0m programme.
S. M. BROMBERG (U.S. EPA, Research Triangle Park, N.C.).
The U.S. EPA initiated the $[1mEnvironmental$[0m Monitoring and $[1mAssessment$[0m Programme (EMAP) in 1990 to $[1massess$[0m the status and

trends of U.S. near-coastal waters, $[1mforests$[0m, freshwater wetlands, surface waters, agro-ecosystems and arid lands. The 6 research areas were supported by sampling design, land characterization, atmospheric monitoring, and quality assurance. Periodic $[1massessments$[0m would be performed to address regional problems rather than site specific problems. -U.S.A.- ; -Journal Paper- ; -Review-

Acque, Rome, Notebook 76, 1987. 139pp. (in Italian, English summary).
Methodology for evaluating environmental impact.
R. MARINI (Istituto di Ricerca sulle Acque, Bari), G. MUMMOLO, and A. LO PORTO.
This report on environmental impact $[1massessment$[0m begins by outlining the stages of such a study: determining the $[1mscope$[0m, predicting $[1mimpact$[0m, evaluating $[1mimpact$[0m, monitoring and alleviating adverse effects. Five types of forecast model are recognized and 3 principle types of methodology are described with examples. These were: use of environmental mapping (map overlay); checklists, matrices and networks; mathematical modelling (vector, linear, non-linear). A method of cross-event analysis is appended. Several methodologies developed and applied in Italy are presented and discussed. The usefulness of each methodology is $[1massessed$[0m according to ten different criteria. Quantitative methodologies were being abandoned in favour of qualitative ones. A bibliography of 107 references appended. -Italy- ; -Report- ; -Theoretical-

ENDS Report, 1990, No.180, 17-19.
$[1mAssessing$[0m environmental assessment: the first eighteen months.
Since implementation of the 1985 EC Directive on environmental assessment of development projects, 121 environmental statements had been submitted in support of planning applications. Analysis by Manchester University Environmental Impact $[1mAssessment$[0m Centre indicated rapid, widespread acceptance of the new regulations and poor quality of many environmental statements. The non-technical summary and other statutory requirements were often lacking, and failure to discuss the $[1mscope$[0m and content of proposed environmental statements with planning authorities and statutory consultees as advised resulted in inadequate consideration of alternative development sites or treatment of landscape $[1mimpacts$[0m. The Nature Conservancy, Countryside Commission and HM Inspectorate of Pollution were drafting guidance documents, and although Department of the Environment criteria for requiring environmental assessment were unclear, a 5-year review clause in the EC Directive would soon become effective. Extensions of environmental assessment requirements to plans and programmes and into integrated pollution control were proposed, and primary legislation might become necessary. -U.K.- ; -Journal Paper- ; -Review-

Journal of Institution of Water and Environmental Management, 1991, 5, No.2, 194-204.
Environmental impact assessment and the water industry: implications for nature conservation.
P. J. BOON (Nature Conservancy Council).
The implications of the EC Directive on environmental impact assessment for nature conservation in fresh waters is examined, with particular reference to the land-drainage and flood-defence work of the National Rivers Authority (NRA) regulated in the U.K. by Statutory Instrument 1217. The process of environmental assessment was divided into 4 phases: screening, review (need for

environmental statement), design, $[1massessment$[0m and documentation, implementation and monitoring. Fifteen environmental statements produced by the NRA/water authorities were evaluated against a set of objective and subjective criteria. The statements were variable in length, $[1mscope$[0m, style and presentation. Survey and data acquisition were generally poorly covered and the evaluation and prediction of potential $[1mimpacts$[0m were weak. -U.K.- ; -Journal Paper- ; -Review-

Wasserwirtschaft, 1992, 82, No.6, 284-285 (in German).
Environmental impact studies and assessments: legal background, approval procedure and implementation.
H. ARLT (Lahmeyer International GmbH, Frankfurt).
A law requiring an environmental impact study on the effects of certain major projects in both the public and private sectors was issued by the Federal government in February 1990, pursuant to a parliamentary decision in June 1985, and taking effect in August 1990. The nature and scope of the new legislation are outlined, including its impingement on other legal requirements including pollution abatement measures, and a flow chart outlining the various steps and the participants in the impact assessment process is presented. Other inputs to the decision-making procedure are summarized and the whole procedure is broken down into 3 successive phases, in which Phase 1 defines the scope of the study. Phase 2 defines the current and proposed objectives of the project, and Phase 3 outlines the consequences of its implementation. The whole process was normally assigned to a consultancy firm, and their report formed an essential input to the final decision-making procedure. -Germany- ; -Journal Paper- ; -Legislation-

$[0mMartinus Nijhoff Publishers, The Hague, Netherlands, NATO AS1 Series D, No. 14, 1983. 439 pp. (36151).
Environmental impact assessment. Proceedings of the Advanced Study Institute on Environmental Impact Assessment, Toulouse, France, August 30 - September 12 1981. NORTH ATLANTIC TREATY ORGANIZATION.
This conference considered the many facets of environmental impact assessments which are relevant to decision making where public works, highways, and urban developments are concerned. The papers consider the stages involved in preparing such an assessment, including the initial procedures at the planning level, the actual methodology, including the use of environmental and economic models, the accurate assessment of scientific impacts, and finally, the possibility of auditing the results on completion of the project concerned. The special problems of post-development auditing are discussed to highlight both the errors and omissions which may occur in the original assessment, and the necessity for adequate sampling at all stages if the correct conclusions are to be reached. -International- ; -Conference Proceedings- ; -General-

Water & Waste Treatment, 1988, 31, No.7, 56.
EC Environmental Assessment directive: implications for the water industry.
P. MEMFORD (Environmental Assessment Services Ltd.), and N. HAWKE.
The Environmental Assessment directive, EC directive 85/337, was to be implemented in the U.K. from 2 July 1988. The directive introduced the concept of formal environmental assessment (EA) for development projects as part of the planning process. EA would become mandatory for projects listed in Annex I and at the discretion of controlling statutory authorities for those listed in Annex II. The major projects listed in Annex I and II are outlined. The impact of the directive on these water-related projects is discussed. -U.K.- ;

-Journal Paper- ; -Legislation-

Environment Canada, Ottawa, 1987. 515 pp. (40627).
Audit and evaluation in environmental assessment and management: Canadian and international experience: volume II supporting studies.
B. SADLER (editor). This volume contains approximately 30 papers describing, in varying detail, the procedures and outcome of the environmental impact studies undertaken in connection with a range of development projects potentially damaging to the Canadian environment. The papers are grouped under four headings, the first dealing with impact prediction, mitigation and monitoring, the second with public participation and social impact, the third with project implementation and management procedures, and the fourth consisting of abstracts of several papers for which the full text was not available. This volume constituted a supplement to the proceedings of the conference on the follow-up of EIA studies, held in October 1985, issued as Volume I. -Canada- ; -Conference Proceedings- ; -General-

Journal of Environmental Management, 1992, 34, No.1, 1-13.
Environmental auditing: artificial waterway developments in western Australia.
J. BAILEY (Murdoch University, W.A.), V. HOBBS, and A. SAUNDERS.
In recent years, environmental auditing has emerged as a way of examining the effectiveness of past environmental impact assessment (EIA) in an attempt to identify ways of improving the utility and efficiency of future assessments. An environmental audit of a range of artificial waterway developments in Western Australia is reported. In particular, 3 types of audit are reported: a compliance audit in which an assessment is made of whether the conditions established by statutory bodies for mitigating the environmental impacts of the developments have been implemented and enforced; a prediction audit in which the nature and accuracy of impact predictions is evaluated; and an EIA procedures audit to evaluate the effectiveness of the overall EIA process. The results of the audit reported are encouraging in so far as the level of compliance and prediction accuracy are concerned, although problems with the lack of monitoring data, which beset earlier audits, prevented follow-up on many impact predictions. -Australia- ; -Journal Paper- ; -Case Study-

$[0mWater Science and Technology, 1981, 13, No.6, 57-71.
Guidelines for environmental impact assessment of dam and reservoir projects.
C. P. REES , (Atkins Research and Development) .
After outlining the purpose of environmental impact assessment, the author describes procedures that can be used to predict the effect on the environment of the construction of dams and reservoirs. -U.K.

General Construction

Marine Pollution Bulletin, 1982, 13, No.10, 338-340. (Reprint). (36415).
Why do environmental research?
D. G. SHAW (University of Alaska, Fairbanks) .
The value and importance of environmental research projects are discussed in the context of the search for information concerning the impact of various industrial or construction projects on the environment. The author defends his approach based on the technique of cost effectiveness analysis for ranking the priorities or importance of different research programmes, as a means of introducing some degree of rational judgment into an otherwise subjective or intuitive process of decision making. Cost effectiveness analysis applied to environmental research projects will enable the information sought about the consequences of a certain course of action to be assessed in the light of the costs of acquiring it. The author takes as an example the problem of an industrial discharge to a coastal marine environment. Stages in the implementation of a research project are considered, and the author emphasizes that analysis at each stage is not a substitute for scientific judgment, but a way of decreasing the degree of uncertainty, and provides a systematic framework for the application of value judgments when answering the question - is it worth doing or not? -U.S.A.- ; -Journal Paper- ; -General-

Environment International, 1987, 13, No.3, 135-141.
Industrial development effects on the ecology of a Pacific Mexican estuary.
S. E. IBARRO-OBANDO (Centro de Investigacion Cientifica y de Educacion Superior, Ensenada), and A. ESCOFET.
Marsh vegetation in the Punta Banda estuary was sampled quantitatively for a 5-month period to assess the environmental effects of a dike built during the initial construction stage of an assembly plant for oil drilling platform supports. Tidal flow was suppressed by the dike, resulting in the establishment of a dominant population of pickleweed (Salicornia virginica) in the lower and middle marshes inside the dike in place of cordgrass (Spartina foliosa) and annual and short-lived species recorded outside the dike. Interstitial soil salinity in the nontidal zone was 1.6 to 3.0 times that in the tidal zone. The estuary was important for fish breeding and development, and summaries of existing information showed that the area provided habitats for 22 species of fish and 77 species of birds. The topography and tidal regime would be modified further by the planned second stage of construction which would disrupt the main circulation channel,and the environmental impact was predicted. -Mexico- ; -Journal Paper- ; -Case Study-

Water Pollution Research Journal of Canada, 1987, 22, No.2, 308-325.
Impact of acid drainage pollution from mineralized slate at Halifax airport.
O. P. LUND (M.M. Dillon Ltd., Willowdale, Ont.), J. G. VAUGHAN, and D. THIRUMARTHI.
An environmental assessment study was conducted to evaluate the effects of acid drainage on the water quality and biota in streams and lakes in the Salmon river catchment area which received runoff from sulphide mineralized bedrock excavated at Halifax airport. Analyses of water samples indicated considerable variation in concentrations but there were significant loadings of acidity and heavy metals, pH values of 3.8-4.6 and aluminium concentrations of 0.3-0.5 mg per litre. Adverse biotic effects included the virtual or complete absence of mayfly and stonefly nymphs and the absence of juvenile age classes of trout. A lime treatment plant installed at the airport was overloaded and treated only

50 per cent of the acid drainage. The large quantity of highly acidic drainage (which was apparently continuing to increase in strength) was attributed to bacterial oxidation of ferrous iron in the oxygenated vadose zone at the site of the waste rock pile, and to chemical dissolution of pyrite in saturated anaerobic conditions.
-Canada- ; -Journal Paper- ; -Case Study-

$[0mCanadian Journal of Fisheries and Aquatic Science, 1984, 41, No.7, 1121-1127. A commentary on environmental impact assessment for large projects affecting lakes and streams . P. A. LARKIN (University of British Columbia, Vancouver) . Environmental impact assessment in relation to major projects influencing the aquatic environment of Canada is discussed, the aim of such assessment being to safeguard public interest in the proper use of resources. The subjects of compromise and trade-offs in such circumstances are evaluated. The assessment should reflect pattern of activity rather than being only a preparation of statements on imminent projects. Anticipating the unforeseen nature of some impacts is stressed, and the necessity for financial provision. At present, environment impact assessment does not fully contribute to environmental science, and should not be seen as a substitute for research.
-Canada- ; -Journal Paper- ; -General-

Reservoirs

$[0mReport by the Water Resources Board. Wat. Resour. Bd Publ. No. 12, H.M. Stationery Office, London, 1972. 49 pp., 8 maps.
Morecambe bay: estuary storage.
Following desk studies on the possibility of constructing a barrage across Morecambe bay (see Wat. Pollut. Abstr., 1968, 41, Abstrs. Nos. 1556 and 1558), a full-scale feasibility study was made to assess the advantages and disadvantages of estuary storage as compared with alternative inland reservoirs. This publication summarizes individual reports from the Consulting Engineers, Economic Study Group (see following abstract), Natural Environment Research Council (on the ecological effects of the proposed construction), and Nature Conservancy (concerned with the loss of intertidal area and bird habitats), and examines the detailed implications of 3 basic forms of development, namely a full barrage, barrages across the Kent and Leven estuaries, and tidal barriers higher up these estuaries together with pumped-storage reservoirs in the bay. Various modifications of these schemes and a hybrid scheme (all shown diagrammatically) were considered and alternative preferences were concluded from the point of view of water resources, environmental effects, and regional economic policy.

$[0mWater International, 1980, 5, No.4, 4-8.
Water and environment.
D. ALHERITIERE , (UN FOOD AND AGRICULTURE ORGANIZATION).
Water helps to determine the quality of the environment, but its characteristics are also a product of the environment. This interrelationship is illustrated with the example of reservoir and dam construction, and more general comments on environmental assessment in water development. Various ways of classifying research and interrelationships with other fields of study are commented upon. Managerial problems connected with water and the environment in developed and developing countries are contrasted. The various international agencies dealing with these problems are reviewed, both within and outside the United Nations system -International-

Journal of Hydrology, 1981, 51, No.1/4, 219-230.
The search for reservoir sites in an urban environment.
C. S. SINNOTT , (THAMES WATER AUTHORITY) , and M. H. DAVIES ,
The authors describe a systematic survey of potential reservoir sites in the Thames Valley, of which 108 were selected for further investigation out of the 207 initially identified, assessing their cost (total construction cost and cost per unit volume of water stored) and size, and applying simple environmental impact indicators. Discounted cost analysis showed that there need be no financial penalty in choosing smaller reservoirs suitably located to meet environmental constraints. -U.K.-

$[0mWater Science and Technology, 1981, 13, No.6, 57-71.
Guidelines for environmental impact assessment of dam and reservoir projects.
C. P. REES , (Atkins Research and Development) .
After outlining the purpose of environmental impact assessment, the author describes procedures that can be used to predict the effect on the environment of the construction of dams and reservoirs. -U.K.-

Water Resources Journal, 1987, March, 13-20.
Environmental implications of water resources projects.
A broad survey is presented of the environmental effects of large-scale water resources developments in Asia, China and the Pacific. Reservoirs constructed for irrigation, flood control or hydroelectricity generation had rapidly lost their design storage through silting, had displaced large numbers of people in the flooded areas, submerged valuable agricultural and silvicultural land, increased the incidence of water-related disease, decreased the availability of nutrients to land downstream, and modified both water quality and local climate. Excessive irrigation had raised the water table to a level causing water-logging of the soil, with a net decrease rather than an increase of cultivable land in some areas. Other topics discussed included dredging and levee construction for flood control, the possible effects of large-volume water storage on seismic activity, and the growing interest in inter-basin water transfer. A need was seen for information exchange mechanisms at the national, regional, and more local level, so that environmental effects experienced in any one area could be readily assessed by all others, and taken into account in future planning. -International- ; -Journal Paper- ; -General-

GWF-Wasser/Abwasser, 1988, 129, No.9, 571-579 (in German, English summary).
Environmental compatibility in project planning and evaluation for hydraulic engineering structures: project experience during the last 10 years.
K. U. RUDOLPH (Private Universitat Witten/Herdecke GmbH).
Based on the provisions of the EC Directive 85/3377, the administrative requirements for conducting an Environmental Impact Assessment are considered in view of existing practices of West German provincial authorities. The author was opposed to creating a special office for such studies as proposed by various nature conservation organizations. Four major reservoir projects undertaken during the last 10 years were used to show there was still no consensus on the scope and content of environmental assessments. The procedures and results to date from an ecological appraisal of the four dam construction sites are reviewed. (English translation 345 pounds sterling, valid for 1989).
-West Germany- ; -Journal Paper- ; -Review-

Water Supply, 1989, 7, No.2/3, P5, 1-4.
$[1mAssessment$[0m of sanitary and $[1menvironmental$[0m characteristics of the Sao Bartolomeu river and Paranoa lake basins, Brasilia, Federal District of Brazil.
A. S. CAMPOS (Water and Sewage Corporation of Brasilia), and I. G. A. MASINI.
Paranoa lake in Brasilia, formed artificially for landscape and recreational purposes and first filled in 1961, underwent an accelerated eutrophication process. Measures planned for the recovery of the lake included the $[1mconstruction$[0m of two sewage treatment works incorporating nutrient removal processes. The water supply needs of Brasilia added to the urgency of the lake rehabilitation programme since a planned $[1mreservoir$[0m on the Sao Bartolomeu river was to be fed partly from Paranoa lake. A programme involving the control of water quality in the catchments of both lakes was developed by the Water and Sewage Corporation of Brasilia (CAESB) with the assistance of the United Nations Development Programme. -Brazil- ; -Journal Paper- ; -Case Study-

Journal of Institution of Engineers (India), 1986, 67, No.CI3, 160-165.
$[1mEnvironmental$[0m aspects of hydro-electric and multipurpose projects in Himalayas.
R. I. SINGH (Multipurpose and Hydro-Electric Projects, Dehradun), and D. KUMAR.
Extensive investigations were being carried out to $[1massess$[0m the environmental impact of various hydro-electric and water exploitation projects in the Ganga-Yamuna valley. Particular studies carried out for the Tehri Dam Project, a storage scheme on the Bhagirathi river, a tributary of the Ganga river, are described. The scheme involved the $[1mconstruction$[0m of a 260.5 m high earth and rockfill dam and an underground powerhouse. The impact of the dam, $[1mreservoir$[0m and excavation works on the population, siltation rate, slope stability along the rim of the $[1mreservoir$[0m, flora, fauna and fishery is discussed. The need for an environmental balance to be maintained is emphasized. -India- ; -Journal Paper- ; -Case Study-

World Water and Environmental Engineer, 1991, January/February, 36-37.
The $[1menvironmental$[0m factor.
C. XUEMIN.
Resettlement arguments, refuted $[1menvironmental$[0m $[1massessments$[0m and land preservation rows involved with the 140 large hydropower development schemes carried out in China during the last 40 years are discussed. The dense populations located in most river valleys in China are cited as the principal cause of the problems. Twenty-two per cent of a dam's $[1mconstruction$[0m cost was now spent on compensation. A 1987 survey of 160 hydropower projects then in operation showed that 140 people were moved per MegaWatt of power produced. The same survey for 44 ongoing schemes showed that only 28 people per MegaWatt were involved. Reduction in scale of many major hydropower projects proposed 40 years ago is discussed with reference to the Three Gorges scheme on the Yangtze river and the Hongshuihe river scheme in south China. The necessity to compensate people deprived of adequate displacement fees in the past is illustrated with reference to the Sanmenxia scheme on the Yellow river and the Xinanjiang project in Zhejiang. Key lessons in relocation now being implemented in present Chinese schemes included beginning relocation work, if possible, at the same time as dam construction, allocation of a small amount of the electricity produced for displaced people at no or nominal cost and allocation of a small amount of the power stations revenue to displaced communities. The recent successful Dongjiang project in Hunan province is described. Problems with the relocation of ancient monuments and $[1mreservoir$[0m induced earthquakes and introduction of Environmental Impact Assessments, are discussed. -China- ; -Journal Paper- ; -Case Study-

Institute of Hydrology, Wallingford, Report No.115, 1991. 138pp.
Instream flow requirements of aquatic ecology in two British rivers: application and assessment of instream flow incremental methodology using the PHABSIM system.
A. BULLOCK, A. GUSTARD, and E. S. GRAINGER.
The application of instream flow environmental methodology using the physical habitat simulation (PHABSIM) system was tested on 2 British streams, the Gwash in Leicestershire and Lincolnshire and the Blithe in Staffordshire to assess the implications of reservoir construction for aquatic organisms in the downstream channel. The rationale and concepts behind the method are discussed, also the data requirements and theoretical basis of the assessment routines, and their application at 5 reaches on the 2 rivers concerned are described. Hydraulic data and ecological findings were used to construct habitat preference curves for a wide selection of fish and invertebrate species. Results of physical habitat simulations are presented in terms of weighted usable area against discharge relationships for each reach and also as weighted usable area duration curves for pre- and post-impoundment flow regimes at 2 sites for 2 species. The results were used to demonstrate the velocity of the method for controlling the release of compensation water and for determining prescribed minimal flow conditions for the reaches concerned. -U.K.- ; -Report- ; -Application-

Regulated Rivers: Research & Management, 1993, 8, No.1/2, 5-14.
Quantification of daily peak hydropower effects on aquatic fauna and management to minimize environmental impacts.
O. MOOG (State Agriculture University, Vienna).
The adverse effects of pulse releases of water arising from intermittent peak generation of power on fish and benthic invertebrates were assessed by surveys in 4 Austrian rivers. A long section of river was disturbed, reductions in benthic invertebrate biomass of 75-95 per cent being observed in the first few km. A reduction of 40-60 per cent of biomass was detected within 20-40 km compared with undisturbed areas. Fish were similarly affected. Flushing, food depletion, catastrophic drift and habitat change were the primary causes of the depletion. Constraints on power generator's operations and modifications to discharge regimes were required to avoid extremely low and high flows. Balancing of flows by management of existing reservoirs or construction of buffer reservoirs would also be beneficial. There are 83 references. -Austria- ; -Journal Paper- ; -Experimental-

International Lake Environment Committee Foundation, Shiga, Japan, 1989. 199pp.
$[1mGuidelines$[0m of lake management. Vol.1. Principles of lake management.
S. E. JORGENSEN, and R. A. VOLLENWEIDER (editors).
This volume is the first of a proposed series dealing with water quality management problems and solutions for lake waters, as affected by conflicting requirements in terms of water use, $[1menvironmental$[0m protection and hydrological regimes. It is composed of 2 parts, the first comprising 8 chapters considering the behaviour of lake ecosystems, $[1massessment$[0m techniques, modelling of lake waters, and the application of remedial measures. The second part contains 3 case histories of specific problems relating to lakes or resources in the Philippines, Brazil and Indonesia, with details of the management policies applied to arrest or prevent deterioration of water quality in each case. -International- ; -Report- ; -Review-$

World Water, 1987, 10, No.11, S29 and S31-S32.
Menta dam impact study follows construction start.
The environmental sensitivity of the Menta dam site in southern Italy, on the edge of a national park, gave rise to problems for ELC Electroconsult, the Milan-based firm working on the project. The dam and associated works were intended to provide drinking water to the city of Reggio Calabria on the Straits of Messina. After the letting of construction contracts, the Ministry of the Environment asked for an environmental impact assessment to be carried out, and for the choice of project to be justified against groundwater and desalination options. The impact of the project was being assessed in terms of geomorphology, geology, groundwater, climate, fauna, vegetation and landscape. -Italy- ; -Journal Paper- ; -Case Study-

Water Resources Journal, 1987, March, 13-20.
Environmental implications of water resources projects.
A broad survey is presented of the environmental effects of large-scale water resources developments in Asia, China and the Pacific. Reservoirs constructed for irrigation, flood control or hydroelectricity generation had rapidly lost their design storage through silting, had displaced large numbers of people in the flooded areas, submerged valuable agricultural and silvicultural land, increased the incidence of water-related disease, decreased the availability of nutrients to land downstream, and modified both water quality and local climate. Excessive irrigation had raised the water table to a level causing water-logging of the soil, with a net decrease rather than an increase of cultivable land in some areas. Other topics discussed included dredging and levee construction for flood control, the possible effects of large-volume water storage on seismic activity, and the growing interest in inter-basin water transfer. A need was seen for information exchange mechanisms at the national, regional, and more local level, so that environmental effects experienced in any one area could be readily assessed by all others, and taken into account in future planning. -International- ; -Journal Paper- ; -General-

Journal of Institution of Water and Environmental Management, 1991, 5, No.3, 250-258.
The Blashford Lakes water supply scheme.
J. C. EASTWOOD (Wessex Water plc), A. J. ELDER, and N. PEARSON.
Wessex Water had developed a new 35 Ml per d water supply source, using lakes formed from worked-out gravel pits, to meet increasing demands for water and to provide security for existing supplies. Having identified the need for the scheme, an engineering feasibility study was carried out in conjunction with a full $[1menvironmental$[0m $[1massessment$[0m. This led to the successful promotion of the State I scheme in 1986. Design and $[1mconstruction$[0m took place immediately after, and the scheme was officially opened in 1989. There are opportunities to expand the scheme as more lakes are formed by gravel working, and proposals for this are advanced. All the key elements in the promotion and development of the scheme are described. -U.K.- ; -Journal Paper-; -Case Study-

Regulated Rivers: Research & Management, 1987, 1, No.1, 49-60.
Environmental impacts of the Tucuri dam on the middle and lower Tocantins river basin, Brazil.
C. J. BARROW (University College of Swansea, U.K.).
Present and possible future environmental impacts of the Tucuri dam in Brazil are assessed. They included: problems of impoundment, particularly from

incomplete clearing of forest vegetation; reservoir siltation; changes to fisheries and agriculture downstream; probable extinction of some animal and plant species; and environmental health problems - future difficulties of malaria control, the possibility of schistosomiasis, onchocerciasis, leishmaniasis, trypanosomiasis and bubonic plague. Common problems associated with the use of environmental impact assessment (EIA) in development countries are considered. EIA of the Tucuri dam was only commissioned after the project had been started and therefore could only have a limited influence. Nevertheless, EIA studies of Tucuri should be of use for planning future Amazonian and tropical hydroelectric projects.
-Brazil- ; -Journal Paper- ; -Case Study-

$[0mJ. Wat. Pollut. Control Fed. 1969 41, 1330-1339.
Bacteriological water quality of several recreational areas in the Ross Barnett reservoir.
R. D. BARBARO B. J. CARROLL L. B. TEBO and L. C. WALTERS
Ross Barnett reservoir is a shallow impoundment on the Pearl river which serves as a source of water supply for Jackson, Miss., and is used for recreational purposes; studies were made on the bacteriological quality of the water during a period of high recreational activity and one of normal use. Statistical analysis of the results showed no significant difference in numbers of total coliform ORGANISMS between the two periods, but during the period of greatest recreational activity four of the 10 samples had average total coliform counts in excess of that recommended for water contact activities, and three of these 4 samples were at marina sites; during the period of normal use only two stations, one at a marina, exceeded the recommended level. Faecal coliform and faecal streptococci counts were significantly higher during the period of greatest activity at all stations, and the faecal coliform counts at the marina stations were significantly higher than those at non-marina stations during both sampling periods.

Water Quality International, 1991, No.3, 25.
East European changes open door to new planning criteria.
L. SOMLYODI (Water Resources Research Centre).
Because the application of systems analysis to environmental problems had been rare in Eastern Europe, few impact assessments had been undertaken which balanced social, economic and technical factors. An exception was the Hungarian government's success in formulating a long term integrated plan to reduce phosphorus inputs to Balaton lake. In contrast, the Hungarian-Czechoslovak joint development of the Danube for hydropower had failed. The work had been halted twice because of fears of environmental damage. The only way to place the project on a sound footing would be to undertake a thorough environmental impact assessment starting from the present situation. In general, East European countries urgently required water pollution control strategies.
-Hungary- ; -Journal Paper- ; -General-

Environmental Toxicology and Chemistry, 1993, 12, No.12, 2293-2307.
Wetland risk assessment.
G. A. PASCOE (Environmental Toxicology International, Inc., Seattle, Wash.).
The assessment of ecological risks in wetlands is reviewed. Wetland definitions, relationships among environmental media, and seasonality of impacts are discussed. Approaches to risk assessment, its methodology, the need for chemical, ecological and toxicity data, and the scope of the technique are considered. The characterization of ecological risks by evaluating the weight

of evidence, creating a risk characterization matrix, and clarifying ecological significance is explained. The results of 2 case studies at Milltown reservoir, Mont., and Kesterson reservoir, Calif., are presented. Guidance for carrying out risk assessments in these complex ecosystems is continually developing. Recent U.S. EPA advice would assist this process. There are 51 references.
-U.S.A.- ; -Journal Paper- ; -Review-

$[0m 1 Int. J. Env. Studies, 1973, 5, No. 4, 299-305.
Water resource development and environment. An approach to impact analysis.
D. W. FISCHER , AND G. R. FRANCIS .
A set of principles to incorporate environmental considerations into management decisions on water development projects is suggested. These principles are then applied via consultations and an impact analysis consisting of three parts: identification of environmental units, assessment of the environmental base, and assessment of the environmental impacts. A bibliography of 40 references and various appendices are included.

Barrages

$[0mReport by the Water Resources Board. Wat. Resour. Bd Publ. No. 12, H.M. Stationery Office, London, 1972. 49 pp., 8 maps.
Morecambe bay: estuary storage.
Following desk studies on the possibility of constructing a barrage across Morecambe bay (see Wat. Pollut. Abstr., 1968, 41, Abstrs. Nos. 1556 and 1558), a full-scale feasibility study was made to assess the advantages and disadvantages of estuary storage as compared with alternative inland reservoirs. This publication summarizes individual reports from the Consulting Engineers, Economic Study Group (see following abstract), Natural Environment Research Council (on the ecological effects of the proposed construction), and Nature Conservancy (concerned with the loss of intertidal area and bird habitats), and examines the detailed implications of 3 basic forms of development, namely a full barrage, barrages across the Kent and Leven estuaries, and tidal barriers higher up these estuaries together with pumped-storage reservoirs in the bay. Various modifications of these schemes and a hybrid scheme (all shown diagrammatically) were considered and alternative preferences were concluded from the point of view of water resources, environmental effects, and regional economic policy.

$[0mWater Science and Technology, 1984, 16, No.1/2, 253-268.
Tidal power from the Severn estuary.
J. CORLETT .
The work of an advisory committee on the feasibility of the Severn barrage scheme included a study of the likely ecological effects of such a barrage. Predictions of water quality following construction of the barrage suggested that there would be little change in non-conservative constituents such as BOD, nitrate, ammonia, phosphate, and oxygen, but metal concentrations could be increased. The new tidal regime could have beneficial effects by increasing the average depth of water over some outfall sewers, thus increasing the initial dilution. However, it was concluded that the barrage would have very wide-ranging environmental consequences, and much more work would be required to assess these, including effects on port access, sewage disposal, recreation, bird life, salmon fisheries, and land drainage. -U.K.- ; -Journal Paper- ; -Case Study-

$[0mThomas Telford Ltd, London, 1982. 240 pp. (35921).
The Severn Barrage. Proceedings of a symposium, London, 8-9 October 1981.
INSTITUTION OF CIVIL ENGINEERS.
This symposium was concerned with the various hydraulic, structural, technical and environmental problems associated with the construction of a Severn Barrage and the generation of electricity from tidal flows. The twenty-two papers and associated discussions review the history of the project, and the vast amount of information on site investigations, model studies, technical aspects of tidal power generation, construction problems, navigation facilities and the consequences for sediment transport and water quality. The final two papers describe the progression of such a scheme by means of a four-year preliminary design study, and the economics of tidal power generation relative to the use of other fuels for the generation of electricity. The contents of these papers confirm that the scheme is still active and that the design proposals have been brought to a very advanced stage , from which site operations could commence on a sound footing. Benefit-cost ratios are assessed in the context of several scenarios involving differing relative proportions of nuclear energy and

fossil-fuel utilization in the generation of future electricity supplies.
-U.K.- ; -Conference Proceedings- ; -Application-

World Water and Environmental Engineer, 1992, January/February, 16-18.
Power struggle.
K. HAYWARD.
The state of the Gabcikovo/Nagymaros twin barrage scheme on the Danube is reviewed. Hungarian opposition caused the cancellation of the Nagymaros part of the project. There were fears that the barrage and the diversion of 90 per cent of the Danube's flow through a power channel would affect groundwater levels, cause deteriorations in river water quality and stimulate algal growth through the removal of silt. Czechoslovakia wished to continue the scheme which would improve navigation and provide electricity for 1.3 million people. It was threatening to proceed with a modified project within its own borders despite possible environmental impacts in Hungary. Although both sides had agreed to an unbiased internationally organized environmental assessment, Hungary had imposed the condition that all work should first cease: this was unacceptable to Czechoslovakia so there was an impasse.
-Europe- ; -Journal Paper- ; -Case Study-

Sea outfalls

§[0mCalif. Fish Game, 1966, 52, 28-48
The marine environment in the vicinity of the Orange County Sanitation District's ocean outfall.
C. H. TURNER E. S. EBERT and N. R. GIVEN
An ecological study of the ocean bed in the vicinity of the outfall from the sewage works of Orange County Sanitation District, Calif., was made during January and February, 1965, in order to assess the effects of submarine sewage disposal on the surrounding water. Ten sampling stations were set up on the ocean bed and at each the number and variety of plant and animal life, the characteristics of the substratum, and the temperature and clarity of the water were determined. The plant and animal life covering the outfall were compared with the flora and fauna on a nearby artificial reef. The methods of study are described and tabulated results are given. The collection of animals observed at each station was typical for the corresponding depths and bottom types, with two exceptions: fewer species were found encrusting the last 100 ft of the outfall compared to the central section, and the variety of species and numbers was smaller on the artificial reef which is influenced by the effluent than on other artificial reefs which had been submerged for similar periods at similar depths. It is suggested that surveys should continue to be made, at least twice yearly, to determine the full effects of the effluent.

§[0mCalif. fish Game, 1965, 51, 81-112
Survey of the marine environment offshore of San Elijo lagoon, San Diego County.
C. H. TURNER E. E. EBERT and R. R. GIVEN
An illustrated report is given of an ecological survey offshore from San Flijo lagoon in San Diego County, Calif., carried out during March-April 1964 in order to provide background data for environmental changes which might occur following the discharge of sewage effluent through a submarine outfall, and to enable an assessment to be made of the adequacy of the standards for the effluent. Observations were made along 3 transects from the intertidal area out to depths of 80 ft, and 239 plants and animals were recorded, only 16 being from sand areas. Four appendices list the biological and physical data obtained, the latter including records of bottom temperature and visibility.

§[0mCalif. FISH Game, 1969, 55, 26-46.
Results of a six-year trawl study in an area of heavy waste discharge: Santa Monica bay, California.
J. G. CARLISLE
The results of a trawl study in Santa Monica bay, California, from 1958 to 1963, to assess the effect on the marine environment of the discharge of sludge and effluent from outfalls of the Hyperion works of Los Angeles (see also Wat. Pollut. Abstr., 1962, 35, Abstr. No. 1860), are given. Fluctuations in abundance, as measured by trawl catches, could not be related to the polluting discharges, and anglers' catches showed only small fluctuations over the study period. Speckled sand-dab showed an attraction to the nutrient-enriched area near the sludge outfall; other species of fish avoided the area of the effluent outfall. It was found that kelp would not develop on artificial reefs in coastal-water areas of the bay where the deposition of particulate matter was related to the discharge of effluents.

$[0mLondon, 1976. 28 pp. (26713).
North Wirral long sea outfall; report on environmental and ecological survey. I. General report, monitoring period 1970-74.
DEPARTMENT OF ENVIRONMENT , WATER ENGINEERING 1, RESEARCH & DEVELOPMENT DIV.
This report outlines the problem of sewage treatment and disposal from the northern part of the Wirral Peninsula, and the various alternative solutions to the disposal problem that had been considered. A series of experiments in the 1960's to elucidate flow patterns within Liverpool bay had suggested that a long sea outfall, in this case of some 3 miles, would be an acceptable solution. The observations given in this report cover about 2 years before and after construction of the outfall, and suggest that the closing of the pre-existing 5 short sea outfalls and the concentration of their discharges into one long outfall has markedly improved the sanitary conditions of the foreshore, and had no ill effects on the overall quality of offshore water. The outfall is, however, operating at less than its design capacity, and continued vigilance is recommended; in particular, the land earmarked for a partial treatment plant should not be given up until theeffects of full-capacity discharge have been assessed. <00>sewage disposal.

$[0m Marine Pollution Bulletin, 1977, 8, No.11, 249-254.
Immediate industrial effects on sediment metals in a clean coastal environment.
G. A. KNAUER .
The results of field studies designed to assess the environmental impact of a new nickel refinery in Halifax Bay, Queensland , are presented. Measurements of the heavy-metal content of sediments in the bay indicated that within 3 weeks from the commencement of discharges, the level of cobalt increased significantly near the outfall. Samples taken from river mouths discharging into the bay also showed elevated nickel levels, which may be connected with atmospheric pollution by nickel. The results suggest that the levels of cobalt, nickel and iron may be expected to increase significantly as a result of the refinery operations. <00> metal industry waste waters ; origin Australia

$[0mProgress in Water Technology, 1979, 4, 77-86.
Receiving water studies for preliminary design.
L. A. KLAPOW , (CALIFORNIA STATE WATER RESOURCES CONTROL BOARD),
and R. H. LEWIS .
The objectives for meaningful conduct of preliminary surveys of the marine environment and acquisition of baseline data prior to the siting of marine sewage outfalls are discussed. A reconnaissance or screening survey to identify the most promising sites should be undertaken prior to an intensive survey in which detailed information regarding currents, dilution and decay processes as well as the nature and abundance of the aquatic fauna are obtained. Criteria for the siting of outfalls should also include an assessment of aesthetic, public health and environmental factors and an evaluation of effluent toxicity. Clear identification of the objectives and a planned survey programme are necessary to correct site selection. -U.S.A.-

$[0mWhittier, Calif., 1974. 124 pp. (08E LOS).
Technical evaluation of best practicable treatment for deep ocean discharge, June 1974.
LOS ANGELES COUNTY SANITATION DISTRICTS and J. D. PARKHURST .
The environmental consequences of the discharge of primary and secondary sewage works effluents through marine outfalls off the southwest coast of California were assessed from surveys of water quality in the coastal region and the

composition of sediments and species distribution of marine organisms in the outfall zone. Detailed results are presented in respect of a wide range of parameters which support the assertion that present methods of treatment are hygienically and environmentally acceptable, in the light of the proved purification capacity of the coastal waters, and that an unqualified enforcement of a statutory requirement for secondary treatment of all such discharges cannot be justified on economic of hygienic grounds . -U.S.A.- ; sewage disposal

$[0mHelgolander Meeresuntersuchungen, 1980, 33, 377-383.
Effect of domestic wastes on the benthic marine communities of southern California.
D. J. REISH , (California State University, Long Beach) .
Arrangements for the discharge of partially treated sewage via marine outfalls at several points along the southern California coast are summarized, and the effects on the benthic fauna described. Case studies concerning the ecological impacts of the discharge of sewage and sewage sludge are briefly reported in respect of the four principal outfalls and four types of benthic environment are distinguished based on the severity of the pollution. At one location a temporary improvement in the quality of the benthic environment, with disappearance of sulphide odours from the sediment, was noted following the multiplication of the echiuroid worm Listriobulus pelodes; by burrowing to depths of 30-50 cm this worm encouraged penetration of dissolved oxygen and hence oxidation of organic matter. In contrast to the beneficial action of this organism, the most highly stressed environments were characterized by the emergence of Capitella capitata as the dominant species . A faunal index, based on the relative abundance of benthic organisms from a selected group of 47 species, is used to assess the degree of pollution of the seabed. -U.S.A.-

$[0mWater & Waste Treatment, 1983, 26, No.8, 28 and 30.
A decade of progress in long sea outfall design and construction.
J. A. CHARLTON (University of Dundee) .
The principal criteria in sewage outfall design are reviewed, in terms of coastal water quality regulations, environmental surveys, coastal hydrodynamic characteristics and dispersion assessment. A technique of tidal current measurement by multiple float-drogue tracking, using radar, is described. Dilution measurement by commercial Rhodamine dyes with fluorescence characteristics, using continuous injection and in situ fluorometry, can be used to simulate a tidally dispersed effluent plume and to predict the performance of an outfall. Radioactive tracers have also been used successfully. Patch or plume dilution measurements can also be used to derive local dispersion coefficient data for use in a mathematical model representing the dilution characteristics of an area. -U.K.- ; -Journal Paper- ; -Review-

Proceedings of Institution of Civil Engineers (Part 1), 1985, 78, 1045-1064.
Planning, design and construction of the Great Grimsby sewage outfall.
C. MASON (Anglian Water), K. J. FLEMONS, and A. G. TAYLOR.
Against recent research findings that harmful environmental effects from discharge of sewage effluents to the sea could be avoided by careful planning, design and construction, a description is given of the three phases leading to the successful completion of a 2 m diameter sewage outfall approximately 3 km long at Grimsby discharging into the Humber river. Details of preliminary site surveys, cost assessments, appraisals of the type and number of pipes to be

used and dilution and dispersion studies are given. -U.K.- ; -Journal Paper- ; -Case Study-

GWF-Wasser/Abwasser, 1988, 129, No.10, 632-638 (in German, English summary).
Kinetics of growth and decay of ~Escherichia coli~ in sewage effluent.
A. HADJIANGHELOU (Aristotelian University of Thessalonika), T. EKATERINI, and H. HADJIANGHELOU.
To assess the design of marine outfalls, the kinetics of growth and decay of faecal bacteria (typically ~E. coli~) were investigated in the laboratory at various dilutions with sea water, tap water and surface water. Sewage constituted a unfavourable environment for ~E. coli~, leading to elevated mortality, although the survivors adjusted to the new environment and proceeded to multiply rapidly up to a final concentration of 1-10 million organisms per ml. Dilutions with plankton-containing water led to elevated mortality rates. At low dilutions, however, the growth rate could still exceed the rate of mortality. (English translation 235 pounds sterling, valid for 1989). -Greece- ; -Journal Paper- ; -Experimental-

Ingegneria Ambientale, 1989, 18, No.7/8, 393-400 (in Italian, English summary).
Protection of Adriatic coastal waters from the phenomenon of eutrophication: how it has changed in the last twenty years. Part 1: phenomenon of eutrophication. R. OLIVOTTI (Universita di Trieste). Eutrophication and its significance in the Adriatic sea are discussed with reference to the author's papers written around 1970. Later investigations, including the role played by phosphorus and nitrogen, confirmed the $[1menvironmental$[0m importance of the phenomenon and its predominantly coastal and localized character: less than 5 per cent of Adriatic waters were considered eutrophic, the remainder being oligotrophic. Eutrophication was evident in a zone extending 40-60 km south of the Po delta. In contrast, a large part of the Trieste gulf was 'abiotic' through anoxia attributable to the submarine $[1moutfall$[0m at Pirano. Where really effective controls were applied, recovery or response of coastal waters was a matter of months at most. The author's $[1massessments$[0m made 20 years ago were still valid and priority should be given to control of local discharges. There are 52 references. (English translation 355 pounds sterling, valid for 1990). -Italy- ; -Journal Paper- ; -Case Study-

Marine treatment of sewage and sludge, Brighton, 1987, Paper No.12, 189-201.
An economic $[1massessment$[0m of inland treatment and marine treatment options for Weymouth and Portland.
R. TYLER (Wessex Water Authority).
A 1976 $[1massessment$[0m of sewage disposal options in Weymouth and Portland recommended marine disposal through an $[1moutfall$[0m discharging in West Bay. The design was changed during development and a reassessment in 1979 confirmed marine disposal as economically and $[1menvironmentally$[0m superior to inland treatment. Construction of the tunnelled $[1moutfall$[0m was completed in July 1983 and Weymouth, Wyke Regis and part of Portland had been connected. Incurred and projected expenditure to completion are tabulated. Headworks operating costs for 1985-1986 totalled 80,500 pounds sterling, 10-20 per cent higher than estimated. The economics of phased works are discussed. -U.K.- ; -Conference Paper- ; -Cost Study-

Water, Maritime and Energy, 1992, 96, No.2, 121-123.
Coastal pollution modelling: why we need modelling: an introduction.
R. A. FALCONER (Bradford University).
Engineers were required to make environmental assessments of discharges to coastal waters and to design outfalls cost-effectively to disperse residual pollution harmlessly. The absence of standard solutions and the uniqueness of each site had caused physical and numerical models to be increasingly used. It was important to appreciate their limitations. Physical models could not scale turbulence and decay rates, but were valuable for small projects and for refining numerical models. Mathematical models contained many underlying assumptions about fluid mechanics, physical processes, chemical and biochemical processes and boundary conditions which were often not appreciated by the inexperienced user. Nevertheless, when skilfully used they were capable of accurate predictions. -U.K.- ; -Journal Paper- ; -Review-

Marine Pollution Bulletin, 1992, 25, No.5/8, 172-180.
An approach to monitoring sewage outfalls: a case study on the Sydney deepwater sewage outfalls.
P. FAGAN (Water Board, Sydney South, N.S.W.), A. G. MISKIEWICZ, and P. M. TATE.
Sydney, N.S.W., was served by 3 major sewerage systems with marine outfalls. Until recently, primary effluent was discharged through 3 cliff-face outfalls, but since mid-1991 discharge had been through deep-water outfalls. The physical environment of the continental shelf in the area is outlined and brief descriptions are given of outfall design. A 5-year monitoring programme had been developed to assess the performance of the outfalls. It would include studies on water quality and beaches, oceanographic studies and modelling, studies on biological communities, and assessment of contaminants in water, sediments, and biota. Preliminary results on the performance of the new outfalls are outlined, and future management plans for further reduction of pollution are indicated. -Australia- ; -Journal Paper- ; -Case Study-

Environmental Toxicology and Chemistry, 1993, 12, No.10, 1803-1812.
In situ response of natural periphyton to an anionic surfactant and an environmental risk assessment for phytotoxic effects.
M. A. LEWIS, C. A. PITTINGER, D. H. DAVIDSON, and C. J. RITCHIE.
Continuous flow toxicity studies were carried out in the Little Miami river, above and below a sewage outfall, to assess the toxicity of linear alkylbenzene sulphonate (LAS) to periphyton in the presence of 20-30 per cent treated municipal effluent. The first-effect concentration of LAS in water not containing effluent was 3.3 mg per litre and in 20-30 per cent effluent was 16.6 mg per litre. Changes occurred in photosynthesis and chlorophyll--a~. These concentrations exceeded LAS concentration measured in rivers above outfalls which averaged 0.04 mg per litre. The floating exposure unit used for the study provided realistic toxicity estimates. There are 53 references. -U.S.A.- ; -Journal Paper- ; -Experimental-

Water Services, 1994, 98, No.1177, 8-9.
Forth protocol.
A. MOORE (Wimpey Environmental).
The phased introduction of the Levenmouth Purification Scheme, Fife, would begin with detailed design work on the construction of primary treatment works and long sea outfall. The Forth River Purification Board had set stringent standards for new discharge schemes requiring that EC Directive guidelines for bathing waters were applied to recreational beaches. A comprehensive study of

the marine environment in Largo bay was carried out to ensure adequate secondary dispersion of wastewater from the proposed long sea outfall and adequate initial dilution of effluent. An initial dilution model was developed and used to identify 15 provisional disposal options, which were assessed using hydrodynamic models and field work. The final short-list was evaluated according to environmental, engineering and cost factors. -U.K.- ; -Journal Paper- ; -Case Study-

WRc plc, Medmenham, Report No.PRU 2276-M/1, 1989. 22pp. (ME/44042).
House of Commons Environment Committee: Water Research Centre memorandum on the pollution of beaches.
WRc plc, Medmenham.
The possible causes and available evidence of adverse effects resulting from the discharge of untreated sewage to coastal waters are considered, and the desirability of introducing physical and/or biological treatment on land prior to discharge to the inshore aquatic environment is discussed. The factors contributing to harmful or unpleasant effects are reviewed, together with the impact of various treatment options on residual levels of bacteria, viruses, heavy metals, nutrients and organic matter. The probable technical and aesthetic benefits of land treatment versus disposal of partially treated sewage via marine outfalls are considered with reference to studies in progress at Langland bay, Swanage and Tenby. Effects on water quality, micro-organisms and shellfish are reviewed, and the risks associated with sea bathing are assessed in the light of epidemiological evidence from other parts of the world. The standards in respect of bathing water quality, shell fisheries and effluent discharges are also considered, together with the extent to which compliance was achieved in the various EC member countries. Other non-quantifiable aspects such as ethical considerations and political pressures favouring a ban on the discharge of pollutants to the marine environment are briefly referred to. From the economic viewpoint, the costs of land treatment exceeded those for discharge via long sea outfalls by a factor of 2-3. -U.K.- ; -Report- ; -Review- ; -Staff Paper-

$[0mSurveyor, 1984, 163, No.4818, 12 and 14-15.
Outfall found a fairway clear of the golf course.
T. ANDERSON (Strathclyde Regional Council) .
The Irvine Valley sea outfall (see also preceding abstract), passes under the western Gold Club at Gailes. To avoid expensive delays caused by protracted negotiations with the golf club it was decided to construct a tunnel through rock from the Gailes pumping station to the diffuser section at sea and thus avoid closing part of the golf course. Tunnel construction took 138 weeks and was finished in 1977 on schedule. -U.K.- ; -Journal Paper- ; -Case Study-

Marine Pollution Bulletin, 1991, 23, 443-447.
Environmental assessment of wastewater marine disposal of Xiaogang zone, Ningbo.
H. MINYUNG H. QIANG, H. ZENCUI, C. HANGPIN, L. XIANGUI, and C. XINZHONG.
A new development, with a planned population of 50,000, was taking place on the coast near Ningbo, China, and close to the mouth of the YongJiang river. Sewage from the area would be treated by bar screening and microscreening before discharge through a 150 m sea outfall equipped with diffuser ports. Mathematical models had been developed to assess the likely effects of the discharge on the coastal waters. Results are summarized and the design of the project was acceptable. -China- ; -Journal Paper- ; -Case Study-

Roads and road widening

Science of the Total Environment, 1990, 93, 449-463.
Applications of magnetic measurements to sediment tracing in urban highway $[1menvironments$[0m.
P. R. BECKWITH (Middlesex Polytechnic, Enfield), J. B. ELLIS, and D. M. REVITT.
The use is described of mineral magnetic techniques to study the transport of surface sediments through a separate storm-water sewer in a small, well-defined, urban catchment area. The use of graphs and equations to analyse the magnetic characteristics of the sediments made it possible to differentiate between solids originating from $[1mroad$[0m surfaces and those originating from roofs. The contribution of both sources to sub-surface sediment and storm-water particulates was $[1massessed$[0m, and roof-derived solids gave more persistent input to suspended solids in storm water. Variations in the sediment contributions from both sources during storm events were related to hydrological and antecedent conditions. -U.K.- ; -Journal Paper- ; -Application-

Water Science and Technology, 1991, 24, No.6, 187-192.
Elements of management systems in coastal regions.
M. B. ABBOTT (International Institute of Hydraulic Engineering, Delft), O. K. JENSEN, and I. R. WARREN.
The specifications for systems for management of coastal waters, known as aquatic environment management systems (AEMS), including monitoring and other data acquisition, modelling, and combined analysis of modelling results and field data are outlined. The various components and structures of the system are shown. Some applications of such systems are outlined, including future development of water resources, optimal timing and duration of maintenance procedures, alarm handling, and providing information on legislation. Incomplete AEMs are being implemented by a monitoring system for the Great Belt region, Denmark, to assess the effect of construction of a road and rail link on the connection between the North sea and the Baltic sea. -International- ; -Journal Paper- ; -Review-

Central London Polytechnic, C.N.A.A. Ph.D. Thesis HM19791, 1978. (350) pp.
The effect of urban discharges, the M11 motorway and drought on an organically polluted urban stream.
C. A. EXTENCE.
Sections of the Roding river were subject to detailed study over a 3-year period to assess the effects of urban drainage, motorway construction and storm sewage overflows on river quality and benthic invertebrates. Both chemical and biological evaluations were performed and demonstrated a marked water quality deterioration in the urban zone during the period, which was attributed mainly to the input of sewage effluents, aggravated by intermittent runoff and discharges from storm sewer overflows. The assessment was complicated by the occurrence of a severe drought during the study period, as a result of which parts of the river dried up and certain organisms were eliminated due to standing or chemical changes in the environment. -U.K.- ; -Thesis- ; -Case Study-

Transportation Research Record, 1983, No.948, 17-20.
Highway impacts on wetlands: assessment, mitigation, and enhancement measures.
M. H. THRASHER (Federal Highway Administration, Washington, D.C.).
Federal agencies should avoid construction in wetlands where there was a

practicable alternative. After discussing types of wetlands and their value, the mitigation of highway impact on wetland is discussed. Careful evaluation of impact and mitigation measures was essential at an early stage of project. Basic ecological features unavoidably disturbed by highway construction should be reconstructed. New wetlands should be created to substitute for areas diminished or destroyed. Improvements to wetland environments should be incorporated into highway projects.
-U.S.A.- ; -Journal Paper- ; -General-

Fish farms

$[0mWass. Z. KARL-MARX Univ. Lpz., 1966, 15, 373-423, 1 folding chart.
Contribution to the limnology of shallow waters with high nutrient concentrations.
D. UHLMANN
The various environmental conditions affecting the development and seasonal changes of the phytoplankton population in shallow waters are reviewed and discussed with reference to an extensive bibliography, and details are given of monthly investigations supported by tables and graphs showing the seasonal distribution of the number of species of individual groups of plankton found in 12 shallow waters such as sewage lagoons, duck ponds, farm ponds, fish ponds and shallow parts of rivers containing excess nutrients. The physical, chemical and biological factors which may either enhance or inhibit the development of diatoms and algae and their destruction by antibiotics are determined. In cases where there is a mass development of Daphnia, phytoplankton are greatly suppressed so that excess nutrients (often more than 1 mg of phosphorus and 10 mg of nitrogen per litre) are not utilized. Once the Daphnia population decreases, as in the winter, phytoplankton development returns, provided light conditions are favourable. When assessing mass development of phytoplankton in shallow waters it must also be taken into account that the cycle of nutrients already present is more important than the high concentration of nutrients which enters the pond or river through tributaries.

$[0mReport of the EIFAC Workshop on fish-farm effluents, Silkeborg, Denmark, 26-28 May 1981 (edited by J. Alabaster), FAO, Rome, 1982, 29-55. (10B FOO).
Fish farm effluents; a United Kingdom survey.
J. F. de L. G. SOLBE (Water Research Centre, Stevenage) .
The results of a nationwide survey of U.K. fish farms, conducted by the Water Research Centre with the assistance of Water Authorities using postal questionnaires, are presented, and the level of pollution and quality of waters receiving discharges of fish farm effluent was assessed. In all data were obtained from 325 farms, or about 70 per cent of the total number in the U.K. The type of facilities employed, the species farmed, the production rate and the quality and fate of the effluents were surveyed, together with their usage of chemicals and the quality of waters into which the effluents are discharged. From the data, mass flows of specific pollutants were calculated and related to the size of the production unit , and possible relationships between the nature and scale of the operation and its environmental effects examined. In the majority of cases adverse effects were related to a high concentration of suspended solids in the discharge. The extent to which fisheries and raw water intakes for potable supplies may be at risk from fish farm effluents is discussed and various approaches to a more accurate assessment of the problem are considered. -U.K.-

Restoration of mineral extraction sites - landfill

$[0mU.S. envir. Protect. Ag., Solid Waste Mgmt Office, SW-88TS, U.S. Govt Printing Office, Washington, D.C., 1971. 14 pp.
Sanitary landfill design, construction, and evaluation.
M. J. WILCOMB and H. L. HICKMAN
The recommendations in this publication suggest the basic requirements involved in the design and construction of a sanitary landfill to minimize environmental pollution; and a method is presented for assessing whether the site is operating well.

$[0mEnvironmental Toxicology and Chemistry, 1982, 1, No.2, 121-134.
A screening procedure for assessing the transport and degradation of solid waste constituents in subsurface and surface waters.
J. W. FALCO , (U.S. EPA) , L. A. MULKEY , R. R. SWANK , R. E. LIPCSEI , and S. M. BROWN .
Details are given of a procedure for the rapid screening of chemicals for their potential for contaminating ground water and surface waters after disposal in landfills and lagoons ; the movement and degradation of the chemicals are estimated from a knowledge of their physical and chemical properties and a defined range of environmental conditions. The method has been applied to a large number of compounds known to be constituents of solid wastes from a variety of industries and the results are analysed and discussed. -U.S.A.-

$[0mArchives of Environmental Contamination and Toxicology, 1984, 13, No.2, 197-206.
Multiple bioassays to assess the toxicity of a sanitary landfill leachate.
S. PLOTKIN (University of Massachusetts, Amherst), and N.M. RAM.
Toxicity tests were carried out with fathead minnows (Pimephales promelas), zooplankton (Daphnia magna), green algae (Selenastrum capricornutum), and bacteria (Photobacterium phosphorium) to determine the potential adverse effects of sanitary landfill leachate from Fitchburg, Mass., on the environment. The leachate was very toxic to the test bacteria, moderately toxic to the daphnids, and slightly toxic to fathead minnows, demonstrating the importance of carrying out toxicity tests with organisms from several trophic levels, when assessing the potential impact of a pollutant on an aquatic ecosystem. -U.S.A.- ; -Journal Paper- ; -Experimental-

Cambridge University Press, Cambridge, England, 1983. 480 pp. (02LC COP).
The scientific management of hazardous wastes.
C. B. COPE, W. H. FULLER, and S. L. WILLETTS.
The legal and practical implications of hazardous waste disposal are examined, with particular emphasis on the practice of landfilling, the conditions under which leachate is formed and the geochemical factors governing the migration of pollutants from a landfill into the environment. The application of both legal and operational controls to waste management sites is reviewed from an objectively critical standpoint to identify both the existing loopholes in the law and gaps in our scientific knowledge. In addition, leachate characteristics, pollutant attenuation and toxicity measurements are reviewed. Other disposal options such as chemical treatment and incineration are compared, and the concepts of risk assessment, cost implications and public attitudes are discussed. -U.K.- ; -Book- ; -Review-

Industrial Water Engineering, 1983, 20, No.1, 8 and 11-17.
Runoff from utility waste landfill to be recycled from detention basin to scrubber make-up.
J. J. LENTZ (Johns Hopkins University, Laurel, Md.).
As part of an evaluation of the site impacts of a proposed 600 MW extension of a power station in Maryland, an analysis was carried out on a plan to use runoff from the working face of the landfill for blended fly ash and scrubber sludge as seven-to-10 per cent of the scrubber make-up needs. The run-off would be captured in a lined retention basin to prevent contamination of the area by heavy metals and high total dissolved solids. Following a preliminary environmental assessment, an estimation of the expected runoff quality and a study of basin operation, a satisfactory design was evolved which balanced the basin capacity and the scrubber pumping rates with the scrubber make-up needs and the rate at which runoff was generated by precipitation. -U.S.A.- ;
-Journal Paper- ; -Case Study-

IBM Journal of Research and Development, 1972, 16, No.2, 117-129.
Subsurface hydrology at waste disposal sites.
R. A. FREEZE (IBM Thomas J. Watson Research Center, Yorktown Heights, N.Y.).
Sanitary landfill was quite promising in its ability to handle large waste loads with a minimum of contamination but waste lagoons, and deep-well injection of liquid wastes into geologic formations, resulted in irreversible subsurface pollution. In all cases the mechanism of pollution was an interaction between the pollutant source and the existing soil moisture and groundwater flow system. A mathematical model of the subsurface flow was developed which could predict this interaction and assess the impact on the environment of a proposed disposal site. It predicted transient and steady state subsurface flow systems in two or three dimensions and considered of both the saturated and unsaturated zones. It could be applied at the reconnaissance stage on a regional basis to analyse many alternative sites and at the chosen site to test the efficiency of various design alternatives and to provide guidance in the design of a monitoring system. The model predicted only convective transport and did not consider dispersion or hydrochemical reactions. -U.S.A.- ; -Journal Paper- ; -Application-

Ingegneria Ambientale, 1985, 14, No.7/8, 428-441 (in Italian, English summary).
Landfill codisposal of domestic and hazardous industrial solid wastes.
R. CANZIANI (Politecnico di Milano), and R. COSSU.
Codisposal of industrial and domestic solid wastes in landfills, including toxic and hazardous materials, could be environmentally advantageous, provided that correct proportions were established by preliminary tests. Biodegradation and biogas production would not be adversely affected. Examples of such codisposal systems are described, involving metallic residues, cyanides, phenols, halogenated organic compounds, hydrocarbons and asbestos. The preliminary tests required for assessing codisposal options are discussed. There are 31 references. (Full translation 330 pounds sterling).
-Italy- ; -Journal Paper- ; -Application-

Vodni Hospodarstvi, 1985, 35, No.10, 257-261 (in Czech, English summary).
Landfill leachates.
M. JANOVSKY (Ceskoslovenske stredisko pre zivotne prostredie, Bratislava), and E. PARRAKOVA.
Storage of wastes in controlled landfills in Czechoslovakia was considered (in terms of environmental protection) still a very acceptable and economic method

of waste disposal. The storage emission and problems resulting from such landfills are considered. The quality of the leachate depended on the quality of the landfill components. To study the effect of these components in a controlled manner, an artificial landfill was constructed to assess its impact on groundwater quality. Physical, chemical and biological characteristics of the artificial landfill are tabulated. (Full translation 108 pounds sterling).
-Czechoslovakia- ; -Journal Paper- ; -Experimental-

Proceedings 38th Industrial Waste Conference, Purdue University, 1983, 261-271.
A comparative assessment of incinerators versus landfills for hazardous waste management.
T. G. SHEA (Engineering-Science, Fairfax, Va.), and J. J. MAYHEW.
A comparison of incineration and landfilling for the disposal of organic, potentially hazardous chemical wastes, suitable for disposal by either method, is discussed. A typical synthetic waste mix was selected, with appreciable quantities of chlorinated aliphatic and aromatic hydrocarbons, plastics monomers and toluene polymers. The design of facilities for the two alternative methods is described, followed by a technical, economic and environmental evaluation of the two methods. No single best solution was obtained for all situations, the final choice being governed by local circumstances. Several areas of study requiring further research are listed.
-U.S.A.- ; -Conference Paper- ; -Case Study- ; chlorinated hydrocarbons

Hazardous Waste and Hazardous Materials, 1986, 3, No.3, 309-320.
A comparison of three risk assessment techniques for evaluating a hazardous waste landfill.
W. B. BUDD (Washington State University, Pullman).
Three risk assessment procedures were applied to an inactive waste disposal facility in eastern Washington: benchmark comparison, formal subjective analysis and the hazard ranking system. The site had previously been used for disposal of hazardous wastes from Washington State University from 1970 to 1980 and detailed records of all wastes materials disposed had been maintained. The site posed only limited hazard to humans and the environment under the benchmark comparison and formal subjective analysis. The hazard ranking system produced a wide range of values but in 90 per cent of the cases, these were not high enough to place the site on the National Priorities List. It was concluded that the multiple assessments might be required when using the hazard ranking system. The formal subjective approach was considered potentially useful in view of projected demands for future waste sight evaluations.
-U.S.A.- ; -Journal Paper- ; -Case Study-

Water Science and Technology, 1987, 19, No.5/6, 1029-1036.
Evaluation of heavy metal leachability from solid wastes.
T. R. BRIDLE (Environment Canada, Burlington, Ont.), P. L. COTE, T. W. CONSTABLE, and J. L. FRASER.
Experiments have been carried out to develop methods for assessing the leachability of heavy metals from solid wastes, based on intrinsic properties of the waste, such as metal solubility and speciation. Data obtained for different types of waste, including sewage sludge (before and after incineration), ashes from incineration of municipal solid wastes and hazardous wastes, power plant ash, and a solidified synthetic waste. The results showed that incineration of sewage sludge significantly reduced the environmental availability of most of the heavy metals in the ash; such ash would therefore be acceptable for landfill disposal. In contrast, metals were readily leached

from ashes from incineration of municipal solid wastes and hazardous wastes; over 80 per cent of cadmium and 40 per cent of zinc in these ashes was water-soluble. Such ashes would, therefore, need to be solidified prior to land disposal. Power-plant ashes exhibited moderate metal leachability, but had a significantly lower metal content.
-Canada- ; -Journal Paper- ; -Experimental-

Environmental Science & Technology, 1987, 21, No.5, 421-426.
Looking back at Love Canal.
J. DEEGAN (Northern Iowa University, Cedar Falls).
The results and conclusions of the Love Canal study are summarized. The monitoring of water from 68 shallow wells for 134 compounds is summarized and confirmed predictions of the hydrogeological study. Contamination of shallow groundwater was confined to areas adjacent to landfill sites. Soil monitoring confirmed that contamination was directly attributable to migration of contaminants from Love Canal. Air monitoring of volatile compounds confirmed the results of other monitoring. Lessons learnt in environmental monitoring and site assessment are highlighted and included the need for assessment based on integrated and sequential studies and the need to adopt deterministic rather than statistically inferential identification of migrating contaminants. The importance of the protection of public health and the environment is discussed.
-U.S.A.- ; -Journal Paper- ; -Case Study-

Water, Air, and Soil Pollution, 1988, 37, No.1/2, 203-215.
Pretreating landfill leachate with peat to remove metals.
J. K. McLELLAN (Civil Engineering Services, Brewer, Me.), and C. A. ROCK.
The effectiveness of peat in removing metals from two different landfill leachates at low hydraulic loadings was assessed. The leachates were from a municipal refuse fill containing aluminium, calcium, cadmium, iron, magnesium, sodium and lead, and from a fill receiving mainly oil and flyash, containing aluminium, calcium, chromium, iron, magnesium, manganese, sodium, lead and vanadium. Although the peat could not remove metals to levels suitable for direct discharge, it could act as a pretreatment process at low hydraulic loadings. Ultimate disposal of the peat would require a dry environment, as deionized water caused desorption of up to 50 per cent from spent peat columns.
-U.S.A.- ; -Journal Paper- ; -Experimental- ; Pb

Soil and Groundwater Protection, Schriftenreihe des Vereins fur Wasser-, Boden- und Lufthygiene, Report Nr.64, 1986, 31-43 (in German).
Hydrogeochemical studies in the region of landfills with a view to assessing their environmental compatibility.
H. KERNDORFF, and V. BRILL.
The use of hydrogeochemical studies as a means of quantifying the nature and magnitude of contaminant transport in groundwater systems affected by the presence of waste deposits is discussed, with reference to some investigations of groundwater chemistry at a typical abandoned landfill site. The interactions between soil and groundwater systems and the irrigation of specific contamination through the soil strata are considered in the light of chemical analysis, the groundwater flow pattern and sampling of the groundwater from observation boreholes drilled on the upstream and downstream margins of the landfill. -West Germany- ; -Chapter- ; -Review-

Archives of Environmental Health, 1987, 42, No.2, 83-86.
Household hazardous waste in Massachusetts.
E. J. STANEK (University of Massachusetts, Amherst), R. W. TUTHILL, C. WILLIS, and G. S. MOORE.
Household disposal of household-generated hazardous waste (HHW) might contaminate ground and surface water supplies, and might adversely affect public health. To assess the magnitude of HHW disposal, a telephone survey of households in Massachusetts was conducted in 1984. Complete interviews were conducted for 504 of 933 residential numbers dialled. A table is given showing the substances disposed, (oil, paint, pesticides, radiator fluid, antifreeze, batteries, asphalt, petrol, paraffin, radiator flush, herbicides and chemicals) and for each of these substances, the percentage of households disposing, average quantity disposed per household, annual amount disposed in Massachusetts, and the percentage disposed in ground, sewer and landfill. Thirty-three per cent of households disposed of automotive oil, and of this, 57 per cent was deposited in ground, sewer or landfill. Ten per cent of households disposed of paint and pesticides, usually by dumping in the ground, sewer or landfills. Four per cent of hazardous waste generated in Massachusetts was from households, and improper disposal made it a major environmental contaminant. -U.S.A.- ; -Journal Paper- ; -Review- ; groundwater

Technology Transfer in Water and Environmental Management, IWEM 89 Conference, Birmingham, 1989, Paper No.14. 10pp.
Above-ground $[1mlandfill$[0m: the engineered approach.
A. STREET (MRM Partnership), and J. P. DUMBLE.
The factors involved in the successful design and operation of above-ground $[1mlandfills$[0m are discussed in the light of recent experience with this system in the U.K., notably at Packington, near Birmingham on a site adjacent to the National Exhibition Centre. Stages involving site identification and $[1massessment$[0m from a geotechnical and hydrogeological aspect, formation of peripheral bund walls, filling and compaction are discussed, together with drainage facilities, water management and $[1mlandfill$[0m gas collection arrangements and $[1menvironmental$[0m monitoring requirements. The practice of above-ground landfilling was gaining in importance, based on sound engineering design principles. -U.K.- ; -Conference Paper- ; -Review-

Abwassertechnik, 1990, 41, No.3, 24-27 (in German).
Sample preparation for $[1massessment$[0m of the leaching of $environmentally$ relevant trace substances from cement-based solidification products.
W. RECHENBERG (Forschungsinstitut der Zementindustrie, Dusseldorf).
Since a realistic $[1massessment$[0m of the leachability of trace substances (eg heavy metals) from cement-consolidated waste products required that the structure of the ultimate material was correctly simulated, test methods in which the sample was comminuted prior to testing or was subjected to acidic decomposition would not give reliable predictions of the long-term stability of the product in a $[1mlandfill$[0m. An alternative method is therefore proposed, in which the test was carried out on an intact cylindrical specimen using the procedure employed for determination of permeability to moisture in compacted soils. The small quantities of liquid which penetrated the specimen during a test were collected and analysed to determine the extent of heavy metal liberation. A description of the test equipment and a discussion of the chemical bonding reactions leading to the stabilization of heavy metals in a cement matrix are included. (English translation 170 pounds sterling, valid for 1991). -West Germany- ; -Journal Paper- ; -Experimental-

Pulp & Paper, 1990, 64, No.4, 59-66.
Tighter environmental regulations will alter mill processes' permits.
K. H. FERGUSON.
Possible impacts of U.S. Federal and State legislative requirements for preservation of environmental quality by the pulp and paper industry are reviewed, with special reference to the water quality $[1menvironment$[0m. Existing U.S. EPA guidelines for permissible effluent discharges from mills of various types, based on the dilution and purification capacity available in receiving waters, were already liable to constriction as state inventories of water quality had become more detailed. Some states had also imposed standards for parameters, such as colour, not listed in the guidelines. Such standards had not always worked against mill owners, as the evolution of the technology required to satisfy them had resulted in the recovery of otherwise wasted valuable products. The industry also feared that toxicity testing, at present mandatory in only a few States, would become a federal requirement. But the industry's principal concern was that its effluents might be classed as hazardous wastes, and defined by the Resource Conservation and Recovery Act, largely as a result of their level of chloroform, derived from the chlorine bleaching process. It was also concerned that states might limit further the volume of water that mills might withdraw from rivers, reflecting public anxiety over low flows following recent extended drought conditions, and in view of such flows might also reduce the volume of effluent permitted by the present permit when it fell due for revision. Probable effects of the Clean Air Act being debated in congress on the air pollution-related problems of the industry, and of federal guidelines regarding the disposal of solid wastes in $[1mlandfills$[0m, are also extensively $[1massessed$[0m. -U.S.A.- ; -Journal Paper- ; -Review-

Public Works, 1991, 122, No.2, 50-51.
Coastal community integrates GIS for resource management.
V. SPEED.
The selection, construction and integration of a Geographical Information System (GIS) in the development and improvement of wastewater facilities for Barnstaple, Mass, is described. Services required included planning, needs $[1massessment$[0m, sewer data, database design and a pilot study, with CAD hardware and software and the ability to link up with outside bodies. Projects proposed as GIS ventures are discussed including analysis of $[1menvironmental$[0m degradation in local estuaries, automated mapping for tax $[1massessment$[0m, $[1mlandfill$[0m monitoring, endangered wildlife studies and population growth management. -U.S.A.- ; -Journal Paper- ; -General-

Pollution Engineering, 1984, 16, No.3, 22-32.
Use of liners for containment at hazardous waste $[1mlandfills$[0m.
F. COPE (EMCON Associates), G. KARPINSKI, J. PACEY, and L. STEINER.
Before discussing the design criteria for a liner system at a hazardous $[1mlandfill$[0m which meets the requirements of the U.S. Resource Conservation and Recovery Act 1976, the relevant regulations are summarized. Linear types are listed and major selection criteria given are performance, waste compatibility, site conditions and $[1menvironmental$[0m factors. Both soil liners and synthetic liners are considered. The importance of $[1massessing$[0m the effects of waste composition and site conditions on liners is underlined. Quality control procedures and liner system cost elements are included. -U.S.A.- ; -Journal Paper- ; -Review-

Journal of Environmental Engineering, 1991, 117, No.5, 559-572.
Permeable treatment beds for plating sludge disposal.
R. W. REGAN (Pennsylvania State University, University Park), C. E. DRAPER, and R. J. LEU.
Aspects of a proposed landfill concept for controlling the leachability of selected heavy metals in metal-finishing sludge, the permeable treatment bed concept, are reviewed. The potential of the concept was evaluated in the laboratory under controlled conditions. The effects of simulated natural and acid rain on the leachability of metals were assessed. The laboratory experiments used model reactors to test the suitability of permeable beds to control the leachability of metal hydroxide sludges placed in a humid landfill environment. The results confirmed the effectiveness of the concept in preventing the release of heavy metals into groundwater.
-U.S.A.- ; -Journal Paper- ; -Experimental-

Journal of Urban Planning and Development, 1991, 117, No.2, 59-76.
Environmental impact assessments for hazardous-waste landfills.
L. W. CANTER (Oklahoma University, Norman).
A methodological framework for an environmental impact study for new hazardous waste landfills is described. Ten study activities are suggested: assembling information; determining institutional requirements; identifying potential environmental impacts, describing the affected physical/chemical, biological, cultural and socio-economic environments; quantitatively predicting the impacts; interpreting predictions; identifying and evaluating mitigation measures; carrying out trade-off analysis to enable selection of a proposed site, landfill design and operating strategy; preparing environmental assessment report; and environmental monitoring.
-U.S.A.- ; -Journal Paper- ; -Review-

Journal of Institution of Water and Environmental Management, 1992, 6, 229-236.
Groundwater protection in the UK: assessment of the landfill leachate source-term.
H. ROBINSON (Aspinwall and Company, Shrewsbury), and J. GRONOW.
The development of U.K. waste disposal policy and the impact of the EC directive on the protection of groundwater against pollution caused by certain dangerous substances are reviewed. The Department of the Environment was to compile a database concerning landfill leachate quality in various conditions and to study the occurrence of substances of environmental importance within leachates. Various related studies being undertaken on behalf of the department are reviewed. These include a study of the attenuation of components of landfill leachate in natural strata and a national survey of the impact of landfills on groundwater quality. -U.K.- ; -Journal Paper- ; -Case Study-

Industrial Waste Management, 1992, 3, No.2, 15 and 17.
Waste management expertise - a highlight of Aspinwall's portfolio.
H. PEARCE.
Aspinwall had over 20 years experience of applying environmental science and technology in the technical waste management sector, including Waste Facility Assessments as an independent and professional third party appraisal against guidelines. Self-assessment questionnaires were available for management to audit their own waste management practices and check their compliances. A major project had been completed for the Hong Kong government on the development of 3 large landfill facilities proposed to accommodate the entire territory's waste over the next 15 years. -U.K.- ; -Journal Paper- ; -General-

Waste Management & Research, 1992, 10, No.3, 235-255.
Distribution and attenuation of hazardous substances in uncontrolled solid waste landfills.
T. ASSMUTH (Water and Environment Research Institute, Helsinki).
A 5 year (1986-1990) field study had been carried out on 43 mixed waste landfill sites to assess the toxicological and environmental impacts and risks associated with these sites. Samples were taken from the soil and waste, as well as liquid interstitial and ground water, and gas samples. The toxicological and environmental risks and impacts were small when compared with other toxicants. However, it was possible that this situation might change due to several factors, including migration and exposure. There are 44 references.
-Finland- ; -Journal Paper- ; -Review-

Sciences et Techniques de l'Eau, 1992, 25, No.4, 469-474 (in French, English summary).
Characterization and treatment of leachates from a sanitary landfill.
J. C. FRIGON (Universite du Quebec, Laval), J. G. BISAILLON, G. PAQUETTE, and R. BEAUDET.
Studies of the composition and treatability of the leachate derived from a sanitary landfill in the province of Quebec are reported. Samples were obtained at monthly intervals at the point where the leachate emerged from the landfill and also at the outlet from 2 non-aerated stabilization ponds connected in series, which were the sole treatment provided on site. In addition the effects of aerobic and anaerobic digestion on the composition of the leachate were assessed in the laboratory. Studies of leachate toxicity towards aquatic organisms were also performed using the Microtox photoluminescent bacterial assay. The existing lagoon treatment was inadequate in reducing the BOD, COD, phenolic compounds, oil and grease to concentrations below the limits prescribed by the Quebec Ministry of the Environment for discharge to stream, although the dissolved iron concentrations was within the prescribed limits, and the toxicity was reduced to an acceptable level. The laboratory tests showed that the leachate was biodegradable to an appreciable extent, with a substantial potential for methanogenesis under anaerobic conditions which was not inhibited by the residual toxicity.
-Canada- ; -Journal Paper- ; -Experimental-

Abwassertechnik, 1990, 41, No.4, 33-35 (in German).
Sample preparation for $[1massessing$[0m the degree of leaching of $[1menvironmentally$[0m relevant trace elements from element-solidified materials, part 2.
W. RECHENSBERG (Forschungsinstitut der Zementindustrie, Dusseldorf).
The possibility of immobilizing harmful trace elements present in materials such as fly ash and furnace ash by mixing with about 9 per cent cement by weight to form a cylindrical block of very low permeability to moisture was investigated. The results of permeability measurements are reported, and were found to linearly related to the extent of heavy metal release when plotted using logarithmic coordinates. The influence of various proportions of cement and different ratios of fly ash to furnace ash is discussed, together with the effects of ageing and resistance to repeated freezing and thawing cycles. Some breakdown of the peripheral layers due to freezing and thawing was apparent with proportions of Portland cement ranging from 8 to 16 per cent by weight, and the influence of the number of freeze-thaw cycles on the suitability of the cement-stabilized material for preparation of the sub-base for highway

$[1mconstruction$[0m is also considered. The use of the Proctor test cylinders for measurements of permeability and freeze-thaw stability was considered to provide a reliable indication of long-term behaviour either in a landfill or for roadmaking purposes. -Germany- ; -Journal Paper- ; -Review-

- recreation

Quarry Management, 1984, 11, No.3, 152-157.
Quarries and waste disposal: case study of practice.
P. A. TOMES (ARC Western Region).
Studies on the Judkins landfill site in Warwickshire, operated by Amey Roadstone Corporation, showed that site preparation works were important to protect the environment, particularly surface water and groundwater quality. A sealed landfill site was created including a leachate drainage system and methane gas control. An extensive monitoring programme to assess groundwater levels and quality and gas production was implemented. Site operation is described. The quarry restoration would include development as a recreational facility, landscaping and industrial development. -U.K.-Journal; -Case Study-

Large residential devts

Archives of Environmental Health, 1987, 42, No.2, 83-86.
Household hazardous waste in Massachusetts.
E. J. STANEK (University of Massachusetts, Amherst), R. W. TUTHILL, C. WILLIS, and G. S. MOORE.
Household disposal of household-generated hazardous waste (HHW) might contaminate ground and surface water supplies, and might adversely affect public health. To assess the magnitude of HHW disposal, a telephone survey of households in Massachusetts was conducted in 1984. Complete interviews were conducted for 504 of 933 residential numbers dialled. A table is given showing the substances disposed, (oil, paint, pesticides, radiator fluid, antifreeze, batteries, asphalt, petrol, paraffin, radiator flush, herbicides and chemicals) and for each of these substances, the percentage of households disposing, average quantity disposed per household, annual amount disposed in Massachusetts, and the percentage disposed in ground, sewer and landfill. Thirty-three per cent of households disposed of automotive oil, and of this, 57 per cent was deposited in ground, sewer or landfill. Ten per cent of households disposed of paint and pesticides, usually by dumping in the ground, sewer or landfills. Four per cent of hazardous waste generated in Massachusetts was from households, and improper disposal made it a major environmental contaminant.
-U.S.A.- ; -Journal Paper- ; -Review- ; groundwater

Water Science & Technology, 1994, 29, No.1/2, 293-302.
Pollution from urban stormwater infiltration.
P. S. MIKKELSEN (Denmark Technical University, Lyngby), G. WEYER, C. BERRY, Y. WALDEN, V. COLANDINI, S. POULSEN, D. GROTEHUSMANN, and R. ROHLFING.
The risk of soil and groundwater pollution from urban stormwater infiltration is discussed. Runoff from highways, roofs, residential land and industrial sites usually contained BOD, nutrients, heavy metals and organic micropollutants. Likely quantities could only be estimated. Ideally, pollution should be reduced at source but in the short term an assessment of environmental impact was desirable. A list of priority pollutants and sources was required but not available. Expert systems or mathematical models helped predict the impact of pollutants on soil and groundwater. Generally, heavy metals and organic micropollutants were removed in soil. The best approach was to treat the urban environment as a total system with infiltration as only 1 solution to the disposal of pollutants in stormwater runoff. There remained considerable ignorance on the water quality aspects of stormwater disposal.
-Europe- ; -Journal-Paper- ; -Review-

Technische Universitat of Berlin, Berlin, IWAWI Report No.114, 1989. (400)pp.
Decision criteria for choice of drainage systems in built-up areas with special reference to the protection of quality of natural waters and the use of alternative methods. C. RACK.
A comprehensive and detailed $[1massessment$[0m of all aspects of urban drainage systems is presented under current pressures for the protection of water quality in the receiving streams, minimization of capital and maintenance costs and the availability of reliable data on which to base a comparative evaluation of alternative systems. The concentrations of pollutants ordinarily encountered in stormwater runoff from paved surfaces are considered, the relative merits of separated and combined sewer systems discussed with respect to pollutant loadings and $[1menvironmental$[0m effects and alternative systems involving storage ponds and infiltration basins for disposal of stormwater

considered. Water quality and §[1mdischarge§[0m models designed to examine the effects of discharges from stormwater overflows are outlined, and the criteria governing the choice of the most appropriate model for a given situation are reviewed. A suggested decision process is illustrated with reference to a typical case study involving a systematic comparison between various possible designs and the choice of the optimal solution. -West Germany- ; -Report- ; -Review-

ß[0mAssociate Committee on Scientific Criteria for Environmental Quality, Ottawa, Report NRCC 18979, 1982. 253 pp. (15 B CAN).
Aminocarb: the effects of its use on the forest and the human environment.
NATIONAL RESEARCH COUNCIL OF CANADA .
The chemical properties, physiological and toxicological effects of aminocarb and its degradation and migration in the environment were assessed on the basis of published data and its use as a means of controlling specific forest pests. The principal degradation reactions are hydrolysis and oxidation, although hydrolysis proceeds more slowly under the mildly acidic conditions encountered in many forest soils. While the compound itself is mildly toxic to fish, the available data suggest that much of the toxicity of product formulations can be attributed to components other than aminocarb itself. Symptoms of cholinesterase inhibition which are typical of carbamate insecticides are manifested and appear to be largely reversible under field conditions. Further, more detailed studies of the effects of metabolites and of the consequences of repeated applications for budworm control are considered desirable. pesticides ; -Canada-

University of Washington Press, Seattle, 1986. 582 pp. (39922).
The forest alternative for treatment and utilization of municipal and industrial wastes: proceedings of the Forest Land Applications Symposium, University of Washington, 1985.
D. W. COLE, C. L. HENRY, and W. L. NUTTER, (editors).
The technical, environmental and political aspects of land treatment of sewage, sewage sludge and certain types of industrial effluent by application to forested areas is reviewed. The information included reports of numerous projects designed to assess the response of tree species to the application of municipal and industrial effluents. Other aspects discussed included microbiological effects, nitrate elimination, effects on wild life and heavy metal accumulation, and short and long-term growth responses to sludge application. Of the 51 papers reproduced here, fifteen were concerned with case studies of the application of either municipal wastewater, municipal sewage sludge, or effluent from the pulp mill and chemical industries.
-U.S.A.- ; -Conference Proceedings- ; -General-

Environmental Toxicology and Chemistry, 1986, 5, 1047-1054.
DOWANOL, an environmentally safe adjuvant.
P. Y. CAUX (Ottawa University, Ont.), P. WEINBERGER, and D. B. CARLISLE.
The environmental safety of DOWANOL TPM (tripropylene glycol methyl ether), an adjuvant used in spray formulations of fenitrothion, was assessed using duckweed Lemna minor. Parameters monitored were growth rate, biomass, photosynthetic function, changes in media electrical potential, total plant ATP, and DOWANOL accumulation and depuration. Adverse effects were observed at the highest test concentration (965 ug per ml), but not at lower concentrations (96.5, 482.5 ug per ml). Recovery was evident within 2 days of plants being transferred to clean water. Plants exposed to 965 ug per ml for 24-48 h accumulated 22 ug DOWANOL per 10 fronds. Concentrations of DOWANOL in forest ponds after aerial spraying were around 1 ug per ml; DOWANOL, used under registration guidelines, was one of the few environmentally safe adjuvants.
-Canada- ; -Journal Paper- ; -Experimental-

Journal of Air & Waste Management Association, 1990, 40, No.7, 976-978.
Identifying ecological indicators: an $[1menvironmental$[0m monitoring and $[1massessment$[0m programme.
S. M. BROMBERG (U.S. EPA, Research Triangle Park, N.C.).
The U.S. EPA initiated the $[1mEnvironmental$[0m Monitoring and $[1mAssessment$[0m Programme (EMAP) in 1990 to $[1massess$[0m the status and trends of U.S. near-coastal waters, $[1mforests$[0m, freshwater wetlands, surface waters, agro-ecosystems and arid lands. The 6 research areas were supported by sampling design, land characterization, atmospheric monitoring, and quality assurance. Periodic $[1massessments$[0m would be performed to address regional problems rather than site specific problems. -U.S.A.- ; -Journal Paper- ; -Review-

Environmental Management, 1990, 14, No.5, 571-587.
Overview of case studies on recovery of aquatic systems from disturbances.
G. J. NIEMI (Minnesota University, Duluth), P. DeVORE, N. DETENBECK, D. TAYLOR, A. LIMA, J. PASTOR, J. D. YOUNT, and R. J. NAIMAN.
A review of published environmental assessment studies identified 164 field investigations of predominantly (79 per cent) lotic aquatic systems with at least 1 end point measured with respect to complete recovery from a recorded disturbance. Examination of approximately 1300 end points showed that most data were available for macroinvertebrates (32 and 19 per cent) and fish (22 and 13 per cent) in lotic systems of 1-3 and 4-6 orders respectively. Data were very limited for large lakes and large lotic systems and for phytoplankton, periphyton, amphibians, micro-organisms and aquatic macrophytes. Most stressor types were chemical and longest recovery times after abatement were required for river channelization, DDT forest spraying and mining and timber harvesting in lotic systems. The recovery rate of specific organisms was influenced by generation time, fecundity, aestivation and resting states, dispersal mechanisms and predator-competition interactions, while factors independent of organisms included changes in habitat and system productivity, time of impact and availability of refugia. Criteria used to determine recovery at different sites varied, with widest use of first appearance of a species and recovery of predisturbance density or size, but most recovery times were less than 3 years. There are 39 references.
-U.S.A.- ; -Journal Paper- ; -Review-

Water Resources Bulletin, 1993, 29, No.4, 575-615.
Red river of the North Basin, Minnesota, North Dakota, and South Dakota.
J. D. STONER (U.S. Geological Survey, Mounds View, Minn.), D. L. LORENZ, G. J. WICHE, and R. M. GOLDSTEIN.
The Red river of the North Basin study unit, part of U.S. Geological Survey's National Water Quality Assessment Programme, is described. The area is largely agricultural. The report provides baseline and historical information relating to water quality. Environmental factors discussed are physical and cultural features, geology, physiography, soils, population and land use, climate, stream flow, floods, droughts, lakes, prairie potholes, wetlands, habitats, groundwater, water use, stream-aquifer interactions and aquatic biology. Special attention is given to the Northern Glaciated Plains, Red River Valley, North-Central Hardwood Forest, Northern Lakes and Forests, and the Northern Minnesota Wetlands. Among challenges to water quality are agricultural runoff, urban runoff, municipal effluents and effluents from food processing. There are 114 references. -U.S.A.- ; -Journal Paper- ; -Case Study-

New Zealand Journal of Marine and Freshwater Research, 1989, 23, 479-490.
$[1mImpacts$[0m of wetland afforestation on the distribution of benthic invertebrates in acid streams of Westland, New Zealand.
K. J. COLLIER (Canterbury University, Christchurch), M. J. WINTERBOURN, and R. J. JACKSON.
Stream water chemistry, physical characteristics and benthic invertebrates were determined at 29 pakihi (wetland) sites in winter and summer to $[1massess$[0m the effects of recent catchment $[1mdevelopment$[0m for exotic tree forestry. In summer stream water temperatures ranged from 11-13C; and were generally higher in streams draining developed catchments than those draining undeveloped deforested catchments or native-forested catchments. The rank order of catchment $[1mdevelopment$[0m was correlated significantly with stream water pH (minimum 4.1), alkalinity and total reactive aluminium (maximum 911 mg per litre), and the apparent acidification of afforested catchment drainage was attributed to leaching of organic acids at the headwaters. Analysis of benthic invertebrate distribution data by TWINSPAN and DECORANA suggested that the major $[1menvironmental$[0m factors were stream water pH and temperature. Very acidic streams (pH often less than 4.5) draining wetland catchments supported 1.3-3.3 times fewer invertebrate taxa than streams (pH consistently more than 4.5) draining native-forested catchments. There are 36 references. -New Zealand- ; -Journal Paper- ; -Case Study-

- Acidification

Graham & Trotman Ltd, London, for the Commission of the European Communities, 1983. 159pp. (15Aa ENV). (36529).
Acid rain: a review of the phenomenon in the EEC and Europe.
ENVIRONMENTAL RSOURCES LTD.
The extent of environmental damage in the Community and in certain other European countries which might be caused by the emission of acid atmospheric pollutants within the member States is examined. The study assessed the available evidence for cause-effect relationships and discusses the physical, chemical and biological processes which were suggested as damage mechanisms. The extent of damage to forests in central and southern Germany is considered as well as the decline and disappearance of fish populations in the lakes of southern Norway and Sweden, and more recently of Scotland, northern England and Wales. The problems associated with the interpretation of the data are discussed and also the feasibility of reversing the present trends, including the probable costs of more stringent emission controls. -Europe-Book-Review-

Commission of the European Communities, Lux, Rep. No. EUR 10563EN, 1986. 51 pp.
Environment and quality of life: facts and uncertainties about acid rain: a challenge for Europe.
M. BENARIE.
The present level of knowledge regarding the effects of acidic deposition is reviewed with respect to its effects on fish stocks, forests and crops, human health, and historic buildings. The evidence for increasing acidity of rainfall in U.S.A. and Western Europe is reviewed, and the evidence for damage to aquatic and terrestrial ecosystems is critically assessed. Positive evidence for decline in fish stocks and damage to buildings due to acid rain is available, but neither crop losses nor any adverse effects on human health could be ascribed to acid rain. Forest damage in Central Europe might be in part attributable to the acidity of rainfall. Existing countermeasures and their economic implications are also reviewed with the conclusion that

elimination of acidic emission from power stations would increase charges for electricity by 10 per cent. Other possible consequences of acid rainfall such as soil acidification and deterioration in surface and groundwater quality are also briefly considered. -International- ; -Report- ; -Review-

Environment, 1986, 28, No.4, 6-11 and 34-39.
The National Academy of Sciences report: acid deposition: trends, relationship, and effects.
A. H. JOHNSON (Pennsylvania University).
The effects of acid deposition have been debated since the mid-1960's, and as a step towards consensus on a sufficient number of issues to formulate policy, the Committee on Monitoring and Assessment of Trends in Acid Deposition was formed under the auspices of the Environmental Studies Board of the U.S. National Research Council. The committee both reviewed the literature and examined data sets covering 8 topics: emissions of acid precursors (particularly sulphur dioxide), atmospheric sulphates and visibility, precipitation chemistry, acid status of surface waters, fish populations, the biological and chemical record contained in lake sediments, patterns in tree rings, and the role of climatic fluctuations. Each of these are discussed with reference to the committee's findings. Acid deposition has an adverse affect on visibility, surface water quality and fish populations but probably does not affect forests. -U.S.A.- ; -Journal Paper- ; -Review-

Windfarms

No suitable references were forthcoming for windfarms.

Mineral extraction - mining and quarrying

$[0mGround Water, 1981, 19, No.6, 626-234.
The use of geologic, hydrologic, and geochemical mapping techniques in environmental assessment.
C. J. COE , (Consulting Geologist) .
The author suggests several interpretative methods of data analysis (i.e. data from the U.S. Geological Survey and from individual State Geological Surveys) for comprehensive environmental assessment of specific mining operations to aid in the management decisions of mine operations. The mapping techniques presented relate to the Appalachian coal field and consist of a standard topographic base map, structure contour maps, static water level maps, plus several iso-concentration maps for pH, iron, manganese, sulphate, and specific conductance. Two mine site studies are demonstrated and discussed in terms of dewatering problems, mining recharge areas, mining coal overlain by an acid overburden, and the impact of prior surface mining. -U.S.A.-

$[0mAWRC Conference on Groundwater in Fractured Rock, Canberra, 1982, 35-46.
A review of fractured rock environments in South Australia.
M.COBB, D.ARMSTRONG, S.BARNETT, R.READ, X.SIBENALER, P.SMITH, and M.STADTER.
Details of the water-bearing rock formations and groundwater provinces of South Australia are presented with an account of the present usage of ground water for domestic consumption , irrigation and stock watering. The dewatering of the Burra Burra copper mine, commenced in 1975, to allow the mine to be worked in the dry by lowering water levels by 70 m is also described. Quality of the ground water varies widely, with salinities ranging from 300 to 30,000 mg per litre and excessive amounts of nitrate, fluoride and heavy metals in some areas. All resource development to date has been project-oriented, with the need for detailed resource assessment becoming rapidly more apparent. Down-hole hammer drilling techniques have greatly increased the potential for future development. -Australia-

$[0mEnvironmental Toxicology and Chemistry, 1984, 3, No.1, 113-124.
An environmental hazard evaluation of uranium in a Rocky Mountain stream.
B. PARKHURST, R. ELDER, J. MEYER, D. SANCHEZ, R. PENNAK, and W. WALLER.
The possible harmful effects of periodic discharges of runoff from a uranium mine into Indian Creek, Colo. , which also receives uranium from natural springs was assessed. The stream water contained up to 4 mg uranium per litre. Both static and flow-through toxicity tests were carried out on brook trout (Salvelinus-fontinalis) using water of similar quality to that in the stream. The high hardness and alkalinity of the stream water considerably reduced the toxicity of uranium to fish, and bioconcentration factors were found to be low. Field studies on benthic invertebrates and fish in the stream confirmed that the concentrations of uranium present in the water were not significantly toxic. -U.S.A.- ; -Journal Paper- ; -Case Study-

Water, Air, and Soil Pollution, 1985, 24, No.2, 153-164.
Effects of nickel addition on nitrogen mineralization nitrification, and nitrogen leaching in some boreal forest soils.
J. B. deCATANZARO (Toronto University, Ont.), and T. C. HUTCHINSON.
In the Northern Hemisphere, the large number of mining and smelting operations resulted in extensive contamination of forested areas by mine wastes and airborne smelter emissions. To assess the effect of this on the forest environment, field and laboratory studies were carried out of the effect of

nickel, as an example of a toxic, smelter-emitted heavy metal, on the nitrogen cycle in the soil from forested areas. Under certain conditions, nickel at a concentration of 100 ug per g of soil stimulated nitrification, and at a concentration of 500 ug per g could stimulate mineralization of nitrogen. In general, rates of nitrification were low, but were higher in soils from the vicinity of a smelter than in uncontaminated soil. The numbers of nitrifying bacteria in uncontaminated soil were very low, but increased when nickel was added. Leaching of nitrate from soil columns was increased by addition of nickel. -Canada- ; -Journal Paper- ; -Experimental-

Graham & Trotman, London, 1983. 158pp. (37572).
Environmental impact of coal production and use in the EEC.
ENVIRONMENTAL RESOURCES LIMITED.
This report aims to assess the projected increase in coal production and combustion in the EEC during the final 20 years of this century and to determine the levels of polluting emissions which would result from indigenous coal production at the expected levels. It also considers the relative merits, from the environmental standpoint, of alternative outlets and conversion technologies for coal. The severe impacts of both open-cast and deep-level mining methods on the geographical environment are discussed and problems associated with the discharge of atmospheric pollutants (acid rain) and the disposal of mine drainage water are also reviewed. Recommendations designed to minimize these impacts in the event of significant increases in future coal production are presented. -Europe- ; -Report- ; -Case Study-

Environmental Technology Letters, 1988, 9, No.9, 931-940.
Copper in the Fly river system (Papua New Guinea) as influenced by discharge of mine residue: overview of the study, and preliminary findings.
W. SALOMONS, M. EAGLE, E. SCHWEDHELM, E. ALLERSMA, J. BRIL, and W. MOOK.
Factors governing potential copper pollution of the Fly river, of the off-river lakes produced when it flooded, and of the Gulf of Papua into which it discharged were evaluated, as part of an investigation into the probable environmental effects of gold and copper ore extraction near the headwaters of one of its tributaries. The levels of copper found at various locations along the river during each of these phases were related to diluting inflows from the tributaries, to the nature and volume of sediment load, to the sorption of copper on sediments, to the copper grain size fraction, and to the use of cyanide, primarily as part of the gold extraction process. The data were used to predict future copper levels once gold extraction ceased, and to assess their probable effect on fisheries in the off-river lakes.
-Papua New Guinea- ; -Journal Paper- ; -Case Study-

Quarry Management, 1984, 11, No.3, 152-157.
Quarries and waste disposal: case study of practice.
P. A. TOMES (ARC Western Region).
Studies on the Judkins landfill site in Warwickshire, operated by Amey Roadstone Corporation, showed that site preparation works were important to protect the environment, particularly surface water and groundwater quality. A sealed landfill site was created including a leachate drainage system and methane gas control. An extensive monitoring programme to assess groundwater levels and quality and gas production was implemented. Site operation is described. The quarry restoration would include development as a recreational facility, landscaping and industrial development. -U.K.-Journal; -Case Study-

Marinas

$[0mCalif. Fish Game, 1963, 49, 265-270
Mass mortality of marine organisms attributed to the 'red tide' in Southern California.
D. J. REISH
Results of a study to compare the fouling (sessile and associated organisms which attach themselves to structures such as floats, pilings and boats) and benthic populations, before and after the extensive red-tide water bloom of the dinoflagellate, Gonyaulax polyedra, in Alamitos bay marina, Calif., in the autumn of 1962, are summarized in tables and discussed. Mytilus edulis was killed either directly by the accumulation of toxic materials in its body or indirectly by the decrease in concentration of dissolved oxygen, resulting from the decomposition of dead G. polyedra. Changes in the benthic fauna were probably the result of the decrease in the concentration of dissolved oxygen in the water and/or a change in the nature of the substratum.

$[0mJ. Wat. Pollut. Control Fed. 1969 41, 1330-1339.
Bacteriological water quality of several recreational areas in the Ross Barnett reservoir.
R. D. BARBARO B. J. CARROLL L. B. TEBO and L. C. WALTERS
Ross Barnett reservoir is a shallow impoundment on the Pearl river which serves as a source of water supply for Jackson, Miss., and is used for recreational purposes; studies were made on the bacteriological quality of the water during a period of high recreational activity and one of normal use. Statistical analysis of the results showed no significant difference in numbers of total coliform ORGANISMS between the two periods, but during the period of greatest recreational activity four of the 10 samples had average total coliform counts in excess of that recommended for water contact activities, and three of these 4 samples were at marina sites; during the period of normal use only two stations, one at a marina, exceeded the recommended level. Faecal coliform and faecal streptococci counts were significantly higher during the period of greatest activity at all stations, and the faecal coliform counts at the marina stations were significantly higher than those at non-marina stations during both sampling periods.

$[0mCalu. Fish Game, 1971, 57, 167-176.
Sequential mortality of the fish fauna impounded in construction of a marina at Dana Point, California.
J. P. WAGGONER and C. R. FELDMETH
Construction of a marina at Dana Point, Calif., resulted in isolation of several inter- and sub-tidal areas with dikes and subsequent pumping out of the water before landfill operations, and studies were carried out on conditions in one of these impoundments during the draw-down period. Mass mortalities of fish were associated with low oxygen concentrations and high temperatures.

$[0mJ. Wat. Pollut. Control Fed., 1973, 45, 97-104.
Pollution of a marina area by watercraft use.
W. N. MACK and F. M. D'ITRI
A study of coliform bacteria in the water at a new marina at Naubinway, Mich., on the shores of lake Michigan, showed a slight increase in coliform organisms related to the number of yachts in the marina, but the numbers were well below the standard for total body contact in Michigan interstate waters. Chemical analyses of the water showed no indication of human pollution, confirming the

greater sensitivity of bacteriological tests for detecting such pollution. Other factors contributing to the presence of coliform organisms, such as septic-tank discharges and faeces from sea-gulls, were also investigated and found to be relatively unimportant.

$[0mWater Research, 1977, 11, No.5, 429-438.
A biological and chemical comparison of various areas of a reservoir.
A. C. HENDRICKS , and J. K. G. SILVEY .
A limnological survey of several physically-different areas of a reservoir in Texas showed no significant difference in condition between a cove that had a marina located on it and a similar cove without a marina. An open-water area in which many trees had been left standing was found to be more eutrophic than other areas near it, while another open-water area with nutrient-rich sediments was less eutrophic than nearby shallower areas.

$[0m Revue Internationale d'Oce\anographie Me\dicale, 1978,
Techniques for the study of biological changes due to restructured shores.
J. P. EHRHARDT .
The author has carried out a survey of the plankton, bacteria, and chemical elements in sea waters whose circulation has been reduced by the construction of dikes or marinas, and which are subject to sewage pollution. The presence of red tides has been observed in the Mediterranean area and its association with the planktonic population and its toxicity were investigated. Aerobic bacteria and coliforms were counted, and the control of the anaerobic bacteria and the testing of their sulphate-reducing activity were studied. Mineral and organic constituents have also been assayed. A bibliography of 41 references is appended. (REF CONTD)50, No.4, 11-19 (in French, English summary). France

$[0m U.S. National Technical Information Service, Springfield,
Recreational boating. A bibliography with abstracts. (Search period covered 1964-January 1978).
M. E. YOUNG , (editor).
This bibliography deals with various topics related to the provision and operation of recreational boating facilities, including the planning and management of marinas, safety precautions, boat insurance, environmental pollution and regional planning of boating amenities.
(REF CONTD)Va., Report No. NTIS/PS-78/0072, 1978. 197 pp. U.S.A.

$[0mProgress in Water Technology, 1980, 12, No. 1, 419-426.
The Cubelles power station - a new solution for the intake and discharge of cooling water.
P. S. BORES , (MADRID UNIVERSITY) .
The arrangements for intake and discharge of cooling water for a 1,000 megawatt power station, on a shallow section of the Catalonian coast, are described. The main features are primary and secondary sand traps, in the form of a beach and a marina, respectively, and a mile-long breakwater. The latter, in order to preserve the aesthetic character of the coastline, is only four feet above mean sea level and is provided with a special energy dissipator. Tests in all sorts of sea conditions have proved the efficiency of the breakwater, in terms of energy dissipation and provision of sheltered water. The design was tested by the British Hovercraft Corporation and it is shown that the risk of waves of more than 2 feet in the marina, even in the worst east winds, is low. The cost of the project, not allowing for revenue from the marina, is about a quarter of that of conventional schemes. -Spain-

Bulletin of Environmental Contamination and Toxicology, 1985, 35, No.6, 835-844.
Polynuclear aromatic hydrocarbons in oyster tissue around three coastal marinas.
J. M. MARCUS (South Carolina Department of Health and Environmental Control, Columbia), and T. P. STOKES.
Adult oysters (Crassostrea virginica) and sediment were collected in spring and summer from 12 stations around each of three coastal marinas. Summer total PAH concentrations in sediment exceeded spring values by 68 and 266 per cent at the Palmetto bay and Outdoor Resorts marinas respectively, reflecting the seasonal increase in boating activity. The 15 per cent decrease measured at Fripp Island marina was heavily influenced by the inexplicable occurrence of fluorene at one station during spring. Total mean PAH concentrations in oyster tissue were 48-61 per cent lower in summer than in spring. Condition index values (a measure of the lipid content of the oysters) also decreased (40-46 per cent) in summer. The spring sampling was done prior to spawning, when large quantities of glycogen and lipid were stored by the oyster. These results indicated that lipid content was the major factor influencing seasonal changes in PAH uptake and accumulation in oysters.
-U.S.A.- ; -Journal Paper- ; -Experimental-

Bulletin of Environmental Contamination and Toxicology, 1986, 36, No.4, 587-594.
Heavy metals in oyster tissue around three coastal marinas.
J. M. MARCUS (South Carolina Department of Health and Environmental Control, Columbia), and A. M. THOMPSON.
Oysters (Crassostrea virginica) and sediment were sampled from sites around the Palmetto marina, the Outdoor Resorts marina, and Fripp Island marina during early April and early August 1983. Cadmium, copper, and zinc were present in all oysters, and lead and nickel in most samples. Chromium was rarely present, and mercury was never detected. Tissue metal concentrations were 12-65 per cent higher in summer than in spring. Sediment metal concentrations showed no seasonal increases, indicating that there was little, if any, increase in metals input to the water system due to marina activities. Statistical analysis revealed that, in most cases, there was a negative correlation between metal concentration and condition index (a measure of the fatness of the oyster). In spring, the condition index was high due to pre-spawning storage of glycogen and lipids. It had been reported (Scott, 1979) that oyster metabolic rates (and consequently uptake rates) were 120 per cent higher in summer than in spring. These findings suggested that accumulation kinetics were dependent on basal metabolic rate and on the size of the tissue pool (for absorption) within the body. Metal:metal correlations in oyster tissue showed strong positive correlations between copper and cadmium at Outdoor Resorts and Fripp Island, and between zinc and cadmium, and zinc and copper at all three marinas.
-U.S.A.- ; -Journal Paper- ; -Experimental- ; Pb

Journal of Limnological Society of Southern Africa, 1984, 10, No.2, 76-78.
A note on salinity and oxygen stratification in the Marina Da Gama, Zandvlei.
B. R. DAVIES (Cape Town University, Rondebosch), and B. A. STEWART.
Dissolved oxygen, salinity and temperature measurements for 2 canals within the Marina Da Gama from the March to December 1983 showed little temperature stratification but pronounced salinity and oxygen stratification. This confirmed predictions that salinity stratification was likely to occur because

the design of the Marina canals was such that they were deeper than the coastal lake allowing dense saline waters entering the system through tidal action to accumulate along the canal bottoms. Other design features exacerbated the problem because of poor water circulation throughout the Marina. Oxygen stratification was mainly associated with salinity stratification but was also enhanced by dense Potamogeton stands. It was recommended that the design of marinas should consider canal depths where salt water intrusions might be expected and should ensure adequate water circulation particularly where there is likely to be extensive submerged plant growth.
-South Africa- ; -Journal Paper- ; -Case Study-

Zeitschrift fur Wasser- und Abwasser-Forschung, 1988, 21, No.2, 36-39 (in English).
Motor-boat-derived volatile organic compounds (VOC) in lakewater.
F. JUTTNER (Universitat Tubingen).
Samples of water were taken from Constance lake close to the entrance to a marina on a Saturday in August 1984, when the fine weather contributed to very heavy motor boat traffic (1293 boat passages were recorded from 08.00 to 17.30 h). Samples were taken hourly and processed within 30 minutes using a closed-loop stripping arrangement. The volatile fraction after desorption from Tenax TA was subjected to GLC separation on a glass capillary column, followed by mass spectrometry. Hexadecene (12 ng per litre) was added to each sample as an internal standard. Typical chromatograms, retention times for specific compounds and their observed concentrations are tabulated, indicating a progressive buildup of polycyclic and benzene derivatives methyl-substituted aromatic hydrocarbons and their derivatives, together with some longer chain aliphatic hydrocarbons.
-West Germany- ; -Journal Paper- ; -Experimental-

Bulletin of Environmental Contamination and Toxicology, 1988, 41, No.6, 910-914.
Heavy metal pollution from a point source demonstrated by mussel (~Unio pictorum~ L.) at lake Balaton, Hungary.
K. V. BALOGH (Balaton Limnological Research Institute, Tihany).
The concentrations of copper, zinc, cadmium, and lead in various tissues of freshwater mussels, collected near a yacht marina on Balaton lake, compared with data for mussels collected from an open-water control site at the other end of the lake. The high concentrations of metals found in mussels from the marina area were attributed to the antifouling and anti-corrosion paints used on the boats; the metal contents of several such paints are tabulated.
-Hungary- ; -Journal Paper- ; -Case Study- ; Pb

Archives of Environmental Contamination and Toxicology, 1988, 17, No.1, 103-113.
Polynuclear aromatic hydrocarbon and heavy metal concentrations in sediments at coastal South Carolina marinas.
J. M. MARCUS (South Carolina Department of Health and Environmental Control, Columbia), G. R. SWEARINGEN, A. D. WILLIAMS, and D. D. HEIZER.
Sediment samples, collected from 15 stations (arranged in a grid pattern) around each of 3 coastal marinas, were analysed for 16 PAH and 7 heavy metals. Sampling was conducted once in the spring and once in the summer. Concentrations of both pollutants were lower in the mid-channel sediments (coarse sand and shell) than in the sediments along the creek banks (fine silts

and clays). Levels of PAH contamination were higher in summer, and were influenced by marina size and marina proximity. Levels of metals contamination showed no significant temporal variations, and did not appear to be influenced by boating activity.
-U.S.A.- ; -Journal Paper- ; -Experimental-

Proceedings of Institution of Civil Engineers (Part 1), 1989, 86, October, 913-935.
Hydraulic modelling of tidal circulation and flushing in coastal basins.
R. E. NECE (Washington University, Seattle), and R. A. FALCONER.
The use of physical and mathematical models to predict tidal circulation and flushing in small coastal basins, harbours and marinas is reviewed. Techniques adopted in both models to quantify tidal flow patterns and water exchange characteristics of harbours and marinas are described, with emphasis on comparative studies where alternative geometries and/or bathymetries were proposed. Advantages and limitations of each approach are discussed and example applications of each technique are described. A physical model study was used to determine tidal flushing behaviour of the proposed harbour Pointe $[1mMarina$[0m, located on Puget Sound north of Seattle, Wash, U.S.A.. A mathematical model (DIVAST) was used to investigate the impact of a land reclamation proposal and the subsequent design of an embankment bridge on the tidal flow and flushing characteristics in Holes bay, Dorset, U.K. Physical models were more appropriate for small-scale projects such as marinas, allowing observation of small grid scale phenomena. Mathematical models were more feasible for larger bodies of water, with field data used for verification.
-International- ; -Journal Paper- ; -Experimental-

Oil & Chemical Pollution, 1989, 5, No.6, 477-488.
$[1mMarina$[0m developments as sources of hydrocarbon inputs to estuaries.
A. P. BIANCHI (Southampton University), C. A. BIANCHI, and M. S. VARNEY.
Samples of estuarine water and sediments collected from the length of Southampton Water over a 3-year period were analysed for volatile and non-volatile hydrocarbons using gas-liquid mass spectroscopy to evaluate the environmental impact of new $[1mmarina$[0m developments. Within 6 months from the start of $[1mmarina$[0m construction in 1984, there were increases in total dissolved hydrocarbons from pre-construction concentrations of 10-100 to 100,000 ug per litre (at low tide), in sediment hydrocarbon concentrations from 150-500 to 1500 mg per kg (dry weight) and in suspended solids concentrations from 0.5-30 to over 1500 mg per litre. The estimated additional loading during peak construction activity was approximately 50 tonnes hydrocarbons per month, which included a range of aromatic alkanes, cycloalkanes and organohalogens. During post-construction stages the overall net hydrocarbon concentration decreased, with the depletion rate in sediments half that in water, but concentrations of Freons increased. Inputs from marine vessels maintained masses of total dissolved organics 2-3 times greater than pre-development levels. Marinas were a major potential source of marine pollution both during and after construction. There are 30 references. -U.K.- ; -Journal Paper- ; -Experimental-

Estuarine, Coastal and Shelf Science, 1989, 29, No.6, 613-620.
The filtration activity of a serpulid polychaete population (~Ficopomatus enigmaticus~ (Fauvel)) and its effects on water quality in a coastal $[1mmarina$[0m.
B. R. DAVIES (Cape Town University), V. STUART, and M. de VILLIERS.

~Ficopomatus enigmaticus~ was sampled in the $[1mMarina$[0m de Gama, near Cape Town, South Africa, to estimate its standing stock; separate estimates were made for the worms attached to the cement canal walls and to the macrophyte ~Pomatogeton pectinatus~. Filter-feeding experiments provided estimates of clearance rates, and it was calculated that the entire volume of the $[1mmarina$[0m would be filtered by the ~F. enigmaticus~ population in 26.1 h. Both ~F. enigmaticus~ and ~P. pectinatus~ were perceived as a nuisance by recreational users of the $[1mmarina$[0m, but this study illustrated the importance of the worm to the maintenance of water quality, and, since half of the total standing stock of this worm was supported by ~P. pectinatus~, the need for careful management of the harvesting of this plant was indicated.
-South Africa- ; -Journal Paper- ; -Experimental- ; plants (aquatic)

Water, Sewage and Effluent, 1989, 9, No.2, 21 and 23.
Water quality management in the coastal zone.
The legal position in South Africa regarding discharge of effluents to the sea is outlined, and set within the context of rapid urban and industrial development along the coast; over 60 sea outfalls were at officially recognized. The duties and probable expense incumbent upon an applicant for a discharge permit are enumerated; these invariably included an environmental impact assessment. The Department of Water Affairs was aware that the cost of long sea outfalls was beyond the means of many communities, and had considerable discretion in allowing short outfalls provided they discharged beyond the surf zone, and that the uses to which the sea was put in the near vicinity of the discharge were not impaired. A flexible policy was also envisaged when applying pollution control requirements on new developments within the coastal zone, according to the degree of environmental protection deemed to be necessary for specific categories of development; examples of anticipated development, apart from urbanization, including, sand and gravel extraction, forestry, and dredging for $[1mmarina$[0m construction.
-South Africa- ; -Journal Paper- ; -Case Study-

Water SA, 1992, 18, No.1, 37-42.
Nutrient status and water quality assessment of the Marina Glades canal system, Kromme estuary, St. Francis bay.
D. BAIRD (Port Elizabeth University), and R. PEREYRA-LAGO.
Measurements were taken, on 7 occasions spanning the holiday season, of physical, chemical and bacterial parameters in the waters of a South African boating marina, when the resident population of about 100 swelled temporarily to over 2000. The marina, consisted of a series of cul-de-sac canals opening off an access canal, which originally formed a short cut from the Kromme river estuary to the open sea, had become land-locked at the sea end by the movement of sand bars. Its waters had consequently become relatively stagnant, being flushed solely by tidal action. A dramatic increase in beds of sub-tidal vegetation had suggested that nutrient discharge had risen, and was accumulating. The physical parameters measured (salinity, dissolved oxygen, water temperature) varied little over the period, and were comparable with those of similar estuary waters in the vicinity. Bacterial numbers were consistently low. But nitrate and soluble (reactive) phosphorus levels rose sharply during peak holiday periods. The source of the nutrients was leaching into the soil from the septic tanks provided for holiday homes. These were effective in bacteria kill, as the bacterial water quality was at all times within the South African standard for recreational coastal waters.
-South Africa- ; -Journal Paper- ; -Case Study-

- **TBT**

New Zealand Journal of Marine and Freshwater Research, 1989, 23, No.2, 287-294.
Tributyl tin levels for sea water, sediment, and selected marine species in coastal Northland and Auckland, New Zealand.
N. KING (Auckland University), M. MILLER, and S. de MORA.
Water and sediment samples were collected from sites at 4 locations, and specimens of oysters (~Crassostrea gigas, Saccostrea glomerata, Ostrea heffordi~),and oyster borers (~Lepsiella scobina~) from sites at one of the locations. Samples and specimens were analysed for tributyltin (TBT), calculated as tin content (TBT-Sn), and the oyster shells were examined. TBT concentrations in water were often indeterminable and had a maximum of 0.32 mg TBT-Sn per litre. $[1mMarina$[0m sediments contained 0.240 mg TBT-Sn per gram. Shell thickening was found in ~C.gigas~, where the number of cavities correlated with the body burden of TBT. In all species, the body burden of TBT was 3-4 times higher than the corresponding water concentration. -New Zealand- -Journal Paper- ; -Experimental-$

Science of the Total Environment, 1991, 105, 149-156.
Dissolved butyltins in fresh and marine waters of the Netherlands in 1989.
R. RITSEMA (Ministry of Transport and Public Works, Haren), and R. LAANE.
An extended investigation was conducted into distributions and seasonal variations of dissolved butyltins in marine and freshwater harbours and marinas in the Netherlands. Dissolved concentrations of tri-, di- and monobutyltin at 26 locations were in the ranges 0.1-7210, 0.1-1340 and 0.1-460 ng per dm3, respectively, during 1989. Concentrations increased from April till the end of May 1989 at Colijnsplaat $[1mmarina$[0m as a result of the launching of boats freshly painted with anti-fouling paints containing butyltins. Levels subsequently decreased. Observed trends in biological effects were consistent with variations in observed concentrations.
-Netherlands- ; -Journal Paper- ; -Case Study-

Naturwissenschaften, 1991, 78, No.5, 219-221 (in English).
Organotins in lake sediment.
K. FENT (Swiss Federal Institute for Water Resources and Water Pollution Control, Kastanienbaum), J. HUNN, and M. STURM.
Butyltins and phenyltins were measured in the water and sediments of a marina on Lucerne lake. Water samples were taken 1 m below the surface and 60 cm deep cores of sediments were obtained. Values found in the water column for mono-, di- and tributyltins (MBT, DBT, TBT) and triphenyltin (TPT) were 13, 12, 252 and 38 ng per litre, respectively. Butyltins were found to sediment depths of 12 cm and phenyltins to 6 cm. TBT concentrations above 200 ug per kg and TPT of 174 ug per kg were noted. Considerable monophenyltin was detected down to 6 cm but concentrations of MBT and DBT were small. The presence of caesium-134 and caesium-137 from nuclear testing and the Chernobyl accident was used to date sediments. It showed some disturbance of sediments but confirmed that the organotins began to be deposited after the construction of the marina in 1978.
-Switzerland- ; -Journal Paper- ; -Case Study-

Marine Environmental Research, 1991, 32, No.4, 213-222.
Organotin in the marine surface microlayer and subsurface waters of south-west England: relation to toxicity thresholds and the UK environmental quality standard.
J. J. CLEARY (Plymouth Marine Laboratory).

Concentrations of organotin, tributyltin (TBT) and dibutyltin (DBT) determined in sea-surface microlayer and subsurface waters sampled annually in summer during 1986-1989 from 15 coastal sites started to decline significantly in 1988 following the introduction of legislation in 1987 to reduce TBT contamination. Maxima for concentrations of organotin and declines in concentration both occurred in areas of high boating activity, with 10- and 20-fold decreases in concentration recorded in subsurface and surface microlayer waters respectively. However 1988 concentrations remained above toxicity threshold values for various marine organisms, and both TBT and DBT were detected at all sites, 1988 TBT concentrations ranged from 38 to over 300 ng tin per litre in the surface microlayer, and from 18 to over 100 ng tin per litre in subsurface waters. Enhanced organotin concentrations in the surface microlayer were of potential biological significance to neuston and littoral zone organisms. A 48 h tidal cycle study at Sutton marina showed mean subsurface TBT concentrations of 51 ng tin per litre at low water and 21 ng tin per litre at high water for successive tides, representing only a 2-fold variation; surface microlayer TBT concentrations were not related to tidal state.
-U.K.- ; -Journal Paper- ; -Case Study-

Marine Environmental Research, 1991, 32, No.4, 89-111.
Reduction in TBT concentrations in U.K. estuaries following legislation in 1986 and 1987.
M. E. WAITE (Ministry of Agriculture, Fisheries and Food, Burnham-on-Crouch), M. J. WALDOCK, J. E. THAIN, D. J. SMITH, and S. M. MILTON.
The effectiveness of legislation introduced in 1986 and 1987 to control the use of tributyltin (TBT)-based antifoulants was assessed by monitoring TBT concentrations in monthly samples of water, sediment, oysters (~Crassostrea gigas~) and mussels (~Mytilus edulis~) collected during 1986-1989 from 12 shellfish sites in 6 estuaries and in monthly water samples from 5 marines or harbours. Mean TBT concentrations in water and shellfish decreased during the study period, with 1989 concentrations generally only 1-third to 1-quarter of 1986 values and shellfish concentrations decreased most markedly in 1987 and 1988; there was no clear trend in sediment concentrations. A mean 1988 TBT concentration of 2 ug per litre in the new Hythe marina, which opened after the 1987 restrictions, indicated illegal use of TBT-based paints on small boats. Oyster shell thickness indices and oyster production increased at all sites, particularly in 1987 and 1988 and oysters with normal shell shape could be grown in 5 estuaries. However in 1989 the environmental quality standard of 2 ng TBT per litre in seawater was achieved at only 1 estuarine site and at none of the marinas. There are 63 references.
-U.K.- ; -Journal Paper- ; -Case Study-

Marine Environmental Research, 1991, 32, No.4, 243-260.
Butyltins in marine waters of The Netherlands in 1988 and 1989; concentrations and effects.
R. RITSEMA (Ministry of Transport and Public Works, Haren), R. W. P. M. LAANE, and O. F. X. DONARD.
Length/thickness and area/thickness ratios of local oyster (~Crassostrea gigas~) populations from the vicinity of Colijnsplaat marina were significantly lower than those from a reference site, indicating a higher tributyltin (TBT) burden. After transfer from a relatively uncontaminated site to 4 sites in the eastern Scheldt estuary for 6 weeks, dogwhelks (~Nucella lapillus~) developed advanced imposex, with 50-100 per cent female sterility. Dissolved TBT was not detected in the Rhine or western Scheldt estuaries or

North sea, but concentrations in marinas and harbours ranged from 120 to 4000 ng per litre. TBT concentrations of up to 1200 ng per g were measured in sediment and suspended matter, and concentrations in mussel (~Mytilus edulis~) tissue ranged from less than 1 to 2300 ng per g (dry weight). An investigation into the distribution of dissolved butyltins in 27 marinas and harbours showed concentrations of 0.1-7210 ng TBT per litre. A clear seasonal variation in TBT concentrations occurred at Colijnsplaat, with the highest value in late May following increased boating activity. TBT concentrations then declined until October when a sharp increase was possibly due indirectly to increased algal growth. -Netherlands- ; -Journal Paper- ; -Case Study-

Environmental Monitoring and Assessment, 1992, 22, No.1, 15-38.
Butyltin and copper monitoring in a northern Chesapeake bay marina and river system in 1989: an assessment of tributyltin legislation.
L. W. HALL (Maryland University, Queenstown), M. A. UNGER, M. C. ZIEGENFUSS, J. A. SULLIVAN, and S. J. BUSHONG.
Dibutyltin (DBT) and tributyltin (TBT) were measured in water samples taken from 6 sites on a creek supporting several marinas and 1 open river location during June-September 1989. Biweekly samples were extracted with hexane, derivatized with hexylmagnesium bromide, cleaned-up, and analysed by gas chromatography. Soluble copper concentrations were also measured. The results were compared with those obtained in 1986 and 1988 which corresponded to periods before and after legislation restricting the application of TBT paint. A survey of TBT paint use showed that the percentage of boat owners employing it fell from 31 to 6 per cent. Mean 4-monthly TBT and DBT concentrations in 1989 were 21-177 and 10-73 ng per litre respectively, with the highest means and peaks found in the marinas at the start of the boating season. DBT concentrations fell significantly from 1986 to 1989, but no clear trend emerged for TBT except at one marina. Mean copper concentrations were 2.7-10.0 ug per litre, being greatest in marinas. They were significantly lower in 1989 compared with 1988. There are 33 references.
-U.S.A.- ; -Journal Paper- ; -Case Study-

Environmental Toxicology and Chemistry, 1993, 12, No.2, 305-314.
Measurement of tributyltin contamination of sediments and ~Crassostrea virginica~ in the southern Chesapeake bay.
F. A. ESPOURTEILLE (Virginia Institute of Marine Science, Gloucester Point), J. GREAVES, and R. J. HUGGETT.
Results are presented from a study on the concentrations of tributyltin (TBT) in sediment and oysters (~Crassostrea virginica~) from the southern part of Chesapeake bay in 1986 and 1987. The most contaminated sediments, containing 4000 ug TBT per kg dry weight, were found in a marina. TBT was found in all oyster samples, even from sites where TBT could not be detected in the sediment. Concentrations in oysters ranged from less than 10 ug per kg on the Atlantic coast of Virginia to 5600 ug per kg in Elizabeth river, Va. However, since the areas with the highest TBT concentrations were usually areas with considerable human activities, consumption of shellfish from these areas would probably be restricted because of the risk of microbial contamination.
-U.S.A.- ; -Journal Paper- ; -Case Study-

Environmental Toxicology and Chemistry, 1994, 13, No.5, 755-762.
Accumulation, depuration and growth effects of tributyltin in the freshwater bivalve ~Dreissena polymorpha~ under field conditions.
K. BECKER van SLOOTEN (Ecole polytechnique federale de Lausanne), and J.

TARRADELLAS.
The uptake and elimination of tributyltin (TBT) by the mollusc -Dreissena polymorpha- was investigated in a freshwater marina in Geneva lake contaminated with TBT released from antifouling paints. TBT accumulation was rapid, reaching 63 ug per g dry weight after 35 d with a bioconcentration factor of 900,000. A steady state with a mean concentration of 63.23 ug per g was reached between days 35 and 105. No effect on growth or mortality was observed. Depuration was slightly slower than accumulation. The half-life of TBT was 25.7 d. The growth rate of the eliminating -D. polymorpha- was half as high as the rate of the accumulating mussels and those caged in a site with low TBT concentrations. There are 48 references.
-Switzerland- ; -Journal Paper- ; -Experimental-

Marine Pollution Bulletin, 1987, 18, No.2 78-83.
Evaluation of butyltin compounds in Maryland waters of Chesapeake bay.
L. W. HALL (Johns Hopkins University, Shady Side, Md.), M. J. LENKEVICH, W. S. HALL, A. E. PINKNEY, and S. J. BUSHONG.
Tabulated data are presented on the concentrations of dibutyltin, tributyltin, and tetrabutyltin in the surface micro-layer and in the water column at 8 sampling locations in Maryland waters of Chesapeake bay over the period July 1985-June 1986. The sampling locations included large and small marinas, a large harbour, 2 major river systems, and a heavily used shipping channel. The highest concentrations of the organotin compounds were found in the 4 marinas. The implications of the findings are considered. Further studies were planned to evaluate the spatial and temporal distribution of tributyltin in receiving systems near the marina areas.
-U.S.A.- ; -Journal Paper- ; -Case Study-

Environmental Monitoring and Assessment, 1987, 9, No.2, 195-220.
TBT in California coastal waters: monitoring and assessment.
M. STALLARD (Scripps Institution of Oceanography, La Jolla, Calif.), V. HODGE, and E. D. GOLDBERG.
A monitoring program for butyltin (monobutyltin, dibutyltin and tributyltin) concentrations in marine, harbour, and coastal waters of California was carried out in order to ascertain ambient levels and to translate the data into proposed public policy. The results are presented in this paper, with emphasis on tributyltin (TBT) which is the most effective anti-fouling agent used in marine paint, but at the same time one of the most toxic substances to be introduced into natural waters. Over 80 sites were sampled, primarily marinas. TBT concentrations in marina waters ranged from 20 to 600 ppt, while lower values were found in harbours and on the coast. Where TBT concentrations were greater than 100 ppt, non-target organisms such as molluscs were depleted. With increasing use of TBT-containing antifouling paints, the effects on coastal organisms could become more drastic, and it is recommended that TBT be banned for use in commercially available marine paints.
-U.S.A.- ; -Journal Paper- ; -Case Study-

Environmental Monitoring and Assessment, 1988, 10, No.3, 229-244.
Spatial and temporal distribution of butyltin compounds in a northern Chesapeake bay marina and river system.
L. W. HALL (Johns Hopkins University, Shady Side, Md.), S. J. BUSHONG, W. E. JOHNSON, and W. S. HALL.
The concentrations of dibutyltin, tributyltin (TBT), and tetrabutyltin over June-September 1986 inclusive in an area of northern Chesapeake bay, comprising

2 tributaries of the bay and 2 boat marinas, are tabulated. High concentrations of TBT were found in early June, coinciding with the launching of freshly painted boats. There was no evidence that concentrations were higher at weekends than during the week. Sampling over a tidal cycle showed that peak concentrations of TBT occurred during a rising tide. The possible effects of these compounds at the concentrations measured on aquatic organisms are discussed.
-U.S.A.- ; -Journal Paper- ; -Case Study-

Environmental Toxicology and Chemistry, 1988, 7, No.1, 41-46.
Acute and chronic effects of tributyltin on a Chesapeake bay copepod.
L. W. HALL (Johns Hopkins University, Shady Side, Md.), S. J. BUSHONG, W. S. HALL, and W. E. JOHNSON.
Tributyltin (TBT) toxicity tests with the estuarine copepod Eurytemora affinis were conducted in both acute and chronic flow-through modes. The 48 h and 72 h LC50 values were 2.2 and 0.6 ug per litre TBT. In a chronic experiment, concentrations of 100 ng per litre significantly reduced the survival of neonates after 6 days of exposure. At concentrations ranging from 12.5 to 100 ng per litre in a second chronic test, no significant effects were found, though a significantly effect was found at 200 ng per litre. In some marina areas of Chesapeake bay, TBT concentrations exceeded the toxic concentrations found in these tests.
-U.S.A.- ; -Journal Paper- ; -Case Study-

Applied Organometallic Chemistry, 1988, 2, No.6, 547-552.
Simultaneous butyltin determinations in the microlayer, water column and sediment of a northern Chesapeake bay marina and receiving system.
C. L. MATTHIAS (Maryland University, College Park), S. J. BUSHONG, L. W. HALL, J. M. BELLAMA, and F. E. BRINCKMAN.
Monobutyltin (MBT), dibutyltin (DBT), tributyltin (TBT) and tetrabutyltin (TTBT) were determined in samples from 7 stations during one sampling period in July 1987. Concentrations of the known shellfish toxicant, TBT, were 60-4130 ng per dm3, 34-367 ng per dm3 and less than 0.05-1.4 ug per g (dry weight) in the microlayer, water column and sediment, respectively. The marina sediments studied showed a 1000-fold enhancement of TBT over water column and microlayer concentrations. TBT levels were higher in the marinas than in the receiving system. The microlayer was depleted in DBT relative to TBT compared to both water column and sediment environmental compartments.
-U.S.A.- ; -Journal Paper- ; -Case Study-

Marine Pollution Bulletin, 1988, 19, No.10, 531-534.
Evidence for rapid degradation of tributyltin in a marina.
P. F. SEIGMAN (Naval Ocean Systems Center, San Diego, Calif.), A. O. VALKIRS, P. M. STANG, and R. F. LEE.
The TBT tributyltin concentration decreased from 0.23 ug per litre to 0.03 ug per litre after 12 days, while dibutyltin (DBT) increased from 0.26 to 0.34 ug per litre. The half-life of carbon-14 TBT (2 ug per litre) added to the yacht basin water was 6 and 7 days in the light and dark, respectively. The principal TBT metabolite was dibutyltin (DBT) with very little formation of monobutyltin and labelled carbon dioxide. Degradation was largely due to biological processes as the half-life of TBT was 94 days when the water was poisoned with formalin.
-U.S.A.- ; -Journal Paper- ; -Experimental-

Marine Pollution Bulletin, 1989, 20, No.6, 290-292.
Organotin compounds in harbour and marina waters from the Northern Tyrrhenian sea.
E. BACCI (Universita di Siena), and C. GAGGI.
Two harbours and 3 marinas in the Northern Tyrrhenian sea were sampled for contamination by organotin compounds. High and relatively constant levels of tributyltin (TBT) and dibutyltin (DBT) were found in Leghorn harbour: organotins were not detected in the smaller Piombino harbour. Concentrations of TBT, and DBT at the power plant outlet at Leghorn harbour were significantly higher than at other sampling sites in the harbour. Concentrations of organotin compounds in the marinas were high. Under favourable meteorological conditions, significant quantities of TBT and related compounds could contaminate open sea sites. -Italy- ; -Journal Paper- ; -Case Study-

Marine Biology, 1989, 102, No.3, 291-297.
Occurrence of tri-n-butyltin-caused imposex in the North Pacific marine snail ~Nucella lima~ in Auke bay, Alaska.
J. W. SHORT (National Marine Fisheries Service, Auke Bay Laboratory, Alaska), S. D. RICE, C. C. BRODERSEN, and W. B. STICKLE.
Imposex occurred in ~Nucella lima~ collected from August 1987 to May 1988 along a tri-n-butyltin (TBT) pollution gradient associated with a $[1mmarina$[0m in Auke bay, Alaska. Imposex, as measured by relative penis size of females to males increased from 0 to 34.7 along the gradient and as measured by vas deferens sequence index increased from 0 to 4.29. Concentrations of TBT in ~N. lima~ increased from about 0.010 ug tin to 0.065 ug tin per g dry tissue weight along the gradient. When ~N. lima~ were exposed to TBT for 1 month at a distant control site, 33 per cent of females grew a penis ranging in size from 0.2 to 0.8 mm. -U.S.A.- ; -Journal Paper- ; -Case Study- ; tributyltin

Hydro electric power

$[0m J. Fisheries Res. Bd. of Canada, 1975, 32, No. 1,
Environmental impact assessment and hydro-electric projects: hindsight and foresight in Canada.
The proceedings of a symposium of the Canadian Conference on Freshwater Fisheries Research held at Ottawa, Ont ., in January 1974, to assess the impact of large hydro-electric dam projects in Canada on the environment are reported. Reports of the environmental impact of the most important of these hydrodam projects are presented in a series of papers, and one of particular interest by Penn, A. F., reports the development of James bay, Quebec , and the role of environmental impact assessment in a legal action by the Indian and Inuit peoples against the James Bay Development Corporation . A list of all hydro-electric projects over 100 MW in size in Canada is appended. (REF CONTD) 97-209.

$[0mCanadian Water Resources Journal, 1981, 6, No.3, 5-19.
Environmental implications and assessments of hydroelectric projects.
P. REYNOLDS (Environment Canada, Ottawa), and S. UJJAINWALLA .
The general environmental benefits and disbenefits of hydroelectric schemes are briefly listed, and then the authors refer to more detailed and specific work on certain aspects. They highlight nutrient, phosphorus, and mercury leaching problems in new impoundments. They refer to work on spawning bed damage, eel and fishery losses, increases in fish parasite abundance, nitrogen supersaturation, and problems from inappropriate site clearing methods. Social impacts, forestry, recreation, and wildlife considerations are touched upon, and the impacts of high voltage transmission lines in particular. The authors recommend, among other things, sectoral assessment review manuals, monitoring programmes, and studies on the cost effectiveness of environmental investigations. -Canada- ; environmental impact

$[0mBiological Conservation, 1984, 28, No.1, 73-87.
Some environmental aspects of the proposed hydroelectric schemes on the Zambesi river, Zimbabwe.
R. F. DU TOIT (University of Zimbabwe, Mount Pleasant) .
Only a very cursory environmental impact assessment for the Mupata and Batoka schemes has been possible. The adverse effects of the 1200 MW Mupata scheme, which will give a large impoundment only 16 metres deep, are many. The Mana pools area, essential to large mammals in the dry season, will be inundated, along with some tree and plant species of known pharmacological value. Water hyacinth growth will be massive, and schistosomiasis, trypanosomiasis, and malaria are to be expected. A useful fishery could also develop, though. The 1600 MW Batoka impoundment will have a much faster flushing rate, of about 15 days. Its fishery will be less commercially valuable, but concomitant developments will undoubtedly benefit the local people. -Zimbabwe- ; -Journal Paper- ; -Case Study-

$[0mJournal of Water Pollution Control Federation, 1984, 56, No.6, 654-664.
Power industry wastes.
T. CHU (Tennessee Valley Authority, Knoxville), and M. L. IWANSKI .
Giving a bibliography of 161 references, the authors review recent literature on wastes from the power industry, dealing with legislation in U.S.A. affecting the power industry (this is summarized in a table); assessment of the environmental impact of hydro-electric power plants, and selection of suitable

sites; assessment of environmental impact of coal-fired power plants, their siting, disposal and utilization of ash, cooling systems and discharge of cooling water, and desulphurization of flue gas; assessment of environmental effects of nuclear power plants and treatment and disposal of the wastewaters; studies on fluidized-bed combustion; and utilization of waste heat. -U.S.A.- ; -Journal Paper- ; -Review-

Canadian Water Resources Journal, 1981, 6, No.3, 47-62.
Investigating whether a large hydro development can be environmentally compatible: The Slave river hydro feasibility study.
B. GROVER (R.L. Walker & Partners Ltd), and C. PRIMUS.
A feasibility and environmental impact study to assess a possible 2000 megawatt hydroelectric development on the Slave river, Alberta, is described. Preliminary results indicated that the project was technically feasible and economically attractive and that a single stage development would be more economical than two smaller developments. The major environmental aspects considered were problems of reservoir leakage through karstic formations, spread of Arctic lamprey upstream, increases in naturally high mercury levels in lake Athabasca and how to select the most environmentally suitable location for the transmission system. Personnel involved in dam design and construction were being encouraged to consider environmental factors. -Canada- ; -Journal Paper- ; -Case Study- JN - Canadian Water Resources Journal 1981

Canadian Water Resources Journal, 1981, 6, No.3, 163-177.
Three case studies of small scale hydro in Newfoundland and Labrador.
B. N. BURSEY (Newfoundland and Labrador Hydro, St. John's).
The problems of environmental impact assessment of three small-scale hydroelectric projects are reviewed. Impacts from these plants on fisheries, wildlife, forestry, historic resources and socio-economic aspects were found to be similar to those from large-scale plants. Environmental impacts were site-specific and survey costs accounted for a larger proportion of the capital costs than large-scale projects. -Canada- ; -Journal Paper- ; -Case Study-

Water International, 1984, 9, No.1, 10-17.
Assessment of the environmental effects of constructing the Three Gorge Project on the Yangtze River.
J. F. LaBOUNTY (Engineering and Research Centre, Denver, Colo.).
The possible environmental effects of the Three Gorge Project on the Yangtze river, whose primary objectives are flood control on the middle and lower reaches, and hydroelectric power and water for irrigation and aquaculture development, are described. The potential drawbacks of relocation of people, loss of habitat for aquatic life and reduced nutrient inputs to downstream and estuarine fisheries are highlighted and possible solutions suggested. The ecology of the resulting reservoir and its differences in terms of water quality compared with the river are considered.
-China- ; -Journal Paper- ; -Case Study- JN - Water International 1984

Regulated Rivers: Research & Management, 1987, 1, No.1, 49-60.
Environmental impacts of the Tucuri dam on the middle and lower Tocantins river basin, Brazil.
C. J. BARROW (University College of Swansea, U.K.).
Present and possible future environmental impacts of the Tucuri dam in Brazil are assessed. They included: problems of impoundment, particularly from incomplete clearing of forest vegetation; reservoir siltation; changes to

fisheries and agriculture downstream; probable extinction of some animal and plant species; and environmental health problems - future difficulties of malaria control, the possibility of schistosomiasis, onchocerciasis, leishmaniasis, trypanosomiasis and bubonic plague. Common problems associated with the use of environmental impact assessment (EIA) in development countries are considered. EIA of the Tucuri dam was only commissioned after the project had been started and therefore could only have a limited influence. Nevertheless, EIA studies of Tucuri should be of use for planning future Amazonian and tropical hydroelectric projects.
-Brazil- ; -Journal Paper- ; -Case Study-

Journal of Water Pollution Control Federation, 1985, 57, No.6, 599-610.
Power industry wastes.
M. L. IWANSKI (Tennessee Valley Authority, Knoxville), and T. J. CHU.
Recent literature is reviewed on legislation affecting the power industry in the U.S.A. and on various aspects of hydro-electric, fossil-fuel, and nuclear power plants, including assessments of environmental effects; studies on acid deposition and acidification of surface waters; disposal and use of ash; cooling systems and cooling-water discharge; desulphurization of flue gas; characterization, treatment, and disposal of wastes from nuclear power plants; and fluidized bed combustion. A bibliography of 183 references is appended.
-U.S.A.- ; -Journal Paper- ; -Review-

Hydrobiologia, 1988, 164, 39-66.
An integrated approach to hydropower impact assessment. I. Environmental features of some Norwegian hydro-electric lakes.
B. RORSLETT (Norwegian Institute for Water Research, Oslo).
The ecological features of a regulated lake operated for hydroelectric power production were characterized and compared with natural lakes. Data from 17 Norwegian lakes collected during 1976-1986 are tabulated. Results of physico-hydrochemical investigations, spectral analysis, water level distributions, water level fluctuations by frequency domain analysis and time domain analysis, time averaged depth measurements, and optics are presented and discussed. There were no clear differences between the hydrochemistry and optics of the regulated and unregulated lakes. All lakes had signs of sublacustrine erosional activity related to internal waves and thermocline movements. Water level schedules, underwater light and erosional processes were identified as major environmental features of regulated lakes. There are 79 references. -Norway- ; -Journal Paper- ; -Experimental-

Environment Canada, Ottawa, 1987. 332 pp. (40626).
Audit and evaluation in environmental assessment and management: Canadian and international experience: volume I commissioned research.
B. SADLER (editor).
The technical papers presented at a conference held in October 1985 to discuss follow-up and post-completion studies of specific projects affecting the environment and to relate their findings to the original environmental impact assessment study undertaken prior to commencement are given. The papers are concerned with various hydroelectric schemes and pipeline development projects in widely separated parts of Canada, and also included a case study of the procedures involved in reaching agreement with conservationists and other aggrieved parties in the development of mining facilities and mine tailings disposal in British Columbian coastal waters.
-Canada- ; -Report- ; -General-

Regulated Rivers: Research & Management, 1989, 3, No.1/4, 381-392.
The Orinoco river: a review of hydrobiological research.
E. VASQUEZ (Fundacion La Salle de Ciencias Naturales, Edo. Bolivar).
Hydrobiological studies of the Orinoco river, some of its major tributaries and floodplain lakes are reviewed to assess the environmental consequences of development programmes including metal mining and processing, heavy oil production, river transportation and hydroelectric power generation. The slightly acidic waters were poor in electrolytes and conductivity correlated negatively with discharge. Zooplankton included 116 rotifer and 58 cladoceran taxa and more than 400 species of algae were identified, with the highest abundance (68,145 organisms per litre) at low water and the lowest (65 organisms per litre) at high water. Diatoms were the major river group and Cyanophyceae were dominant in the floodplain lakes. Aquatic macrophytes increased rapidly in lakes during flooding; 17 species were identified in 4 lakes including ~Eichhornia crassipes~, ~Oxycarium cubense~ and ~Paspalum repens~. The Orinoco basin contained at least 318 species and subspecies of freshwater fish, and the potential fishery was estimated as 45,000 tonnes per year. Hydrobiological data would be considered in plans for development programmes, but further information was needed particularly on the floodplain system, urban and industrial areas and the delta region. There are 65 references. -Venezuela- ; -Journal Paper- ; -Case Study-

Journal of Institution of Engineers (India), 1986, 67, No.CI3, 160-165.
$[1mEnvironmental$[0m aspects of $[1mhydro-electric$[0m and multipurpose projects in Himalayas.
R. I. SINGH (Multipurpose and Hydro-Electric Projects, Dehradun), and D. KUMAR.
Extensive investigations were being carried out to $[1massess$[0m the environmental impact of various $[1mhydro-electric$[0m and water exploitation projects in the Ganga-Yamuna valley. Particular studies carried out for the Tehri Dam Project, a storage scheme on the Bhagirathi river, a tributary of the Ganga river, are described. The scheme involved the construction of a 260.5 m high earth and rockfill dam and an underground powerhouse. The impact of the dam, reservoir and excavation works on the population, siltation rate, slope stability along the rim of the reservoir, flora, fauna and fishery is discussed. The need for an environmental balance to be maintained is emphasized. -India- ; -Journal Paper- ; -Case Study-

World Water and Environmental Engineer, 1991, January/February, 36-37.
The $[1menvironmental$[0m factor.
C. XUEMIN.
Land preservation, resettlement arguments and refuted $[1menvironmental$[0m $[1massessments$[0m were some of the problems besetting many large-scale hydrcpower development projects currently underway worldwide. Several million people had been relocated in over 150 large hydroschemes carried out in China during the last 40 years. Factors being considered in the planning of such schemes in China and in relocation planning and compensation costs are discussed. Problems were also caused by reservoir induced earthquakes. Following their introduction in 1980, most Chinese $[1mhydroelectric$[0m institutions now incorporated an established environmental impact assessment (EIA) section, required for all medium and large-scale proposals. -China- ; -Journal Paper- ; -General-

New Scientist, 1992, 134, No.1822, 12-13.
British aid: a hindrance as much as a help.
F. PEARCE.
Despite initial aims of U.K. investment in irrigation and hydroelectric projects in Africa, such as the Bura Irrigation Project in Kenya, established with funding from the World Bank and the U.K.'s Overseas Development Administration (ODA), many projects had proved to be costly failures. The performance of U.K. aid projects had been assessed in a recently published report from the National Audit Office Overseas Aid: Water and Environment', evaluating the economy, efficiency and effectiveness of government departments. Causes of those failures were primarily inefficient financing and management, exacerbated by poor project appraisal and lack of surveys on environmental impact and social implications. Problems caused by these failed schemes, often resulting in conditions worse than those initially, are examined with reference to projects in Africa and Pakistan. -International-Journal Paper-Case Study-

Archiv fur Hydrobiologie, 1992, 124, No.4, 451-458.
Cadmium, copper and lead in sediments and aquatic macrophytes in the lower Nelson river system, Manitoba, Canada: II. Metal concentrations in relation to hydroelectric development.
E. PIP (Winnipeg University, Manit.), and J. STEPANIUK.
The concentrations of cadmium, copper, and lead in sediments and aquatic plants at sites in the lower Nelson river, upstream and downstream from 3 major hydro-electric dams were studied. The proportion of coarse sediment particles and the copper content of the sediments increased at the downstream sites, and these sites also had the lowest mean community species richness. The concentration of copper and cadmium in macrophytes were significantly greater at downstream sites, particularly in mid-July, but filamentous algae showed no significant variation in metal content between upstream and downstream sites. Metal cycling in downstream communities was important when assessing the environmental effects of hydro-electric developments. -Canada- ; -Journal Paper- ; -Case Study-

Alternative Energy Sources III, 1983, 9, 279-297.
A comparison of environmental issues related to development of small hydropower resources at new versus existing sites.
J. M. LOAR (Oak Ridge National Laboratory, Tenn.), and S. G. HILDEBRAND.
The potential environmental consequences of developing small hydropower resources at existing dam sites are compared to those at new sites. Many of the effects were common to both, such as blockage of fish migration routes, water level fluctuations, inadequate streamflow, altered water quality, dredging and dredged material disposal and altered aquatic and terrestrial habitats. However, the impact from development of new sites was likely to be greater because at existing sites environmental changes had already taken place. The assessment of environmental impact was more difficult for new sites. Mitigation of adverse impacts by changes in design or operation depended on accurate predictions of environmental effects. There is a bibliography of 45 references. -U.S.A.- ; -Journal Paper- ; -Review-

World Water, 1988, 11, No.1, 44-45 and 47.
Smaller schemes may bring more risk.
J. M. JEWSBURY (Liverpool School of Tropical Medicine), and A. M. A. IMEVBORE.
The increasing commitment of the World Bank to assessing the impact of new development projects on ecology and health was mainly with schemes of

sufficient size to require international funding. These included hydroelectricity and large irrigation projects. However, there was a need for environmental health and assessment at all levels of water impoundment and use. The scale of issues involved in this assessment is illustrated with data from case histories from Nigeria. Guidelines for a comprehensive programme of research on which to base future policies are presented.
-U.K.- ; -Journal Paper- ; -Theoretical-

Regulated Rivers: Research and Management, 1988, 2, No.3, 277-292.
Hydropower development on rivers in Scotland.
F. G. JOHNSON (North of Scotland Hydro-Electric Board, Edinburgh).
The U.K.'s limited hydropower resources was concentrated in Scotland. About 4000 GWh were produced each year. The greater part of the Scottish schemes, most of which were constructed between 1945 and 1965, were of the reservoir storage type, though some pumped storage schemes had been built more recently. Two pumped storage schemes (Ffestiniog and Dinorwic) had also been built in Wales. The current performance of these schemes, including environmental aspects, are considered, and the prospects for further projects, including run-of-river schemes, is assessed. -U.K.- ; -Journal Paper- ; -Review-

National Water & Soil Conservation Authority, Wellington, Miscellaneous Publication No.103, 1987. 230 pp. (41217).
Lake managers handbook.
W. N. VANT (editor).
The behaviour of lake ecosystems and the factors determining changes in water quality, productivity, vegetation, littoral characteristics and other features are discussed to provide a sound background for an assessment of lake management practices. Various aspects of the management of freshwater lakes in New Zealand are considered including discussions of changes that had occurred in recent times due to raising or lowering of the water level and the utilization of lakes for hydroelectric power generation. The objective was to enable the natural resources of upland and lowland lakes to be used effectively without impairing the quality of the environment, including the maintenance of fish populations, wildlife habitats, and ecological communities in a manner which preserved both the useful and attractive features of the water body and lakeside amenities. -New Zealand- ; -Report- ; -Case Study-

World Water, 1989, 12, No.7, 15-16.
A changing approach to reclamation of the West.
R. OPIE.
The U.S. Bureau of Reclamation (BuRec) established in 1902 to provide irrigated agricultural land in the 18 westernmost states, was adopting an essentially managerial role following the 1987 $[1mAssessment$[0m of water and power programmes. The trend away from large construction projects was due to the economic situation and increased $[1menvironmental$[0m awareness, and three quarters of BuRec's federal construction funds were allocated to the Central Arizona project, the Central Utah project and the Dam Safety programme. Most of the 521 water structures built by the Bureau, including Grand Valley, Strawberry Valley and Weber basin $[1mhydropower$[0m stations on the Colorado river would be transferred to non-federal control, but a few projects such as the Colorado River Storage project would remain under federal management. Major changes to existing structures planned up to 1992 included replacement and updating of many $[1mhydropower$[0m stations, control of water temperature below the Shasta dam on the Sacramento river, reversal of groundwater depletion

on the central California coast and pollution control projects in the mid-Pacific region. Future emphasis at BuRec would be on increasing efficiency and optimizing water supply and utilization. -U.S.A.-Journal Paper-General-

New Scientist, 1992, 133, No.1808, 50-54.
The hidden cost of Canada's cheap power.
P. RAPHALS.
The actual and potential environmental consequences of Hydro-Quebec's hydroelectric power schemes are explained. Around 10,000 MW came from the La Grande project which had diverted 3 major rivers and flooded 10,000 km2 of land. Two further projects were planned in adjoining catchments; they would add 11,500 MW capacity and flood 10,000 km2. The Cree were opposing the developments in the courts. One serious result of the reservoirs was the mobilization of mercury from the rocks as methyl mercury by the introduction of organic matter. The element had entered the food chain and caused the Cree, whose diet was high in fish, to be brought close to subacute mercury poisoning. Human hair samples had 10 times the WHO standard of 6 ppm mercury. Estimates of when the mercury would attain safe levels were 20-100 years. Another concern was the greatly increased flow of fresh water into Hudson bay with unknown effects on the ecology and ultimately, many important fisheries. An exhaustive environmental assessment was required before further schemes were undertaken. -Canada- ; -Journal Paper- ; -Case Study-

Regulated Rivers: Research & Management, 1993, 8, No.1/2, 5-14.
Quantification of daily peak hydropower effects on aquatic fauna and management to minimize environmental impacts.
O. MOOG (State Agriculture University, Vienna).
The adverse effects of pulse releases of water arising from intermittent peak generation of power on fish and benthic invertebrates were assessed by surveys in 4 Austrian rivers. A long section of river was disturbed, reductions in benthic invertebrate biomass of 75-95 per cent being observed in the first few km. A reduction of 40-60 per cent of biomass was detected within 20-40 km compared with undisturbed areas. Fish were similarly affected. Flushing, food depletion, catastrophic drift and habitat change were the primary causes of the depletion. Constraints on power generator's operations and modifications to discharge regimes were required to avoid extremely low and high flows. Balancing of flows by management of existing reservoirs or construction of buffer reservoirs would also be beneficial. There are 83 references. -Austria- ; -Journal Paper- ; -Experimental-

Water Resources Bulletin, 1993, 29, No.1, 107-117.
Use of a hydrologic model in a basin-wide water allocation proceeding.
L. S. DOLAN (Montana Department of Natural Resources and Conservation, Helena), and D. K. DeLUCA.
A PC-based hydrological model of the 54,000 mile2 upper Missouri river basin included irrigation, municipal, dam and reservoir and streamflow components. Data required for an Environmental Impact Statement (EIS) to determine the effects of water reservation applications were computed for a 59 year base period using a mass-balance approach. Simulation of monthly streamflow and reservoir operations for the 6 alternative water resource planning decisions examined enabled quantification of potential impacts for hydropower production and recreation values. Model results were used qualitatively for fisheries and wildlife resources where impacts could not be quantified directly. Graphical presentation of model-estimated streamflow informed decision makers and the

general public of the environmental consequences involved. The assessment of cumulative effects in the EIS was limited because only 35 sites could be modelled accurately and because of uncertainties inherent in simulation modelling; the results of sensitivity analyses were included in the EIS. -U.S.A.- ; -Journal Paper- ; -Theoretical-

Water & Pollution Control, 1992, 130, No.1, 16.
Swedish technology - building an invisible power plant.
The environmental stipulations governing the construction of a hydroelectricity generating station in Sweden and the means adopted to satisfy them, are described. Ecological investigations were pursued, to assess the environmental impact of reducing streamflow; when this was found satisfactory, other requirements (such as maintaining fish stocks, permitting continued reindeer migrations and not marring the landscape) were dealt with. For the Klippen works, no major dam would be built, the works would be subterranean and the tunnel leading water to it would be drilled, not blasted. A series of low dams would be built across the stream, to form shallow pools which would be stocked with fish and a bridge would be built at the traditional reindeer crossing point to permit continued passage by Lapps and their herds. The spoil from the tunnelling (11 km at a mean of 6.5 m diameter) would be used partly to extend an airfield and partly to form artificial hills, which would be grassed over. The project would be completed by 1994. -Sweden- Journal Paper-Case Study-

$[OmWater Science and Technology, 1984, 16, No.1/2, 281-295.
Integration of ecological and engineering aspects in planning large-scale tidal power development in the Bay of Fundy, Canada.
D. C. GORDON (Bedford Institute of Oceanography, Dartmouth, N.S.) .
For many years, the possibility of using tidal power in the Bay of Fundy for electricity generation has been considered, and a number of feasibility studies (which are outlined) have been carried out, but have not been implemented because of the cost. However, it now appears that large-scale development in the upper part of the bay could be economic, and a pilot-scale project is under construction. The author reviews the proposed scheme and summarizes the results of basic studies to assess possible environmental effects; fuller investigation of such effects will be made before final decision on the scheme is taken. -Canada- ; -Journal Paper- ; -Case Study- ; Fundy, bay of

[OmWater Science and Technology, 1984, 16, No.1/2, 307-317.
Assessing the environmental impact of the Annapolis tidal power project.
W. G. TIDMARSH (Martec Ltd, Halifax, N.S.) .
The author describes the pilot-scale project for power generation on the Annapolis estuary N.S. , (see preceding abstract) , and reviews the results of studies on the environmental effects of the existing tidal barrage which will serve as a dam for the power scheme. Aspects of particular concern were release of suspended solids from disposal of till removed during excavations, bank erosion and bottom scour resulting from sluice-gate and power plant discharges, passage of migratory fish through the barrage and flood-flow management. It was concluded that although measures could be taken to minimize interference with drainage from adjacent marshlands and to assist fish passage upstream, there was insufficient information about possible fish mortalities in the turbine, and further studies are required. -Canada- ; -Journal Paper- ; -Case Study-

Water International, 1984, 9, No.1, 10-17.
Assessment of the environmental effects of constructing the Three Gorge Project on the Yangtze River.
J. F. LaBOUNTY (Engineering and Research Centre, Denver, Colo.).
The possible environmental effects of the Three Gorge Project on the Yangtze river, whose primary objectives are flood control on the middle and lower reaches, and hydroelectric power and water for irrigation and aquaculture development, are described. The potential drawbacks of relocation of people, loss of habitat for aquatic life and reduced nutrient inputs to downstream and estuarine fisheries are highlighted and possible solutions suggested. The ecology of the resulting reservoir and its differences in terms of water quality compared with the river are considered.
-China- ; -Journal Paper- ; -Case Study- JN - Water International 1984

Alternative Energy Sources III, 1983, 9, 279-297.
A comparison of environmental issues related to development of small hydropower resources at new versus existing sites.
J. M. LOAR (Oak Ridge National Laboratory, Tenn.), and S. G. HILDEBRAND.
The potential environmental consequences of developing small hydropower resources at existing dam sites are compared to those at new sites. Many of the effects were common to both, such as blockage of fish migration routes, water level fluctuations, inadequate streamflow, altered water quality, dredging and dredged material disposal and altered aquatic and terrestrial habitats. However, the impact from development of new sites was likely to be greater because at existing sites environmental changes had already taken place. The assessment of environmental impact was more difficult for new sites. Mitigation of adverse impacts by changes in design or operation depended on accurate predictions of environmental effects. There is a bibliography of 45 references.
-U.S.A.- ; -Journal Paper- ; -Review-

Regulated Rivers: Research & Management, 1990, 5, No.4, 305-317.
The downstream impacts of the Burgomillodo reservoir, Spain.
J. A. CAMARGO (CIT-INIA, Madrid), and D. G. de JALON.
Environmental impacts of the construction of the Burgomillodo dam and reservoir in the middle Rio Duraton, northern Spain, for hydropower generation purposes were assessed in terms of the physico-chemical characteristics and aquatic communities of an upstream and 3 downstream sites. Downstream from the reservoir, water temperature, pH and dissolved oxygen were significantly lower, while hardness, alkalinity, suspended inorganic matter and conductivity showed reduced annual variability. Overall, the impacts on the downstream ecosystem were adverse, including a decrease in species richness, density and biomass of the zoobenthic community, although species richness and abundance of macrophytes increased just below the dam. There are 51 references. -Spain-

Sewage Treatment Works - extension and installation

$[0mJ. of Wat. Pollut. Control Fed., 1975, 47, No. 11, 2694-2701
Environmental effects of advanced waste-water treatment at South Lake Tahoe.
D. C. ANTONUCCI and F. D. SCHAUMBURG .
Although the advanced waste-treatment plant at South Lake Tahoe, Calif., effectively removes organic matter and nutrients from the sewage, the application of these sophisticated treatment processes requires the use of significant amounts of energy and treatment chemicals, the production of which may have effects on the environment. In addition, several types of contaminant are discharged to the land and air as a result of the treatment operations. It is concluded that further research is required to assess whether advanced waste treatment processes effectively reduce the net level of degradation in the total environment.

Korrespondenz Abwasser, 1993, 40, No.8, 1274-1276 (in German, English summary).
Environmental compatibility of chemicals used in effluent treatment.
J. HAHN (Institut fur Wasser-, Boden-und Lufthygiene des Bundesgesundleitsamtes, Berlin).
The Institute for Water, Soil and Atmospheric Hygiene recently initiated a study of the detailed composition of chemicals used widely in the treatment of sewage and industrial effluents, to quantify the amounts of impurities and other ingredients which constitute a potential threat to the environment. The objectives and general scope of this long-term investigation are outlined, together with some of the chemicals which are due to be examined, such as technical grades of hydrochloric acid, polyelectrolytes, and heavy metals present in coagulants. These will be examined using high-resolution analytical methods and will also be tested in bench-scale biological treatment systems to assess the fate of the contaminants. The programme is due to commence in 1994. (English translation 125 pounds sterling, valid for 1993). -Germany-Review-

UM 1163 - ASSET MANAGEMENT PLANNING: INTERIM $[1mGUIDELINES$[0m FOR PERFORMANCE AND CONDITION OF $[ImASSESSMENT $[0m OF WATER SUPPLY SYSTEMS
P LAMBERT - DECEMBER 1990
OBJECTIVES To investigate requirements and methods for the measurement of performance and asset condition in the new regulatory and business $[1menvironment$[0m.
REASONS The $[1menvironment$[0m in which utilities now operate has to balance the demands of new commercial pressures, the regulatory framework and statutory requirements. The requirements for monitoring, evaluating and reporting performance and asset condition is therefore of increased importance for the effective management of a utility. A proper balance needs to be struck between the resources required for gathering information and the benefits that accrue through its use.
CONCLUSIONS
(1) Condition and Performance measures should be considered within an overall framework where importance is also taken into account.
(2) Importance can be measured in a number of ways but in the context of this report two aspects are used: Strategic Classification, and Criticality. Strategic Classification is quantified on the basis of number of people potentially affected by failure of a system element (e.g. a treatment works) and incorporates their degree of dependency on that element. Criticality looks at components within an element (e.g. a pumpset) and incorporates both immediacy and quality effects resultant from failure of that component.

(3) Performance measures must include those required by the regulators, but companies will also require additional measures of technical and financial performance of systems. Technical performance will include measures of adequacy, reliability, timeliness, quality, compliance, and public expectation and opinion. Financial performance will include measures of effective use and efficient operation.
(4) Action to improve condition should not be determined on the basis of condition alone except where safety or regulatory requirements dictate. An empirically based condition grading system has been developed for the main types of asset.
(5) Strategies for $[1massessing$[0m and monitoring condition are required, and must take account of importance and performance. This is because it is uneconomic to measure everything. Initial $[1massessment$[0m is likely to be 'problem driven'. Monitoring to detect changes in condition must take account of the type of asset and the type of deterioration expected.
(6) The information collected when implementing the approach described in these Guidelines will provide a significant input to the job of investment planning. Further study could usefully be carried out of the varying types of deterioration for different types of asset to establish, if possible, the economic break-even points between condition grade, deterioration and replacement,
RECOMMENDATIONS
The approach described in these $[1mGuidelines$[0m for a water supply system should be extended to cover a sewerage and sewage treatment system. Further work should then be carried out to prove the methodologies. This should be carried out in a number of successive stages:
(i) Trial the $[1massessment$[0m of strategic classification and criticality by examining a typical water supply system and a typical sewerage catchment area.
(ii) Carry out a trial condition $[1massessment$[0m exercise on representative elements of the study areas.
(iii) Produce asset condition summaries, priorities for investment, efficiency and utilisation reports on representative elements of the study areas.
RESUME OF CONTENTS
The $[1mGuidelines$[0m are separated into three volumes. Volume 1 gives an Introduction and sets out the concepts of Strategic Classification, Technical and Financial Performance, Criticality of components and Condition Grades. Volume 2 sets out the way in which the various concepts can be applied progressively to focus on the highest priority areas or items. At each step refinement of the selection criteria is possible. Policies for updating information are also covered.
Volume 3 gives detailed Condition Grade criteria for different types of asset, ways in which actual and forecast condition of assets can be summarised and presented and concludes with ways in which the various performance measures and condition grades can be applied to individual system elements.

Ingegneria Ambientale, 1989, 18, No.7/8, 406-418 (in Italian, English summary).
Environmental impact $[1massessment$[0m of water pollution control projects: example of applications to the southeastern area of Etna.
S. DE ROSA, C. BOSCO LO GIUDICE, and F. PATERNO DEL JOSCANO.
A methodology is proposed for environmental impact $[1massessment$[0m (EIA) which expressed the total value of the impact, induced on the $[1menvironment$[0m by projected schemes, through synthetic quantitative indices strictly correlated to the variables in the project. A provisioned weighting of between 0 and 1.0 was applied either to each single component or

to groups of $[1menvironmental$[0m components having the same type of impact. Components considered were wastewater disposal, alternatives to the landscapes, roadworks, land area involved, noise pollution, and costs. The method was applied to 4 schemes for sewage treatment and disposal in an area of Sicily, including Catania and Acireale, where tourism was an important source of income. Maps of the sewer networks, types of treatment plant and their location, and proportion of population served by each are presented, with tables including indices for road conditions during sewer $[1mconstruction$[0m, areas affected by $[1mconstruction$[0m noise, land required, capital and operating costs for each scheme, and the final EIA results with individual weightings and calculated indices. The method was rapid and clear encouraging public participation in decision making thus diminishing opposition to proposed schemes (English translation 475 pounds sterling, valid for 1990). -Italy- ; -Journal Paper- ; -Case Study-

Korrespondenz Abwasser, 1988, 35, No.11, 1164-1167 (in German, English summary)
Pollutant load calculations with the SMUSI experimental programme.
E. FREUND (Hessisches Ministerium fur Umwelt-und Reaktorsicherheit, Weisbaden), T. BRANDT, D. JACOBI, and H. ZAISS.
The pollution load simulation model SMUSI was developed at the Water Engineering Institute of Darmstadt Technical University at the instigation of the $[1mEnvironmental$[0m Agency for the State of Hesse, to be used as an evaluation tool by the Hesse water management authorities. Previously no legally recognised procedure had existed by which $[1mconstruction$[0m schemes and tenders for combined sewer installations could be $[1massessed$[0m, and the SMUSI programme was designed to fulfil this function as a means of checking the extent and volume of sewage pollution to be dealt with in the context of new sewerage projects. A description of the general content and structure of the model with details of the relevant variables is given together with an indication of how it could be employed. -West Germany - Journal Paper-

Public Works, 1991, 122, No.2, 50-51.
Coastal community integrates GIS for resource management.
V. SPEED.
The selection, $[1mconstruction$[0m and integration of a Geographical Information System (GIS) in the development and improvement of wastewater facilities for Barnstaple, Mass, is described. Services required included planning, needs $[1massessment$[0m, sewer data, database design and a pilot study, with CAD hardware and software and the ability to link up with outside bodies. Projects proposed as GIS ventures are discussed including analysis of $[1menvironmental$[0m degradation in local estuaries, automated mapping for tax $[1massessment$[0m, landfill monitoring, endangered wildlife studies and population growth management. -U.S.A.- ; -Journal Paper- ; -General-

Public Works, 1991, 122, No.5, 71 and 98.
Fast track design keeps sludge plan on course.
A new sludge dewatering facility for Westchester County, N.Y., was planned, environmentally assessed, designed and was now under construction within severe time constraints and space limitations to meet the critical construction timetables set by the 1988 Ocean Dumping Ban Act. The new facility, located at the existing Yonkers Joint treatment works, incorporated 4 high solids advanced dewatering centrifuges, liquid sludge pumping and mixing systems, dewatered sludge pumps and pipelines, polymer feed systems, centrate pumping, dual odour control systems (mist scrubbers and carbon adsorption) and a complete

instrumentation and control system. Dewatered sludge was transferred by pipeline rather than open conveyors to prevent odours. Relative capital, operating and maintenance costs for the various units are discussed.
-U.S.A.- ; -Journal Paper- ; -Case Study-

Environment International, 1992, 18, No.1, 3-9.
From data warehouse to information craft shop: the changing shape of information support for environmental protection.
M. K. SPARROW (Harvard University, Cambridge, Mass.).
Changes in the environmental protection strategies within the U.S.A. are examined. Emphasis was moving from productivity to environmental quality, and from abatement to prevention. The effects of these changes on the relationships between federal and state environmental protection agencies and on the information support required are discussed. The coordination and integration of data collection for the State/EPA data management programme, a major nationwide initiative to transform the style of information management within the environmental community is described. The programme comprised: establishing on-line connections to 7 databases on emissions, aerometric data, air compliance data, sewage treatment plant construction, water quality data, permit compliance data and hazardous waste data; and data integration to support decision making, use of geographic information systems and support of toxic substances and risk management programmes. The extent to which this initiative supported the emerging strategies is assessed and its effect on interagency cooperation evaluated. Future implications for the programme are considered.
-U.S.A.- ; -Journal Paper- ; -Review-

Rheinhaus Westfahlian Technische Hochschule, Aachen, Report No.108, 1988. 367 pp (in German).
Odour emissions from sewage works.
F. B. FRECHEN.
A comprehensive review is presented of the nature and sources of foul odour emissions from sewage treatment plants, factors governing their intensity and methods of treatment for exhaust gases as a means of odour elimination. The survey commences with an outline of the physiological basis of odour detection, and methods of measurement using both sensory and analytical procedures. A review of previously published reports on odour control and prevention is given followed by an account of measurements and surveys performed in order to identify the principal technical, climatic and topographical features affecting the level of public nuisance resulting from sewage works odours. Detailed accounts of the design of exhaust gas treatment systems are presented, involving the use of biofilters, injection of $[1mwaste$[0m gases into the aeration tank, chemical scrubbing, active carbon filtration, exhaust gas combustion, and the relative efficiencies compared. Finally, conclusions and recommendations are outlined comprising the methods for factory $[1massessment$[0m of the level of odour emissions, possible countermeasures for complying with legal and $[1menvironmental$[0m quality standards and the selection of appropriate exhaust gas treatment systems. -West Germany- ; -Report- ; -Review-

GWF-Wasser/Abwasser, 1993, 134, No.8, 474-481 (in German, English summary).
EIA of sewage treatment plants - the importance of the assessment process and its impact on the official decision.
G. FEHR (Ingenieurgemeinschaft agwa, Hannover), and M. JURGING.

The conduct of an environmental impact assessment (EIA) under the terms of the latest German legislation for new or enlarged sewage treatment facilities is discussed. The manner in which the process was conducted had an important bearing on the outcome; by involving the relevant official environmental assessors in the nature and scope of the investigation it was possible to achieve a much clearer and more definitive view of the consequences of proceeding with a particular scheme or some other system. In this way it became possible to compare like with like'. The procedure and the yardsticks by which the consequences could be assessed are illustrated with reference to 3 case studies. (English translation 360 pounds sterling, valid for 1994). -Germany- ; -Journal Paper- ; -Review-

Redevelopment of contaminated land

$[0mHeavy metals in the Environment, International Conference, Amsterdam - September 1981, CEP Consultants Ltd, Edinburgh, 1981, 254-258. (15D EUR).
The development of a bacterial indicator system to assess bioavailability of metals in contaminated land.
B. H. OLSON , (University of California, Irvine) , and I. THORNTON .
Bacterial cultures were prepared from five samples of metal-contaminated soil obtained from reclaimed pasture on the site of abandoned zinc mines at Shipham, Somerset England. The soils contained from 30 to 800 ug per g of Cd, 6 per cent Zn and about 1 per cent Pb; two control samples were also taken from pasture overlying the dolomitic host rock. The resistance of the indigenous bacterial populations to various concentrations of lead , zinc and cadmium, either singly or in combination, was evaluated in the laboratory. In single metal assays the descending order of toxicity was Cd, Zn, Pb; when a combination of metals was employed in the screening media, the resistance patterns of the bacterial populations were similar to those previously observed, but the percentage of the sensitive population was larger. Generally as metal concentration in the soil increased, the proportion of the autochthonous bacterial population which exhibited resistance decreased, hence multiple metal inputs to the environment can be expected to have a greater inhibitory effect on the natural bacterial populations than single metal inputs. -U.K.-

$[0mPublic Health Engineer, 1982, 10, No.4, 195-201.
2. The development of contaminated land.
M. A. SMITH (Building Research Establishment) .
Contaminated land is defined as land containing material that can be hazardous to man, the environment or buildings and general review of the problem is presented. General guidance is given on the problems of site investigation, site assessment and remedial action, with case histories described to illustrate some practical problems. The need for a multidisciplinary approach is illustrated by the example of the reclamation of site of a disused gas works, which posed a number of chemical, hydrological and environmental problems. The work in this connection of the Building Research Station, the Interdepartmental Committee on the Redevelopment of Contaminated Land and the Construction Industry Research and Information Association, is discussed. -UK-

Welsh Office, 1984. 95pp. (37749).
Survey of contaminated land in Wales: final report.
This report is the product of a survey conducted at Liverpool University on the methods of identifying contaminated sites on a regional scale, using Wales as a prototype area because of its prolific history of industrial activity and diversity of natural landscape. For the purpose of the survey, contaminated land was considered to consist of land which contained material presenting a potential hazard to site users, present or future, or to site developers, the natural environment and building structures. The final report contains accounts of both the methodology and its application to the specific region under consideration. No field sampling was involved and hence the scale and extent of contamination would require assessment on site. -U.K.-Report-Case Study-

L'impresa Ambiente, 1990, No.1, 42-46 (in Italian).
Techniques for recovery of contaminated areas.
E. D. F. FRANGIPANE (Politecnico di Milano, Italy), and G. ANDREOTTOLA.
After reference to contaminated sites in U.S.A., Great Britain, Germany and the

Netherlands, the principal characteristics of such sites are tabulated and types of operation available for their recovery are reviewed. The soil might be excavated and treated on- or off-site, then redeposited; this was often costly and too hazardous. Treatment might be direct in-situ with no excavation, the site might be isolated by physical barriers. The most appropriate treatment would depend on physico-chemical characteristics and should be preceded by an accurate site study, characterization of the contamination, and $[1massessment$[0m of risk to man and/or the $[1menvironment$[0m. Tables are presented giving possible thermal, extractive and microbiological treatments and their suitability for treating sandy and muddy $[1mland$[0m $[1mcontaminated$[0m by hydrocarbons (aliphatic, aromatic, polynuclear, halogenated), pesticides, heavy metals and metalloids, cyanides. In-situ treatment, though less expensive and preserving site integrity, had restricted applicability, substances used for purification could be left behind in the ground, becoming contaminants in turn, and it was impossible to check the extent of recovery. -International- ; -Journal Paper- ; -Review-

Proceedings 39th Industrial Waste Conference, Purdue University, 1984, 291-303.
Biological treatment required for clean-up of contaminated ground water at a hazardous waste dump site.
E. L. STOVER, D. F. KINCANNON, and T. S. MANICKAM.
Work is described by the New Hampshire Water Supply and Pollution Control Commission to contain and clean up the groundwater pollution that has occurred at the Gilson $[1mRoad$[0m Hazardous Waste Site. A feasibility $[1massessment$[0m completed in January 1982 was funded by the U.S. Environmental Protection Agency under the Comprehensive $[1mEnvironmental$[0m Response, Compensation and Liability Act of 1980 (Superfund). The first phase of the management of containment at the site consisted of installation of an impermeable surface cap and of a bentonite slurry cut-off wall around the site. The primary consultants retained Environmental Engineering Consultants Inc. to participate in the second phase of investigation, design and building of a groundwater treatment system to reduce groundwater contamination to acceptable levels. Contaminants found in nearby wells included volatile organics, extractable organics and heavy metals. Detailed results are given of biological treatability studies conducted with activated sludge, aerated lagoon and rotating biological contactor systems. -U.S.A.-Conference Paper-Case Study-

Martinus Nijhoff, Dordrecht, 1986. 923 pp. (39768).
Contaminated soil: First International TNO Conference on Contaminated Soil, 11-15 November 1985, Utrecht, the Netherlands.
J. W. ASSINK (TNO, Apeldoorn, Netherlands), and W. J. VAN DEN BRINK, (editors).
The problems connected with the migration of pollutants in contaminated soils, the assessment of fine and toxic hazards and methods for reclaiming contaminated sites formed the basis of over 100 papers contributed to this symposium. The papers are grouped into sections considering the behaviour of specific contaminants, the impact of contaminants on public health and the environment, the role of governments and other authorities in instituting remedial action, techniques of site investigation and analysis and the management of remedial action and risk assessment. Some typical case histories concerning the rehabilitation of dump sites and abandoned refuse tips are discussed, and details of the extent of soil, sediment and water contamination arising as a consequence of chemical waste disposal are included.
-International- ; -Conference Proceedings- ; -General- ; the soil

Railways

No suitable references were forthcoming for railways.

Waste disposal sites

$[0mWat. Pollut. Man. 1972, 105-110.
Marine pollution.
J. E. PORTMANN
In connexion with the increasing need for disposal of wastes in coastal waters, the author reviews, with a bibliography of 48 references, the effects of various types of waste waters on the marine environment, including effects on marine organisms, and public health hazards, and concludes that effects are localized except for substances which are accumulated in the food chain (the effects of which can be assessed by routine monitoring of food species or sensitive indicator species) and nondegradable substances which may have biological effects far from the disposal site.

$[0mChem. Engng Prog. Symp Ser., 1971, 67, No.107. 616 pp. dollars 15.
Water-1970.
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
This publication, concerned with progress in the control of pollution in the aquatic environment, contains most of the papers presented at meetings of the American Institute of Chemical Engineers during 1970. Aspects considered include the role of the chemical engineer in pollution control, eutrophication and assessment of eutrophication potential, river basin management, utilization of cooling water dispersion of pollutants, disposal of liquid and particulate wastes in the ocean, demineralization, secondary and advanced treatment of waste waters (including the kinetics of slime organisms, removal and recovery of phosphorus and other by-products, removal of heavy metals from mine drainage, treatment of various individual trade waste waters, joint treatment of sewage and trade waste waters, and re-use of effluent), and transport and disposal of sludge.

$[0mSludge, 1979, 2, No.4, 21-25.
Pharmaceutical industry sludge.
R. SWAN .
The problems caused by the diversity of wastes produced by the pharmaceutical industry are discussed. A wide range of organic chemicals and biological products are produced and the most common hazardous wastes are halogenated and non-halogenated solvents and organic chemical residues. Methods used for waste-water treatment, generally activated-sludge systems, treatment and disposal of wastes from botanical production, and the major problem of the 75,000 tons of mycelia produced annually by fermentation processes, are described. Research by the National Oceanic and Atmospheric Administration into techniques for analysing and tracking the pharmaceutical wastes dumped in the sea off Puerto Rico, and for assessing their environmental effects, is reported. -U.S.A.-

$[0mJournal of Hazardous Materials, 1980, 3, No.4, 285-291.
Some independent assessments of the Sealosafe/Stablex method for toxic waste treatment.
C. L. CHAPPEL , (POLYMERIC TREATMENTS LTD.) , and S. L. WILLETTS .
The SEALOSAFE method of toxic waste treatment, also cperated under the name of STABLEX, has been assessed by research workers in the U.K. and abroad. The method involves blending, homogenizing and pretreating a variety of wastes to

bring the waste mix to the desired condition prior to polymerization. An initial slurry is formed which sets to a hard, rock-like material which is described as environmentally inert. The research work was concentrated on claims about the product's permeability, structural integrity, environmental properties and most significantly its leaching characteristics. The results of the research offer considerable independent evidence to substantiate the claims of SEALOSAFE operators as to the leaching characteristics and environmental isolation of metals. -U.K.-

$[0mU.S. National Technical Information Service, Springfield, Va., Report No. PB 80-114291; U.S. Environmental Protection Agency Report EPA-600/9-79-023a, 1979. 426 pp. (02L WAN).
Municipal solid waste: land disposal. Proceedings of the Fifth Annual Research Symposium, held at Orlando, Fla. , March 26, 27, 28, 1979.
M. P. WANIELISTA , and J. S. TAYLOR , (editors).
This symposium, organized by the Solid and Hazardous Wastes Research Division of the U.S. Environmental Protection Agency , reviewed the current status of solid waste disposal methods in U.S.A. , with particular reference to municipal refuse and its behaviour in landfill sites. Topics covered include methods of identification of pollutants in leachate and gas released from sanitary landfills, an assessment of their effects on the environment, control methods for regulating migration of pollutants and studies of pollutant transport through the soil and underlying strata. -U.S.A.-

$[0mEnvironmental Health Perspectives, 1979, 33, 131-157.
Health and environmental impacts of increased generation of coal ash and FGD sludges. Report to the Committee on Health and Ecological Effects of Increased Coal Utilization.
C. J. SANTHANAM , (ARTHUR D. LITTLE, INC., CAMBRIDGE, MASS.) , R. R. LUNT , S. L. JOHNSON , C. B. COOPER , P. S. THAYER , and J. W. JONES .
The increasing environmental effects of coal ash and flue gas desulphurization wastes associated with increased coal usage by utilities and industry are predicted, based on data from 1977. Details of the present technology and production of coal ash and FGD sludges and their characteristics are given. Federal and state regulations for disposal on land and at sea, together with disposal and utilization options are outlined. The impacts are then assessed for each EPA region. The data indicate that with good control technology and implementation of existing regulatory frameworks, regional-scale impacts are likely to be small, but site-specific ones could be significant. Further data on radionuclides, trace metals, and other pollutants are required. -U.S.A.-

$[0mMAFF Directorate of Fisheries Research, Lowestoft, 1980, Fisheries Technical Report No.59, 40 pp. (P08E MUR).
The field assessment of effects of dumping wastes at sea: 7.
Sewage sludge and industrial waste disposal in the Bristol Channel.
L. A. MURRAY, M. G. NORTON , R. S. NUNNY , and M. S. ROLFE .
The authors present the results of surveys in the vicinity of the licensed dumping grounds in the Bristol Channel, to provide a baseline assessment of the area, especially the benthic zone, in physical, chemical, and biological terms, to identify the dispersal pathways and ultimate fate of the sediments and their constituents, and to identify any noticeable effects of dumping on the environmental and ecological characteristics of the affected areas. Sediments were analysed for organic content, micro-organisms and heavy metals. There appeared to be only slight changes in the nature of the benthos due to the

mobility of the sediments under the influence of wave action and tidal currents, coupled with the sparse nature of the indigenous flora. -U.K.-

$[0mIndustrial waste: proceedings of 13th mid-Atlantic conference, (edited by C. P. Huang), Ann Arbor Science Publishers, Inc., Ann Arbor, Mich., 1981, 533-536. (09A HUA).
Citizen response to industrial waste.
P. D. BUSH , (Valley Advocate newspaper) .
Several case histories of effective public protests against the siting or operation of waste disposal facilities in the U.S.A. are recounted to emphasize the strength of public protest movements, the speed with which public opinion can be harnessed in environmental causes, and in certain cases the perceptiveness of public assessment of the risk, compared with the slowness of regulatory officials to investigate or control a suspected nuisance. Pollution hazards have arisen from tank-truck washing operations, PCB disposal operations and lead-contaminated industrial wastes, which were suspected by local residents and subsequently confirmed by environmental surveys and analyses mounted in response to a public outcry in the affected communities. -U.S.A.-

$[0mJournal of Water Pollution Control Federation, 1984, 56, No.6, 654-664.
Power industry wastes.
T. J. CHU, and M. L. IWANSKI.
Giving a bibliography of 161 references, the authors review recent literature on wastes from the power industry, dealing with legislation in U.S.A. affecting the power industry (this is summarized in a table); assessment of the environmental impact of hydro-electric power plants, and selection of suitable sites; assessment of environmental impact of coal-fired power plants, their siting, disposal and utilization of ash, cooling systems and discharge of cooling water, and desulphurization of flue gas; assessment of environmental effects of nuclear power plants and treatment and disposal of the wastewaters; studies on fluidized-bed combustion; and utilization of waste heat. -U.S.A.- ; -Journal Paper- ; -Review-

Analysis of Organic Micropollutants in Water, Oslo, 1983, 242-254. (22B EUR).
The impact on the ecology of polychlorinated phenols and other organics dumped at the bank of a small marine inlet.
J. FOLKE (Water Quality Institute, Horsholm), J. BIRKLUND, A. K. SORENSEN, and U. LUND.
Leaching of penta- and tetrachlorophenols from a dump containing chemical wastes at the edge of the Holbaek fjord was investigated and its impact on the marine biota examined. The levels of chlorinated phenols were determined in samples of sea water, sediment and edible mussels (Mytilus edulis) obtained from a bay adjoining the mouth of the fjord. The general condition of the marine ecosystem was also assessed by a bottom survey along several transects at right angles to the shoreline. There were no signs of any acutely toxic effects due to the release of chlorinated phenols into the estuarine environment, and the levels of the two target compounds were only slightly elevated. Since their concentrations in the leachate were quite high, regular monitoring during the next 10 years was considered advisable.
-Denmark- ; -Conference Paper- ; -Case Study-

Water, Air, and Soil Pollution, 1985, 24, No.2, 153-164.
Effects of nickel addition on nitrogen mineralization nitrification, and nitrogen leaching in some boreal forest soils.
J. B. deCATANZARO (Toronto University, Ont.), and T. C. HUTCHINSON.

In the Northern Hemisphere, the large number of mining and smelting operations resulted in extensive contamination of forested areas by mine wastes and airborne smelter emissions. To assess the effect of this on the forest environment, field and laboratory studies were carried out of the effect of nickel, as an example of a toxic, smelter-emitted heavy metal, on the nitrogen cycle in the soil from forested areas. Under certain conditions, nickel at a concentration of 100 ug per g of soil stimulated nitrification, and at a concentration of 500 ug per g could stimulate mineralization of nitrogen. In general, rates of nitrification were low, but were higher in soils from the vicinity of a smelter than in uncontaminated soil. The numbers of nitrifying bacteria in uncontaminated soil were very low, but increased when nickel was added. Leaching of nitrate from soil columns was increased by addition of nickel.
-Canada- ; -Journal Paper- ; -Experimental- JN - Water, Air, and Soil Pollution 1985

Environmental Progress, 1985, 4, No.1, 61-65.
Effects of waste oil contamination.
S. METZLER (Franklin Associates Ltd., Prairie Village, Kans.), and C. JARVIS.
The environmental impact of using waste oil as a dust suppressant on roads was investigated. Potentially hazardous constituents found in waste oils were evaluated and dispersion models applied to assess the effects of evaporation, seepage, dust transport and rainfall runoff. In some cases sensitivity analyses were conducted. Deterioration of the environment could occur although the associated health risks were still being debated.
-U.S.A.- ; -Journal Paper- ; -Experimental- JN - Environmental Progress 1985

$[0mSubfile = AQLINE 1985 , User Ref = 85-3484 , Acc Date = 29-Jul-85
Water Pollution Control, 1985, 84, No.2, 251-261.
The treatment and disposal of complex organic effluents.
L. F. REYNOLDS (ICI plc, Brixham), B. R. H. WILLIAMS, and D. W. HARRISON.
In recent years, the chemical industry had been producing a greatly increased variety of compounds, many of which were speciality products produced in relatively small amounts. Many of these new compounds, such as pharmaceutical products, weedkillers, and pesticides, were biologically active, and careful control was necessary to avoid adverse environmental effects. The authors discuss the approach to these problems adopted by ICI, with reference to the management and assessment of wastewaters from production of speciality chemicals, possible sources and characteristics of the wastewaters, suitable methods of waste treatment, and final disposal. Some specific examples are outlined, and diagrams are included illustrating the decision process for environmental impact review of a new product, and a problem-solving procedure to determine the final effluent disposal route. Possible future trends for the control of chemical wastes are indicated.
-U.K.- ; -Journal Paper- ; -General-

U.K. Atomic Energy Authority, Harwell, Report AERE-R11496, 1985. 41pp. (38311).
A survey of the current potential analytical techniques for the speciation of radionuclides in nuclear waste repository groundwaters and simulation leachates.
P. M. POLLARD (U.K. AERE, Harwell).
An assessment of the radiological hazards created by the release of radionuclides from nuclear waste repositories to the environment required a knowledge of both the quantity and the chemical speciation of the nuclides

present. Current and potential analytical tools for determining the species present in repository groundwater and in simulated leachates are discussed. The relevant techniques are described and their relative advantages assessed. The methods comprised a range of electrochemical, spectrophotometric and physicochemical techniques, none of which could be expected to be entirely satisfactory over the complete range of sampling and environmental variables envisaged. Speciation methods worthy of further development are indicated and a programme of research suggested.
-U.K.- ; -Report- ; -Review-

Industrial Water Engineering, 1983, 20, No.1, 8 and 11-17.
Runoff from utility waste landfill to be recycled from detention basin to scrubber make-up.
J. J. LENTZ (Johns Hopkins University, Laurel, Md.).
As part of an evaluation of the site impacts of a proposed 600 MW extension of a power station in Maryland, an analysis was carried out on a plan to use runoff from the working face of the landfill for blended fly ash and scrubber sludge as seven-to-10 per cent of the scrubber make-up needs. The run-off would be captured in a lined retention basin to prevent contamination of the area by heavy metals and high total dissolved solids. Following a preliminary environmental assessment, an estimation of the expected runoff quality and a study of basin operation, a satisfactory design was evolved which balanced the basin capacity and the scrubber pumping rates with the scrubber make-up needs and the rate at which runoff was generated by precipitation.
-U.S.A.- ; -Journal Paper- ; -Case Study-

IBM Journal of Research and Development, 1972, 16, No.2, 117-129.
Subsurface hydrology at waste disposal sites.
R. A. FREEZE (IBM Thomas J. Watson Research Center, Yorktown Heights, N.Y.).
Sanitary landfill was quite promising in its ability to handle large waste loads with a minimum of contamination but waste lagoons, and deep-well injection of liquid wastes into geologic formations, resulted in irreversible subsurface pollution. In all cases the mechanism of pollution was an interaction between the pollutant source and the existing soil moisture and groundwater flow system. A mathematical model of the subsurface flow was developed which could predict this interaction and assess the impact on the environment of a proposed disposal site. It predicted transient and steady state subsurface flow systems in two or three dimensions and considered of both the saturated and unsaturated zones. It could be applied at the reconnaissance stage on a regional basis to analyse many alternative sites and at the chosen site to test the efficiency of various design alternatives and to provide guidance in the design of a monitoring system. The model predicted only convective transport and did not consider dispersion or hydrochemical reactions.
-U.S.A.- ; -Journal Paper- ; -Application-

Vodni Hospodarstvi, 1985, 35, No.10, 257-261 (in Czech, English summary).
Landfill leachates.
M. JANOVSKY (Ceskoslovenske stredisko pre zivotne prostredie, Bratislava), and E. PARRAKOVA.
Storage of wastes in controlled landfills in Czechoslovakia was considered (in terms of environmental protection) still a very acceptable and economic method of waste disposal. The storage emission and problems resulting from such landfills are considered. The quality of the leachate depended on the quality

of the landfill components. To study the effect of these components in a controlled manner, an artificial landfill was constructed to assess its impact on groundwater quality. Physical, chemical and biological characteristics of the artificial landfill are tabulated. (Full translation 108 pounds sterling).
-Czechoslovakia- ; -Journal Paper- ; -Experimental-

Journal of Environmental Quality, 1985, 14, No.4, 569-574.
Comparative toxicology of laboratory organisms for assessing hazardous waste sites.
W. E. MILLER (Corvallis Environmental Research Laboratory, Ore.), S. A. PETERSON, J. C. GREENE, and C. A. CALLAHAN.
Algae (Selenastrum capricornutum), daphnia (D. magna), earthworms (Eisenia foetida), microbes, wheat (Triticum aestivum), lettuce (Lactuca sativa), radish (Raphanus sativa), red clover (Trifolium pratense), and cucumber (Cucumis sativa) were evaluated as test organisms for determining the short-term toxicity of heavy metals (copper, cadmium, zinc), herbicides (2,4-D, esteron 99), and insecticides (aldrin, dieldrin, endrin). EC50 values for metals showed that algae and daphnia were most sensitive, followed by the Microtox test (Photobacterium fisherii), dissolved oxygen depletion rate tests (mixed sewage micro-organisms), and earthworms. Higher plants were most sensitive to 2,4-D. Differences in chemical formulation and commercial source influenced the toxicity of herbicides and insecticides in the algae and daphnia tests. The use of these screening-level terrestrial and aquatic bioassays to identify potential environmental hazards at waste sites is discussed with reference to the Western Processing site at Kent, Wash.
-U.S.A.- ; -Journal Paper- ; -Experimental-

H.M. Stationery Office for Environment Department, London, 1985. 29pp. (38258).
Disposal facilities on land for low and intermediate-level radioactive wastes: report on the consultation exercise on the draft principles for protection of the human environment.
This report is a summary of the major comments by various bodies on the Draft Principles for assessing the suitability of land disposal sites for waste radioactive materials in the low and intermediate level categories. The report focuses primarily on the various amendments to the original draft put forward by the various parties to the consultation exercise and is arranged under various headings relating to general issues, the Radioactive Substances ^ Act 1960, radiological protection, the Town and Country Planning ^ Act 1971, the Nuclear Installations Act 1965, site selection, the life of a disposal facility and international requirements. The major points are summarized, and the response of the government is printed alongside. The final text of the Assessment Principles, incorporating such amendments as were considered appropriate has been issued separately.
-U.K.- ; -Report- ; -Review- ; DOE, Scottish Office, DOE, Welsh Office ; DOE, Northern Ireland ; Ministry of Agriculture, ^ Fisheries and Food

H.M. Stationery Office, London, 1986. 80pp. (39232).
Assessment of best practicable environmental options (BPEOs) for management of low- and intermediate-level solid radioactive wastes.
The nature of low-level and intermediate-level radioactive wastes from nuclear establishments in the U.K. is discussed and 70 different types of waste identified. The quantities and characteristics of these wastes were evaluated against the various methods of disposal to arrive at a waste disposal strategy complying with safety limits and environmental considerations at the disposal

site. The best practicable environmental option for most low-level and short-lived intermediate-level waste was near-surface disposal in engineered trenches. The alternatives to this disposal method are discussed in the light of the attendant safety, economic and political considerations.
-U.K.- ; -Report- ; -Review-

Proceedings 38th Industrial Waste Conference, Purdue University, 1983, 261-271 (09A PUR).
A comparative assessment of incinerators versus landfills for hazardous waste management.
T. G. SHEA (Engineering-Science, Fairfax, Va.), and J. J. MAYHEW.
A comparison of incineration and landfilling for the disposal of organic, potentially hazardous chemical wastes, suitable for disposal by either method, is discussed. A typical synthetic waste mix was selected, with appreciable quantities of chlorinated aliphatic and aromatic hydrocarbons, plastics monomers and toluene polymers. The design of facilities for the two alternative methods is described, followed by a technical, economic and environmental evaluation of the two methods. No single best solution was obtained for all situations, the final choice being governed by local circumstances. Several areas of study requiring further research are listed.
-U.S.A.- ; -Conference Paper- ; -Case Study- ; chlorinated hydrocarbons

Quarterly Journal of Engineering Geology, 1986, 19, No.4, 375-388.
Groundwater management problems in abandoned coal-mined aquifers: a case study of the Forest of Dean, England.
P. J. ALDOUS (Bristol University), P. L. SMART, and J. A. BLACK.
The significance of mining activity for present day management of the water resources of the Forest of Dean is described, and an assessment is given of the previous effects of waste disposal based on historical data. The major collieries were abandoned in 1965, but the coal measures aquifers continued to be used. Careful planning of drainage routes prior to colliery abandonment was necessary to minimize environmental effects of acid and ferruginous discharges from poor quality water disposed to surface watercourses. Continued small-scale mining after abandonment could cause a deterioration in lined river channels which retard surface water infiltration. Safe disposal of wastes into voids in mined coal measure aquifers was possible, but prediction of hydrogeological behaviour of such aquifers was made difficult by unrecorded workings and the possibility of random collapse. There could also be uncertainty about the hydrological integrity of coal barriers. More detailed studies involving water tracing and borehole investigation of head conditions were necessary if adequate prediction of environmental impact was to be made.
-U.K.- ; -Journal Paper- ; -Case Study-

Chemical Society Review, 1986, 15, No.3, 291-307.
The environmental chemistry of radioactive waste disposal.
J. R. DUFFIELD (University of Wales Institute of Science and Technology, Cardiff), and D. R. WILLIAMS.
Risks posed as a result of the disposal of radioactive wastes are discussed in terms of possible threats to man and contamination pathways. Nuclear accidents although rare had a large immediate impact; contamination due to waste disposal occurred more frequently but with low impact on the environment. The chemistry of waste containment is discussed in terms of balanced retardation and release of radionuclides. Factors influencing the required amount of retardation

include groundwater, the aqueous speciation of radionuclides and sorption onto solid surfaces such as cement or clay. The identification of weak links in multibarrier systems using risk assessment techniques is discussed. Twelve speciation and other programs used in modelling and simulation techniques at UWIST are detailed. These include chemical speciation analysis, reaction path analysis chemical transport analysis and coupled reaction path/chemical transport programs. Calculation procedures and validation techniques are outlined. The equilibrium speciation of plutonium (IV) oxide dissolved in water/carbon dioxide solution is illustrated. Further research on radioactive waste disposal is required. -U.K.- ; -Journal Paper- ; -Review-

Hazardous Waste and Hazardous Materials, 1986, 3, No.3, 309-320.
A comparison of three risk assessment techniques for evaluating a hazardous waste landfill.
W. B. BUDD (Washington State University, Pullman).
Three risk assessment procedures were applied to an inactive waste disposal facility in eastern Washington: benchmark comparison, formal subjective analysis and the hazard ranking system. The site had previously been used for disposal of hazardous wastes from Washington State University from 1970 to 1980 and detailed records of all wastes materials disposed had been maintained. The site posed only limited hazard to humans and the environment under the benchmark comparison and formal subjective analysis. The hazard ranking system produced a wide range of values but in 90 per cent of the cases, these were not high enough to place the site on the National Priorities List. It was concluded that the multiple assessments might be required when using the hazard ranking system. The formal subjective approach was considered potentially useful in view of projected demands for future waste sight evaluations.
-U.S.A.- ; -Journal Paper- ; -Case Study-

American Journal of Epidemiology, 1985, 122, No.3, 418-433.
Community exposure to hazardous waste disposal sites: assessing reporting bias.
L. H. ROHT (Texas University, Houston), S. W. VERNON, F. W. WEIR, S. M. PIER, P. SULLIVAN, and L. J. REED.
The health status of residents of Calcasieu Parish, Louisiana, in which two hazardous waste disposal sites were located was surveyed in 1981-82 to study the effects of the sites on the environment and on the health of local residents. A nearby unexposed community was used as a comparison. Hypochondriasis and respondent's opinion about environmental effects of waste sites were used as indices to assess reporting bias. Air and water quality data showed little evidence of chemicals being released from the sites in hazardous concentrations. Data were analysed for association between symptom reports and indices of reporting bias. The prevalence of hypochondriasis did not differ appreciably by community. Residents near to one of the waste disposal sites who were of the opinion that the sites had an effect on the environment reported 2-3 times more symptoms on average than residents of the unexposed community. There was little difference in reported symptoms between exposed and comparison communities for residents who were of the opinion that the sites had no effect on the environment. The usefulness of self-reported symptoms in such studies was discussed. There are 32 references. -U.S.A.-Journal Paper-Experimental-

Water Science and Technology, 1987, 19, No.5/6, 1029-1036.
Evaluation of heavy metal leachability from solid wastes.
T. R. BRIDLE (Environment Canada, Burlington, Ont.), P. L. COTE, T. W. CONSTABLE, and J. L. FRASER.

Experiments have been carried out to develop methods for assessing the leachability of heavy metals from solid wastes, based on intrinsic properties of the waste, such as metal solubility and speciation. Data obtained for different types of waste, including sewage sludge (before and after incineration), ashes from incineration of municipal solid wastes and hazardous wastes, power plant ash, and a solidified synthetic waste. The results showed that incineration of sewage sludge significantly reduced the environmental availability of most of the heavy metals in the ash; such ash would therefore be acceptable for landfill disposal. In contrast, metals were readily leached from ashes from incineration of municipal solid wastes and hazardous wastes; over 80 per cent of cadmium and 40 per cent of zinc in these ashes was water-soluble. Such ashes would, therefore, need to be solidified prior to land disposal. Power-plant ashes exhibited moderate metal leachability, but had a significantly lower metal content.
-Canada- ; -Journal Paper- ; -Experimental-

Chemosphere, 1986, 15, No.7, 947-957.
Environmental monitoring for PCB and trace metals in the vicinity of a chemical wastes disposal facility - III.
K.BADSHA (ReChem International Ltd., Southampton), G.EDULJEE, and N.SCUDAMORE
The waste treatment plant of ReChem International Ltd at Fawley provided facilities for chemical treatment and incineration of a wide variety of chemical wastes. A monitoring programme to assess the environmental effects of gaseous emissions from this plant is described. Diagrams showing wind directions and sampling locations are included, and tabulated data are presented on the concentrations of trace metals and polychlorinated biphenyls in soils and foliage August 1984 - March 1986. Statistical analysis of the data indicated that the concentrations of the pollutants were within the background level found at other sites, and were not affected significantly by any point source emissions within the study area. -U.K.- ; -Journal Paper- ; -Case Study-

Health Physics, 1987, 53, No.5, 473-486.
An improved environmental pathway model for assessing high-level waste repository risks.
C. M. MALBRAIN (WasteChem Corporation, Paramus, N.J.), and R. K. LESTER.
A model was developed to show the environmental effects and radiological risks after closure of a high-level nuclear waste repository. The buildup of radionuclides in the biosphere is described and allowed the analysis of prolonged releases potentially associated with geologic waste repositories. The predicted population risks associated with release of particular radionuclides over a long time might be significantly altered by this model. The model was compared with the U.S. EPA biosphere model.
-U.S.A.- ; -Journal Paper- ; -Theoretical-

Pollution Equipment News, 1988, 21, No.1, 93-97.
Mobile waste processing systems and treatment technologies.
W. GLYNN, A. LORE, C. BAKER, and A. QUAGLIERI.
This article, based on a book published by Noyes Publications, U.S.A. gives an assessment of the applicability, design and operation of mobile treatment systems which could be designed and operated to handle almost any waste processed by permanent units. The U.S. EPA provided guidelines on mobile systems use covering waste characteristics, site constraints, potential environmental impacts, costs and technology support requirements. The importance is stressed of identifying the favourable and restrictive

characteristics of wastes with respect to each treatment system. Consideration should be given to whether a particular technology could handle a variety of wastes, whether non-toxic waste components would cause fouling or plugging of equipment, and whether wastes need pretreatment. Details are given of the processes of liquid injection incineration, fluidized bed incineration, infrared incineration, plasma arc technology, the advanced electric reactor (also known as the high temperature fluid wall), supercritical water oxidation and wet air oxidation.
-U.S.A.- ; -Journal Paper- ; -Review-

Lewes Publishers, Inc., Chelsea, Mich., U.S.A., 1985. 418 pp. (39633).
Management of toxic and hazardous wastes.
H. G. BATT, R. M. SYKES, and T. L. SWEENEY (editors).
Papers presented at the Third Ohio Environmental Engineering Conference, held at Columbus, Ohio, in March, 1983, are given. Thirty five papers are divided among eight sections concerned respectively with general aspects, impact on groundwater, waste treatment, waste recycle, land disposal, disposal site clean-up, risk assessment and legal considerations. The subjects included numerous case histories of the design and operation of disposal facilities and of remedial studies and rehabilitation and clean-up measures designed to curtail environmental pollution at disposal sites, in the light of current U.S. legislation and EPA regulatory requirements, regarding atmospheric, soil and groundwater pollution control measures.
-U.S.A.- ; -Conference Proceedings- ; -General-

Journal of Water Pollution Control Federation, 1985, 57, No.6, 599-610.
Power industry wastes.
M. L. IWANSKI (Tennessee Valley Authority, Knoxville), and T. J. CHU.
Recent literature is reviewed on legislation affecting the power industry in the U.S.A. and on various aspects of hydro-electric, fossil-fuel, and nuclear power plants, including assessments of environmental effects; studies on acid deposition and acidification of surface waters; disposal and use of ash; cooling systems and cooling-water discharge; desulphurization of flue gas; characterization, treatment, and disposal of wastes from nuclear power plants; and fluidized bed combustion. A bibliography of 183 references is appended.
-U.S.A.- ; -Journal Paper- ; -Review-

Journal of Water Pollution Control Federation, 1985, 57, No.6, 619-625.
Radioactive wastes.
W. J. BOEGLY (Oak Ridge National Laboratory, Tenn.), and H. J. ALEXANDER.
Recent literature is reviewed on national and international programmes for the control of radioactive wastes; on the treatment and disposal of high-level and low-level radioactive wastes and transuranium wastes; on retrieval storage and on transportation of radioactive wastes; on the environmental transport of radionuclides; on safety analysis and risk assessment; and on remedial action. A bibliography of 130 references is appended.
-U.S.A.- ; -Journal Paper- ; -Review-

Proceedings 7th International Ocean Disposal Symposium, Wolfville, Nova Scotia, 1987, 625-643.
Ecological and human health risks for sewage sludge disposal at the 106-mile site.
H. A. WALKER (U.S. EPA, Narragansett, R.I.), J. F. PAUL, J. A. NOCITO-GOBEL, and J. H. GENTILE.

Following the legal decision to begin sludge dumping on the 106-mile site, revised environmental assessment methods for offshore disposals sites were needed to evaluate permit applications and determine the impact of dumped sludge. Qualitative risk assessment was undertaken and exposure calculations made, based on various dispersion models, estimating the upper bounds of contaminant exposure in either the upper water column or sediments. The risk assessment framework used began with introduction of wastes into the environment and followed various pathways to the ecological and human health endpoints. Based on the assessment of 15 pollutants no ecological water quality criteria violations were predicted for the upper mixed layer of the water column based on projected loading data.
-U.S.A.- ; -Conference Paper- ; -Case Study-

Soil and Groundwater Protection, Schriftenreihe des Vereins fur Wasser-, Boden- und Lufthygiene, Report Nr.64, 1986, 31-43 (in German).
Hydrogeochemical studies in the region of landfills with a view to assessing their environmental compatibility.
H. KERNDORFF, and V. BRILL.
The use of hydrogeochemical studies as a means of quantifying the nature and magnitude of contaminant transport in groundwater systems affected by the presence of waste deposits is discussed, with reference to some investigations of groundwater chemistry at a typical abandoned landfill site. The interactions between soil and groundwater systems and the irrigation of specific contamination through the soil strata are considered in the light of chemical analysis, the groundwater flow pattern and sampling of the groundwater from observation boreholes drilled on the upstream and downstream margins of the landfill. -West Germany- ; -Chapter- ; -Review-

JAPCA, 1988, 38, No.12, 1530-1541.
The waste minimization assessment: a useful tool for the reduction of industrial hazardous wastes.
M. DRABKIN (Versar Inc., Springfield, Va.).
The U.S. EPA sponsored scheme was a step-by-step examination of waste-generating industrial processes with options for waste minimization. Ten such case studies had been carried out, and two examples are described in detail. These covered electric arc furnace stainless steel pickling operations and solvent waste from ceramic capacitor manufacture. Benefits in terms of cost savings and reduced environmental effects could be achieved using the programme. -U.S.A.- ; -Journal Paper- ; -Application-

Water Science and Technology, 1989, 21, No.8/9, 821-831.
A computerized degree of hazard assessment for evaluation of wastes: an innovative aid to management of residuals.
M. J. PLEWA (Illinois University, Urbana), R. A. MINEAR, D. ADES-McINERNEY, D. L. THOMAS, and G. D. MILLER.
A computerized screening and evaluation system for assessing the environmental hazards associated with the disposal of waste was applied to a randomly selected group of applications submitted to the Illinois Waste Disposal Authority under the terms of the U.S. Resource Conservation and Recovery Act. Data supplied with the applications were used to rank the level of hazard due to toxicity, infectious disease, flammability, leaching and biological activity. The essential features of each stage, and the mode of interpretation for an overall hazard evaluation are discussed. Limitations due to non-availability of essential data are also considered.

-U.S.A.- ; -Journal Paper- ; -Experimental-

Lappenbusch Environmental Health, Inc., Alexandra, Va., 1988. 360 pp. (41619).
Contaminated $[1mwaste$[0m sites, property and your health.
W. L. LAPPENBUSCH (Lappenbusch Environmental Health, Inc., Alexandra, Va.).
This volume presents background data on the nature and properties of a wide range of $[1menvironmental$[0m pollutants emanating from contaminated waste disposal sites, together with guidance on the methods of risk $[1massessment$[0m and the evaluation of health hazards resulting from exposure to chemicals at low doses. The dose-addition method of risk analysis for non-carcinogens and the response addition method for carcinogens are differentiated and the principles governing risk analysis for multiple low-level exposure to chemicals in the $[1menvironment$[0m are explained, based on the procedures developed by the author. Acceptable limits for specific pollutants in drinking water, freshwater ecosystems, soil, food and the atmosphere are listed. -U.S.A.- ; -Book- ; -Review-

Proceedings 39th Industrial Waste Conference, Purdue University, 1984, 463-467.
Keynote address: the Comprehensive $[1mEnvironmental$[0m Response, Liability and Compensation Act of 1980.
J. H. RUSSELL (Baker and Hostetler Inc., Cleveland, Ohio).
The Comprehensive $[1mEnvironmental$[0m, Response, Liability and Compensation Act of 1980, known as CERCLA or Superfund, is discussed. Unlike other recent U.S. $[1menvironmental$[0m legislation, CERCLA operated retroactively. The U.S. EPA had been given the power to: target a waste site, carry out a site $[1massessment$[0m (or RIFS -Remedial Investigation Feasibility Study), determine what was needed and then clean up the site. Resources to do this were taken from the 1.6 billion U.S. dollars Superfund but the Agency had the power to obtain reimbursement for the clean up from the generators of the $[1mwaste$[0m. A definition of joint and several liability is given and current CERCLA practice is reviewed with examples, including the interpretation of Rule 68. Hazardous waste disposers were advised to arrange insurance at an early stage and to make certain that the insurers understood current hazardous waste litigation, including tort litigation and mass disaster litigation. -U.S.A.- ; -Conference Paper- ; -Review-

Analysis of Solids-Refuse-Abandoned Dump Sites (Sample Collection, Treatment and Evaluation): Report of Seminar in Roetgen, March 1990 (edited by E.B. Bohnke), Rheinhausen-Westfalen Technische Hochschule Aachen, 1990, 63-79 (in German).
Aspects of the investigation and $[1massessment$[0m of $[1mwaste$[0m materials.
H. H. RUMP (Dames & Moore GmbH, Frankfurt).
Problems presented by the analysis of $[1mwastes$[0m, contaminated soils and materials generated during the decomposition of refuse are reviewed, including the difficulties of obtaining a representative sample, selection of the most appropriate analytical method, and the identification of potentially hazardous substances of unknown origin. The range of existing methods of extraction of $[1menvironmental$[0m samples is considered and the most important determinands governing the risks to human and environmental health are enumerated. A general test protocol for $[1massessing$[0m the nature and degree of contamination of spot samples is outlined, comprising field and laboratory test methods and the analytical tools required for identification of specific constituents are indicated. Flow-charts for suggested procedures in respect of solid, liquid and aqueous samples are illustrated. -West Germany- ; -Chapter- ; -Review-

Pollution Engineering, 1984, 16, No.3, 22-32.
Use of liners for containment at hazardous waste landfills.
F. COPE (EMCON Associates), G. KARPINSKI, J. PACEY, and L. STEINER.
Before discussing the design criteria for a liner system at a hazardous landfill which meets the requirements of the U.S. Resource Conservation and Recovery Act 1976, the relevant regulations are summarized. Linear types are listed and major selection criteria given are performance, $[1mwaste$[0m compatibility, site conditions and $[1menvironmental$[0m factors. Both soil liners and synthetic liners are considered. The importance of $[1massessing$[0m the effects of $[1mwaste$[0m composition and site conditions on liners is underlined. Quality control procedures and liner system cost elements are included. -U.S.A.- ; -Journal Paper- ; -Review-

New Civil Engineer (Supplement), 1991, September, 14.
Model solution.
P. REYNOLDS.
Advanced mathematical modelling was being used by AEA Technology, Harwell, to quantitatively determine the dispersion of radionuclide through the environment and assess the relative safety of sealed nuclear waste buried at Sellafield, Cumbria. The studies, for nuclear waste disposal agency U.K. Nirex, incorporated a complex suite of computer models combined with exploration tools from the oil industry. In addition to standard modelling of groundwater in porous rock, fracture network analysis and finite element models of the Sellafield geology were being applied. Other models investigated the life of the repository, transport of gas evolved from decaying waste, human intrusion, living habits and marine and land food chains. Construction of the 2500 million pounds sterling, 800 m deep underground complex, with 250 m long by 25 m wide caverns, was schedule to start in 1995.
-U.K.- ; -Journal Paper- ; -Case Study-

Commission of the European Communities, Luxembourg Environment and Quality of Life Report EUR 14000 EN, 1992. 24pp. (ME/43743).
The radioactive wastes and environmental protection: an overview.
E. ZAMORANI (Ispra Joint Research Establishment, Italy), and S. NEETA.
Land-based disposal of radioactive wastes originating from the operation of nuclear power plants and the reprocessing of spent nuclear fuel requires the immobilization of radioactive constituents in an inert matrix prior to disposal in a repository. The process of chemical stabilization available for ensuring long-term stability of the solidified waste are briefly considered, and results obtained under experimental conditions are summarized. Two processes in particular were considered to be viable, namely vitrification and stabilization/solidification. Their relative merits, the degree of immobility for target ionic species as determined by leachability tests and the cost-effectiveness of the methods under practical conditions are assessed.
-Italy- ; -Report- ; -Review-

Industrial Waste Management, 1992, 3, No.2, 15 and 17.
Waste management expertise - a highlight of Aspinwall's portfolio.
H. PEARCE.
Aspinwall had over 20 years experience of applying environmental science and technology in the technical waste management sector, including Waste Facility Assessments as an independent and professional third party appraisal against guidelines. Self-assessment questionnaires were available for management to

audit their own waste management practices and check their compliances. A major project had been completed for the Hong Kong government on the development of 3 large landfill facilities proposed to accommodate the entire territory's waste over the next 15 years.
-U.K.- ; -Journal Paper- ; -General-

Waste Management & Research, 1992, 10, No.3, 235-255.
Distribution and attenuation of hazardous substances in uncontrolled solid waste landfills.
T. ASSMUTH (Water and Environment Research Institute, Helsinki).
A 5 year (1986-1990) field study had been carried out on 43 mixed waste landfill sites to assess the toxicological and environmental impacts and risks associated with these sites. Samples were taken from the soil and waste, as well as liquid interstitial and ground water, and gas samples. The toxicological and environmental risks and impacts were small when compared with other toxicants. However, it was possible that this situation might change due to several factors, including migration and exposure. There are 44 references.
-Finland- ; -Journal Paper- ; -Review-

Water Science & Technology, 1993, 27, No.1, 77-86.
Design methods for the development of wastewater land disposal systems.
K. THOMA (Land Energy Pty. Ltd, Macclesfield, S.A.), P. A. BAKER, and E. B. ALLENDER.
Recent changes to water quality legislation in Australia had made it necessary to re-appraise systems for land disposal of sewage and industrial wastewaters and to consider the long-term effects of nutrients and potential contaminants on the soil of the disposal site and on downstream water quality. This would involve assessment of the hydrological and geological characteristics of the area, selection of a suitable disposal site, choice of method of waste application, and environmental monitoring. Two case studies to illustrate the necessary approach are presented. One involved the planning and design of a land-disposal system using waste water from a chemical works to irrigate a eucalyptus plantation, and the other involved assessment and planning of a large-scale land-disposal system for treated sewage effluent from a large city.
-Australia- ; -Journal Paper- ; -Review-

Environment Business, 1993, April, Effluent & Wastewater Treatment Supplement, 18-19.
Digestion stops trouble brewing.
With increasing effluent discharge costs and limited options for final disposal, a waste audit was carried out by Environmental Biotechnology Limited (EBL) at the brewery and soft drinks site of Hall & Woodhouse to evaluate effluent characteristics on site. Data collected during operation of the anaerobic treatment facility were reviewed and all effluent streams assessed. Several options were evaluated with a redesigned anaerobic treatment system still the most economically attractive option. The design incorporated novel heating and mixing technologies, operating in conjunction as part of an externally mounted system, capable of significant energy savings and enhanced COD removal rates. Flow of effluent discharged from the site was balanced using a variable volume reactor, with the dissolved air flotation unit upgraded and all sludge recycled to the digester as a source of bacterial biomass. All pre-treated effluent was discharged to sewer. Design of the new system began in November 1991. -U.K.- ; -Journal Paper- ; -Application-

GWF-Wasser/Abwasser, 1993, 134, No.1, 10-15 (in German, English summary).
A 3D-groundwater model for testing the environmental compatibility of the Kehl incineration plant for special wastes.
M. VOGT (Lahmeyer International GmbH), and M. VOIGT.
As part of an environmental impact assessment for the hazardous waste incineration plant at Kehl, a complex 3-dimensional groundwater flow and transport model was employed to study the consequences of spillages or other pollutant releases on the groundwater in the Kehl aquifer. A description of the model and of the method of discretization employed for the area concerned, at different subsurface depths, is presented. This is followed by a description of the results obtained for the ease of direct infiltration of pollutants at the site and also for diffuse pollutant inputs resulting from wash-out of atmospheric emissions emanating from the flue gases, based on a coupling of the groundwater flow model with an atmospheric transport model for pollutants. The results are considered in very general terms, for situations comprising a worst case' assumption for point-source emissions, and also for the cumulative distribution of a conservative substance throughout the expected life of the plant. -Germany- ; -Journal Paper- ; -Case Study-

Proceedings 39th Industrial Waste Conference, Purdue University, 1984, 291-303.
Biological treatment required for clean-up of contaminated ground water at a hazardous waste dump site.
E. L. STOVER (Environmental Engineering Consultants Inc., Stillwater, Okla.), D. F. KINCANNON, and T. S. MANICKAM.
Work is described by the New Hampshire Water Supply and Pollution Control Commission to contain and clean up the groundwater pollution that has occurred at the Gilson $[1mRoad$[0m Hazardous Waste Site. A feasibility $[1massessment$[0m completed in January 1982 was funded by the U.S. Environmental Protection Agency under the Comprehensive $[1mEnvironmental$[0m Response, Compensation and Liability Act of 1980 (Superfund). The first phase of the management of containment at the site consisted of installation of an impermeable surface cap and of a bentonite slurry cut-off wall around the site. The primary consultants retained Environmental Engineering Consultants Inc. to participate in the second phase of investigation, design and building of a groundwater treatment system to reduce groundwater contamination to acceptable levels. Contaminants found in nearby wells included volatile organics, extractable organics and heavy metals. Detailed results are given of biological treatability studies conducted with activated sludge, aerated lagoon and rotating biological contactor systems. -U.S.A.-Conference Paper-Case-Study-

Public Health Engineer, 1987, 14, No.6, 43-46.
Sludge disposal into the 1990s: 2. sludge disposal to sea as operated by Thames Water.
M. J. HANBURY (Thames Water), M. K. GREEN, and M. J. ANDREWS.
Sludge for sea disposal is produced by Beckton, Crossness, Deephams and Riverside sewage treatment plant. Four ships take the sludge from Beckton and Crossness to the Barrow Deep disposal site. Legislation controlling sea disposal is outlined. A study of the environmental status of the Thames estuary and the effects of sludge dumping was initiated in 1985 by Thames Water and the Water Research Centre. Thames Water's policies regarding sludge disposal are discussed. The EC Directive on the Dumping of ^ Waste at Sea is outlined. Alternatives to sea disposal were assessed (landfill, incineration)
-U.K.- ; -Journal Paper- ; -Case Study-; Beckton sewage works ; Crossness sewage works ; Deephams sewage works ; Riverside ^ sewage works

[0mEnvironmental Toxicology and Chemistry, 1982, 1, No.2, 121-134.
A screening procedure for assessing the transport and degradation of solid waste constituents in subsurface and surface waters.
J.W. FALCO, (U.S. EPA), L.A. MULKEY, R.R. SWANK, R.E. LIPCSEI and S.M. BROWN.
Details are given of a procedure for the rapid screening of chemicals for their potential for contaminating ground water and surface waters after disposal in landfills and lagoons ; the movement and degradation of the chemicals are estimated from a knowledge of their physical and chemical properties and a defined range of environmental conditions. The method has been applied to a large number of compounds known to be constituents of solid wastes from a variety of industries and the results are analysed and discussed. -U.S.A.-

Marine Pollution Bulletin, 1991, 22, No.7, 334-339.
'Oyster-watch' for monitoring coal ash lagoons in an $[1menvironmentally$[0m sensitive area of Hong Kong.
A. ASHTON (China Light and Power Company).
The $[1menvironmental$[0m $[1massessment$[0m and planning stage of a project to install lagoons for the disposal of coal ash from the Castle Peak Power Station (one of the largest coal fired installations in the world), in Deep bay, in the western New Territories of Hong Kong, and the Mai Po marshes nature reserve, are described. The 3 adjoining lagoons (West, Middle and East sites), situated at Tsang Tsui on the mouth of the Bay, had an estimated total capacity of 7.5 million m3 covering nearly 1 km2. Ash was transported as a seawater slurry to the lagoons through an underground $[1mpipeline$[0m and supernatant seawater was returned by a second underground $[1mpipeline$[0m to the power station for discharge to an open body of tidal water in the vicinity rather than into the bay. A grout-filled geo-textile mattress had been incorporated into the rubble-filled outer seawalls at the design stage to reduce permeability. Results of a monitoring survey using the Pacific oyster (~Crassostrea gigas~), the commercially cultivated species in Deep Bay, for 6 months prior to commencement of lagoon filling, in 1987, followed by nearly 3 years of regular monitoring up to December 1989, indicated no detectable changes in concentrations of selenium, arsenic, zinc, cadmium, lead, copper and chromium at any of the monitored sites after ash deposition began. The necessity for monitoring the $[1menvironmental$[0m effects of current and projected developments in the area is emphasized. -Hong Kong- ; -Journal Paper- ; -Case Study- ; Pb

Large industry/manafacturing devt.

$[0mU.S. envir. Protect. Ag., Envir. Protect. Technol. Ser.
EPA-R2-73-058, U. S. Govt Printing Office, Washington, D. C., 1973. 104 pp.
A study of the photodegradation of commercial dyes.
J. J. Porter
To assess the polluting potential of textile industry waste waters when discharged to streams and reservoirs, experiments were carried out on the stability of 36 commercial dyes in water to visible and ultraviolet light. Further studies on 2 dyes showed that they were degraded at least 10 times more rapidly in artificial light than in sunlight. The experiments confirmed that most commercial colours are resistant to photodegradation, and many weeks would be required to produce appreciable dye degradation in the natural aquatic environment.

$[0mAmbio, 1976, 5, No. 2, 77-79
A comparative study of the effects on the marine environment of wastes from cellulose industries in Scotland and Sweden
T. H. PEARSON , and R. ROSENBERG
A study to assess the influence of effluents from cellulose industries on the benthic faunas of comparable fjordic systems on the west coast of Sweden and Scotland is reported. The study areas are described, and generalizations are made about sequential changes in the interrelationship of benthos and sedimentary structure. The results of species diversity investigations are presented graphically and it is suggested that discharge of suspended organic material into a semi-enclosed marine area may result in the elimination of benthic animals in an area within 1-2 km of the discharge point. The advantages and disadvantages of using indicator species, comparing faunal groups, and using diversity indices in the description of ecological changes are briefly considered. A bibliography of 18 references is appended.

$[0mEnvironmental Health Perspectives, 1979, 33, 131-157.
Health and environmental impacts of increased generation of coal ash and FGD sludges. Report to the Committee on Health and Ecological Effects of Increased Coal Utilization.
C.J. SANTHANAM, R.R. LUNT, S.L. JOHNSON, C.B. COOPER, P.S. THAYER, & J.W. JONES
The increasing environmental effects of coal ash and flue gas desulphurization wastes associated with increased coal usage by utilities and industry are predicted, based on data from 1977. Details of the present technology and production of coal ash and FGD sludges and their characteristics are given. Federal and state regulations for disposal on land and at sea, together with disposal and utilization options are outlined. The impacts are then assessed for each EPA region. The data indicate that with good control technology and implementation of existing regulatory frameworks, regional-scale impacts are likely to be small, but site-specific ones could be significant. Further data on radionuclides, trace metals, and other pollutants are required. -U.S.A.-

$[0mIndian Journal of Environmental Health, 1983, 25, No.2, 81-91.
Appropriate environmental analysis approach to siting of industry - a case study.
V. RAMAN (NEERI, Nagpur) .
A case study is presented of the application of environmental impact analysis and assessment to a proposed 50 tons per day sulphuric acid plant in the rural district of Vidisha, Madhya Pradesh. A comparative environmental

assessment of three possible sites was carried out in which the mutual impacts of the project and the environment were considered for each of the sites. The main constraint was that the location should be in an underdeveloped area, to qualify for government aid. A secondary constraint was reasonable and quick access to the neighbouring city of Bhopal. The sites were graded according to infrastructure, prevailing industry and pollution, air pollution routes, proximity of human habitation, availability of labour, potential for wastewater treatment and disposal and susceptibility to floods. -India- ; -Journal Paper- ; -Case Study-

$[0mIndian Journal of Environmental Health, 1983, 25, No.1, 1-14.
Environmental impact analysis for siting of industries.
B. B. SUNDARESAN (National Environmental Engineering Research Institute, Nagpur) , and V. RAMAN .
Concern over the siting of industrial developments with economic considerations rather than environmental quality in mind is discussed. Environmental impact analysis is proposed as a method of assessing the suitability of a particular site for a particular development or industry. This method is illustrated with tables and uses the examination of broad areas of impact as well as specific parameters with a check list of characteristics in grid form. Case studies from India and the U.S.A are discussed to illustrate the analytical methods.
-India- ; -Journal Paper- ; -Application-

Ingegneria Ambientale, 1985, 15, No.10, 563-572 (in Italian, English summary).
Biological methods for assessing environmental impact on the sea: biocoenotic mapping.
R. BARONE (Universita di Palermo), R. DELORENZO, D. DRAGO, G. GIACCONE, and P. N. MUSCETTA.
An ecological study of the marine environment and community in the sea area in front of the petrochemical complex at Porto Torres, Sardinia, was carried out by an interdisciplinary group from Palermo University and from the principal industries. The survey of benthos and plankton revealed the present condition of pollution and provided a basis for judging the effectiveness of a projected industrial wastewater treatment plant. Monthly measurements were made of temperature, salinity, transparency, nutrients, and chlorophyll, and phytoplankton and zooplankton were sampled horizontally and vertically. Seasonal measurements were made of particles, sediments, and the benthos was surveyed, particularly in association with the ~Posidonia oceanica~ colonies, which were regularly mapped. There were a zone in equilibrium, a regressive area occupying 50 per cent of the harbour with diminishing ~Posidonia~ populations, and a recently dead ~Posidonia~ community over 40 per cent of the harbour area. These changes were caused by altered water exchanges due to construction of breakwaters and wharves, instability of the substratum due to excavation and discharges, and decreased light penetration. Eutrophication was not evident. Some signs of recovery were observed after a protective barrier was erected against discharges from the treatment plant under construction. (Full translation 194 pounds sterling).
-Italy- ; -Journal Paper- ; -Case Study-

Water Science and Technology, 1988, 20, No.3, 87-93.
Application of environmental risk analysis to groundwater protection.
M. O. ETTALA (Paavo Ristola Ltd., Consulting Engineers, Salpakangas).
The author described the approach developed for assessing the risks to groundwater from industrial operations and for developing methods for

controlling such risks. This approach was applied to several factories in Finland engaged in the chemical, forest, and foodstuffs industries. Diagrams are included showing the work stages involved in the risk analysis and different parts of environmental analysis, and examples of the survey charts used in the environmental risk analysis are tabulated.
-Finland- ; -Journal Paper- ; -Experimental-

Pulp & Paper, 1990, 64, No.4, 59-66.
Tighter environmental regulations will alter mill processes' permits.
K. H. FERGUSON.
Possible impacts of U.S. Federal and State legislative requirements for preservation of environmental quality by the pulp and paper industry are reviewed, with special reference to the water quality $[1menvironment$[0m. Existing U.S. EPA guidelines for permissible effluent discharges from mills of various types, based on the dilution and purification capacity available in receiving waters, were already liable to constriction as state inventories of water quality had become more detailed. Some states had also imposed standards for parameters, such as colour, not listed in the guidelines. Such standards had not always worked against mill owners, as the evolution of the technology required to satisfy them had resulted in the recovery of otherwise wasted valuable products. The $[1mindustry$[0m also feared that toxicity testing, at present mandatory in only a few States, would become a federal requirement. But the $[1mindustry$[0m's principal concern was that its effluents might be classed as hazardous wastes, and defined by the Resource Conservation and Recovery Act, largely as a result of their level of chloroform, derived from the chlorine bleaching process. It was also concerned that states might limit further the volume of water that mills might withdraw from rivers, reflecting public anxiety over low flows following recent extended drought conditions, and in view of such flows might also reduce the volume of effluent permitted by the present permit when it fell due for revision. Probable effects of the Clean Air Act being debated in congress on the air pollution-related problems of the $[1mindustry$[0m, and of federal guidelines regarding the disposal of solid wastes in landfills, are also extensively $[1massessed$[0m. -U.S.A.- ; -Journal Paper- ; -Review-

Environmental Toxicology and Chemistry, 1991, 10, No.12, 1511-1540.
The hazard assessment of pulp and paper effluents in the aquatic environment: a review.
J. W. OWENS (Procter & Gamble Paper Products, Cincinnati, Ohio, U.S.A.).
Based on environmental research in the paper pulping industries of Scandinavia and the U.S.A., the complex environmental impacts of paper pulping effluents on the aquatic environment are examined and the objectives of a hazard assessment defined. The interaction of complex effluents with site-specific factors is evaluated, with reproduction being the most sensitive, consistent and relevant end point tested to date in the laboratory, in mesocosms and experimental streams and in field situations near some pulping discharges. Receiving water and sediment analyses performed in selected environmental studies of pulping effluents are summarized together with process and treatment types and effluent discharge loads. Contaminant exposure, within organism responses, whole-organism effects and effects at the community level are discussed for a range of flora and species including benthos, zooplankton, bacteria, diatoms, protozoa and fish. Data from a case study at the bleached kraft mill at Norrsundet, Sweden, for the littoral benthic community, extensive reproductive and mortality studies on several fish populations and physiological biochemical

measurements in perch, are presented. Potential connections between data and environmental contaminants are discussed. The need for a stepwise, tiered strategy to methodically reduce uncertainties associated with complex effluents is examined. There are 268 references.
-International- ; -Journal Paper- ; -Review-

Water Resources, 1991, 18, No.2, 194-198.
Protection of surface water against phenol emissions from insulating materials manufacturing plants.
V. M. KHVAT (All-Union Scientific Research Institute of Water Conservation, Turkmen), O. P. RONENKO, I. D. KOLOVA, and M. M. VAVELSKII.
The consequences of the release of phenol compounds into the environment of ventilation-system exhaust gases from the production of insulating materials for the electronics industry were considered. Phenol levels in the near-ground air at such manufacturing facilities could be up to 20 times permissible levels, and total emissions could amount to several tens of tons annually. Most of this was deposited in the immediate surroundings and was carried by rainfall into watercourses. A method of assessing the scale of pollutant transport from this source is proposed. Holding tanks to protect waters against pollution by runoff are also suggested. -U.S.S.R.- ; -Journal Paper- ; -Experimental-

Water Services, 1992, 96, No.1156, 8-9.
Pollution solution.
With the polluter pays' principle being adopted worldwide, new legislative pressures combined with the introduction of green levies were forcing industry to examine methods of improving wastewater treatment systems. Companies were increasingly required to be aware of their responsibilities in relation to new legislation and public awareness, assessing the impact of their activities on the environment. Expertise on total industrial wastewater management services offered by Halliburton NUS Environmental is described. Recent U.K. assignments conducted are discussed including a process study on existing effluent treatment systems for a major petroleum refinery, evaluation of cost-effective methods for complying with consent limits for an insulation company and assessment of an on-site wastewater treatment facility for an electronics works. -U.K.- ; -Journal Paper- ; -Review-

Surveyor, 1994, 181, No.5286, 10-11.
Easing the drain on water resources.
D. MASON.
The National Rivers Authority strategy for sustainable water resources, launched in March 1994, is discussed. The strategy emphasized demand management and included schemes for water transfer from areas with surplus to those of shortage. Industry, business, agriculture and the domestic user would be encouraged to save water through audits, demonstration projects and advice. The strategy document stressed a flexible approach to water resource development. Priorities included baseline studies of the river corridors of the Severn and Thames rivers; environmental assessment of using Vyrnwy reservoir to supplement Thames, Severn, Trent and Wessex regions; water transfer from the Severn to the Thames rivers; development of interregional hydrological models; and research into the need for minimal flows in rivers and to estuaries. Pre-feasibility studies and environmental assessments were being carried out as part of this strategy.
-U.K.- ; -Journal Paper- ; -General-

Environmental Monitoring and Assessment, 1985, 5, No.2, 137-154.
Assessing soil lead contamination in Dallas, Texas.
K. W. BROWN (Environmental Monitoring Systems Laboratory, Las Vegas, Nev.), J. W. MULLINS, E. P. RICHITT, G. T. FLATMAN, S. C. BLACK, and S. J. SIMON.
In the summer of 1982, the U.S. EPA carried out a comprehensive monitoring programme to study environmental contamination near 2 secondary lead smelters and at one reference site in Dallas. The study included collection and analysis of almost 3000 samples of soil, about 1000 samples of blood, and 840 samples of house dust. Methods used to sample and analyse the soil and to interpret the results are described, and tabulated data are included showing the effect of various methods of processing the samples on the lead content of the soil. Isopleths of the estimated lead concentrations at the different sites, and possible errors, are shown in a series of maps, and the value of geostatistics for identifying and evaluating environmental contamination is discussed.
-U.S.A.- ; -Journal Paper- ; -Experimental- ; Pb

Water, Air, and Soil Pollution, 1985, 24, No.2, 153-164.
Effects of nickel addition on nitrogen mineralization nitrification, and nitrogen leaching in some boreal forest soils.
J. B. deCATANZARO (Toronto University, Ont.), and T. C. HUTCHINSON.
In the Northern Hemisphere, the large number of mining and smelting operations resulted in extensive contamination of forested areas by mine wastes and airborne smelter emissions. To assess the effect of this on the forest environment, field and laboratory studies were carried out of the effect of nickel, as an example of a toxic, smelter-emitted heavy metal, on the nitrogen cycle in the soil from forested areas. Under certain conditions, nickel at a concentration of 100 ug per g of soil stimulated nitrification, and at a concentration of 500 ug per g could stimulate mineralization of nitrogen. In general, rates of nitrification were low, but were higher in soils from the vicinity of a smelter than in uncontaminated soil. The numbers of nitrifying bacteria in uncontaminated soil were very low, but increased when nickel was added. Leaching of nitrate from soil columns was increased by addition of nickel. -Canada- ; -Journal Paper- ; -Experimental-

$[0m 8 Marine Pollution Bulletin, 1977, 8, No.11, 249-254.
Immediate industrial effects on sediment metals in a clean coastal environment.
G. A. KNAUER .
The results of field studies designed to assess the environmental impact of a new nickel refinery in Halifax Bay, Queensland , are presented. Measurements of the heavy-metal content of sediments in the bay indicated that within 3 weeks from the commencement of discharges, the level of cobalt increased significantly near the outfall. Samples taken from river mouths discharging into the bay also showed elevated nickel levels, which may be connected with atmospheric pollution by nickel. The results suggest that the levels of cobalt, nickel and iron may be expected to increase significantly as a result of the refinery operations. <00> metal industry waste waters ; origin Australia

Golf courses

$[0mProc. Amer. Soc. civ. Engrs, 1959, 85, SA6, 79-85, Pap. No. 2252
Waste water reclamation for golf course irrigation.
R. C. MERZ
In recent years there has been an increase in the use of sewage-works effluents for irrigation of golf courses. The quality of effluent required for recreational irrigation is not so critical as for general agricultural irrigation, and the use of effluents for this purpose conserves available potable water for higher uses. The author describes a number of installations in the U.S.A. where sewage-works effluents are used successfully for irrigation of golf courses.

$[0mPubl. Wks,. N.Y., 1963, 94, No. 3, 88-90
Waste water reclaimed for golf course use.
R. STONE
After reviewing the use of reclaimed water for irrigation of golf courses the author describes the recently-completed water and land reclamation project of Whispering Lakes municipal golf course at Ontario, Calif. The golf course and additional tertiary treatment facilities for the waste waters were designed integrally with the existing 6 m.g.d. Ontario-Uplands sewage-treatment plant which provides primary sedimentation, biological filtration and heated sludge digestion, the gas produced being used as fuel for pumping and other purposes. About 0.5 m.g.d. of the filter effluent is pumped to the tertiary treatment plant (a flow diagram of which is given), the remaining 5.5 m.g.d. being discharged to spreading basins for recharge of the ground water or for irrigation. Two large fenced lakes, which operate as stabilization basins either individually, in series, or in parallel, provide a minimum detention period of 30 days for the reclaimed effluent. The effluent from these lakes flows to an additional treatment tank and thence to 2 chlorine-contact tanks designed to allow detention for 24 hours after preliminary chlorination; this effluent is post-chlorinated before being discharged to the semi-automatic irrigation system or to a series of decorative lakes. Problems encountered with similar projects, including health hazards, corrosion, aesthetics and chemical quality of water, are discussed.

$[0mJournal of Water Pollution Control Federation, 1984, 56, No.5, 474-481.
Irrigation of public use areas by land application of combined industrial and domestic waste effluent.
W. H. SLOAN (Naval Facilities Engineering Command, Charleston, S.C.) .
At Pensacola Naval Air Station both domestic sewage and various types of industrial wastewaters from the maintenance and repair of aircraft receive full treatment. The wastewaters are treated to remove undesirable components such as cyanides, oil , and phenols. Sewage is treated by the activated-sludge process; primary and industrial sludges are dewatered by evaporation, and surplus activated sludge receives aerobic digestion. A flow diagram of the treatment plant is included. Previously, the effluents were discharged to Pensacola bay, but it is now planned to use some of the combined effluent for irrigating two golf courses after further treatment by filtration and chlorination. This will help reduce the polluting load on the bay and should improve the quality of the golf-course turf. Details are given of the site and of the planned management of the scheme. -U.S.A.-; -Journal Paper-; -Case Study

BioCycle, 1985, 26, No.2, 39-40.
Effluent reuse in southeast Florida.
Reuse of wastewater in southeast Florida in slow rate irrigation, overland flow and high rate infiltration is discussed. Overland flow treatment was not a practical method on the relatively permeable soils and flat topography of southeast Florida. High rate of infiltration systems had limited nutrient removal ability and were suitable only for small, usually private facilities. Slow rate irrigation was by contrast considered suitable both for private farm land use and public areas such as golf courses.
-U.S.A.- ; -Journal Paper- ; -General-

Wildlife Society Bulletin, 1985, 13, No.3, 228-233.
Nuisance Canada goose problems in the eastern United States.
M. R. CONOVER (Connecticut Agricultural Experiment Station, New Haven), and G. G. CHASKO.
In 1982 questionnaires were sent to water companies in Connecticut and golf courses throughout the eastern U.S.A. Replies were received from 40 water companies. Twenty-nine stated that Canada geese spent some time on their reservoirs and 18 considered this to be a nuisance. Commonest complaints were that the faeces lowered water quality and littered company land. Only one water company allowed hunters. Most replied that goose problems had arisen within the previous 5 years. This suggests a possible increase in problems caused by geese. -U.S.A.- ; -Journal Paper- ; -Case Study-

World Wastes, 1985, 28, No.8, 46 and 48.
Sludge keeps grass green in municipal golf course.
The City of Monroe, N.C., disposed of 2 million gallons of sludge from a retention lagoon by applying it to a municipal golf course to improve soil fertility. The sewage treatment works used an activated sludge process and 65 per cent of its capacity originated as industrial wastewater. The treated areas were closed to the public for 60 days to ensure dispersal of any pathogens.
-U.S.A.- ; -Journal Paper- ; -Case Study-

Public Works, 1988, 119, No.11, 78-79.
The amazing economics of wastewater reuse.
J. JOERNS, and W. B. MORIARTY.
Plans to use the secondary effluent from the La Porte sewage works Tex., to irrigate the championship golf course, are described. Improvements needed to convey the effluent to the golf course included installing two small submersible pumps in the outer channel of the chlorine contact basin. Good interim storage capability was provided by the 16 acres of lakes around the course. Pump operation was controlled by an automatic, level-type control system with flow monitoring by a Doppler-type flowmeter. Soil from the root zone of the golf course was tested annually for pH, total nitrogen, potassium, phosphorus and conductivity. The substantial annual water cost savings are analysed. -U.S.A.- ; -Journal Paper- ; -Case Study-

Water (Australia), 1989, 15, No.6, 28-30.
Total water management on resort islands: design, operation and maintenance.
G. A. NOLAN (Ullman and Nolan Pty Ltd), and I. R. CAMERON.
The problems of water supply and sewage disposal in the many resort islands off the coast of Queensland are discussed. The small size of the islands, the steepness of the slope of many of them, their consequent inability to develop a classical river system, their dependence on rainfall from tropical cyclones and

the dependence of the latter on the development of the equatorial monsoon, and the general absence of significant altitude which would induce great precipitation, combined to make the volume of surface water unreliable. Such aquifers as existed were shallow, and very susceptible to saline intrusion. Resort populations were normally at their highest during the driest times of the year, when the need for lawn and golf course watering was also greatest. Water supply had, to date, been ensured through the use of roof catchments, small reservoirs, boreholes, import by barge or pipeline, and desalination. Package treatment systems, generally employing extended aeration, Imhoff tanks or oxidation ditches, were used for wastewater treatment, with the effluent either discharged to deep tidal waters or chlorinated and used for irrigation. -Australia- ; -Journal Paper- ; -Case Study-

Public Works, 1989, 120, No.6, 58-60.
The creation of a park.
K. A. ARENT (Johnsen Design and Planning Inc., Mt. Kisco, N.Y.).
The planning and creation of Salt Meadows Park, a community park proposed for the 300 acres of open space adjacent to Long Island Sound, N.Y., is described. The site was currently used for a sewage works, landfills and golf course. It had flood control dikes, and tidal saltwater and inland wetlands. Following a feasibility study, site analysis and conceptual development, a master plan was formulated to include public works, environmental and recreational zones and incorporating features such as the wetlands. Phase one of the 15 million U.S. dollar project, designed to initiate public funding and increase support, comprised a walkway, fishing docks, bridge and a wildlife sanctuary. The scheme included continuous monitoring and testing of the landfill site prior to construction. -U.S.A.- ; -Journal Paper- ; -Case Study-

Comparative Biochemistry and Physiology, 1992, 101C, No.1, 63-66.
Accumulation and excretion of pesticides used in golf courses by carp (~Cyprinus carpio~) and willow shiner (~Gnathopogon caerulescens~).
T. TSUDA (Shiga Prefectural Institute of Public Health and Environmental Science, Ohtsu), S. AOKI, M. KOJIMA, and T. FUJITA.
The accumulation and excretion of 9 pesticides (simazine, chlorpyriphos, isoxathion, tolclofos-methyl, flutolanil, isoprothiolane, chlorothalonil, captan and iprodione) was investigated in ~Cyprinus carpio~ and ~Gnathopogon caerulescens~. The average bioconcentration factors (BCF) in whole body of ~G. caerulescens~ were 3.9, 18 and 350 for simazine, chlorothalonil and captan, respectively. In ~C. carpio~, BCF values were 220, 460, 20, 27, 25, 100, 440 and 360 for tolclofos-methyl, chlorpyriphos, flutolanil, isoprothiolane, chlorothalonil, captan, isoxathion and iprodione, respectively. The BCF values of captan in both fishes were considerably lower than those estimated from its Pow (correlation between n-octanol-water partition coefficients) value. Excretion rate constants for ~G. caerulescens~ were 0.77 per h for simazine, 0.04 per h for chlorothalonil and 0.02 per h for captan. For ~C. carpio~ they were 0.04 per h for tolclofos-methyl, 0.02 per h for chlorpyriphos, 0.12 per h for flutolanil, 0.19 per h for isoprothiolane, 0.01 per h for captan and 0.03 per h for isoxathion. -Japan- ; -Journal Paper- ; -Experimental-

Construction News, 1992, 10 No.6294, 18.
Fins find their form for future.
J. SIMPSON.
Fin drains were increasingly being installed along highways and in urban road drainage, at landfill sites, on sports pitches and golf fairways and to relieve

external water pressure on service reservoirs. The drains consisted of a geotextile filter, usually a coarse matted or woven fabric, surrounding a rigid plastic core. The filter formed a horizontal or vertical layer in the ground intercepting the flow of water through the soil. Advantages of fin drains included effective drainage, long service life, reduced installation and service life costs and environmental acceptability. Fin drains were being used in conjunction with geomembranes for landfill sites to prevent leachate escaping from the tip and polluting groundwater. The potential for these geocomposite drains is discussed.
-U.K.- ; -Journal Paper- ; -General-

Airport devt.

Marine Pollution Bulletin, 1991, 23, 349-353.
The Kansai international airport project and environmental impact assessment.
M. MAEDA (Kansai International Airport Co., Ltd., Osaka).
A new international airport was under construction on an artificial island 5 km offshore in Osaka bay, Japan. Measures to assess the environmental effects of the construction are outlined and results from monitoring turbidity of the sea water are summarized. As a result, the construction process was modified and the time of sand dumping was altered to take account of tidal movements and improve sedimentation of the dumped material.
-Japan- ; -Journal Paper- ; -Case Study-

Pipelines

$[0mPipes and Pipelines International, 1980, February, 15-20.
Environmental impact assessment of pipelining.
C. P. REES , (ATKINS RESEARCH AND DEVELOPMENT) .
The need for an analysis of the impact on the environment of the laying of a pipeline is emphasized by the author and has been acknowledged by the U.K. Department of the Environment. The process of environmental impact analysis is described and the systematic, reproducible and interdisciplinary approaches required are indicated. A sequence of nine steps, five preliminary and four detailed, are presented in a flow diagram, and each step is outlined. Examples of typical documents are given and the advantages of environmental impact analyses are summarized. -U.K.-

$[0mWater Resources Bulletin, 1984, 20, No.1, 1-8.
Suitability analysis for selection of pipeline routes.
C. A. WHITEHURST (Louisiana State University, Baton Rouge, La.) .
A brief review is presented of environmental assessment methods used to study environmental management problems. Suitability analysis involving the use of matrices is frequently performed as a convenient way of organizing all the factors representing environmental concerns; the matrices also proved useful in defining the present state of an environmental regime and in maintaining an inventory of regional features and potential impacts. The method is evaluated by examining the potential impact of a major pipeline construction on the water resources in a central area of southern Louisiana.-U.S.A- Jnl Paper-Case Study-

Environment Canada, Ottawa, 1987. 332 pp. (40626).
Audit and evaluation in environmental assessment and management: Canadian and international experience: volume I commissioned research.
B. SADLER (editor).
The technical papers presented at a conference held in October 1985 to discuss follow-up and post-completion studies of specific projects affecting the environment and to relate their findings to the original environmental impact assessment study undertaken prior to commencement are given. The papers are concerned with various hydroelectric schemes and pipeline development projects in widely separated parts of Canada, and also included a case study of the procedures involved in reaching agreement with conservationists and other aggrieved parties in the development of mining facilities and mine tailings disposal in British Columbian coastal waters.
-Canada- ; -Report- ; -General-

Gas Engineering & Management, 1989, 29, No.5, 130-136, 138 and 140-142.
Horizontal directional drilling. A new 'slant' on trenchless technology.
P. HAY (British Gas East Midlands).
Horizontal directional drilling was used to construct a 7 bar pipeline providing a gas supply to British Sugar Corporation, Newark, across the Trent river, two railway lines, the route of the proposed Newark by-pass and a deep drainage ditch. Problems involved in laying the pipeline are discussed together with advantages and limitations of horizontal directional drilling. Authorities affected by the drilling operation included Severn Trent Water, British Waterways Board, British Rail and consultants for the Newark by-pass project. Project assessment, specification and tender contract are outlined. Details are given of the pipe string construction, installation of the drilling rig and ancillary equipment, drilling of the pilot hole and installation of the

pipeline. Following hydraulic testing, the project was completed to schedule on 15 March 1989, with little environmental disturbance and considerable cost savings. -U.K.- ; -Journal Paper- ; -Case Study-

Pipes & Pipelines International, 1989, 34, No.6, 7-10.
Environmental assessment and U.K. cross-country pipelines.
A. A. RYDER (RSK Environment Ltd.).
The main requirements of the recently introduced Electricity and Pipe-line Works ($[1mAssessment$[0m of $[1mEnvironmental$[0m Effects) Regulations 1989, are examined. The regulations applied to power stations and to cross-country pipelines that required pipeline construction authorization under the Pipe-lines Act, 1962. The environmental assessment process is outlined and its impact on $[1mpipeline$[0m promotors considered. The minimal content of an environmental assessment, forming part of the pipeline construction authorization, is discussed. -U.K.- ; -Journal Paper- ; -Review-

Pipes & Pipelines International, 1991, 36, No.1, 13-17.
Engineering a greener $[1mpipeline$[0m: a practical approach.
M. HADLEY (Environmental Services Trident Consultants Ltd).
Ways in which the fundamental principles of environmental assessment could be accommodated within $[1mpipeline$[0m project management are examined. Questions concerning the $[1menvironmental$[0m aspects of pipelines general to the industry are discussed. Legislation involved in $[1mpipeline$[0m environmental assessment is outlined, particularly the EC Directive 85/337/EC and U.K. Statutory Instruments. Items covered in atypical environmental impact assessment are summarized and the relationship of $[1massessment$[0m performance to project timescales evaluated. -U.K.- ; -Journal Paper-

Water Environment & Technology, 1992, 4, No.11, 11-12.
Better wetlands data improves pipeline proposals.
K. BOWERS (Biohabitats, Inc., Towson, Md.).
The Baltimore Gas and Electric Co. used a new computer-based wetlands delineation system to prepare environmental assessment packages for a proposed gas pipeline project affecting Chesapeake bay critical areas and nontidal wetlands. Traditional field-investigation and literature-survey techniques with geographic information system (GIS) software were used to compile and analyse environmental resources data. Global positioning system (GPS) data were used to determine geographic coordinates. To minimize the potential impact on the wetlands the following best management practices were devised: excavated material would be removed in layers and later replaced in the original sequence, the existing seed bank would be preserved, all construction equipment would be kept outside the wetlands boundaries except when performing work when stabilization mats would be used, all wetland areas would be returned to preconstruction grade and seeded with an approved wetland seed mix, and geotextile fabric would be used for extra stabilization and sediment control. -U.S.A.- ; -Journal Paper- ; -Case Study-

Pipes & Pipelines International, 1993, 38, No.4, 21-23.
How green is your pipe?
J. M. HOFFMAN (Stanton plc, Nottingham).
Environmental factors were becoming an increasingly important criteria affecting material selection for pipelines. The environmental impact assessment is outlined together with its use in evaluating environmental criteria for pipeline materials. Some of the key issues likely to emerge from such an

assessment are examined. Aspects of pipe manufacture, pipe operation, decommissioning and disposal are discussed in relation to various materials. These included medium- and high strength polyethylene, unplasticized PVC and ductile iron. -U.K.- ; -Journal Paper- ; -Review-

UM 1030 - AN $[1mASSESSMENT$[0m OF THE PERFORMANCE OF DECON RVS 250A MICROTUNNELLING EQUIPMENT
C E TREGOING - OCTOBER 1989
OBJECTIVES To collect and present information on the performance of a particular microtunnelling system working under contract conditions and used for the installation of gravity pipelines.
REASONS The Water Industry can potentially achieve significant benefits from the wider use of trenchless $[1mconstruction$[0m techniques. However, there is a need for objective performance data relating to the abilities and limitations of the equipment. The availability of this information will assist engineers and others involved with underground pipeline installation in the $[1massessment$[0m of suitable methods.
CONCLUSIONS
1. The equipment was successful in installing a new sewer through the particular ground conditions encountered.
2. Some development work for the equipment took place during the course of the project.
3. The pipeline was installed to a tolerance superior to that allowable in the contract.
4. The disruption to the community was less than would have resulted from open-cut $[1mconstruction$[0m.
5. A new sewer can be installed without disturbing existing services.
6. Significant savings in $[1mconstruction$[0m costs were made by using the system.
RECOMMENDATIONS
1. Specification of this type of equipment should be considered by the Water Industry, particularly in an urban $[1menvironment$[0m.
2. The system should be used in order to decrease disruption, avoid existing services and reduce $[1mconstruction$[0m costs.
3. An increased level of site investigation work should be carried out relative to that normally carried out for conventional trenching works.
4. Further experience with this type of equipment should be collated and disseminated to the Water Industry.
RESUME
The information gathered from monitoring the performance of a particular microtunnelling system working under contract conditions is presented. The capabilities and limitations of the equipment are $[1massessed$[0m for these particular conditions. Recommendations concerning the utilisation of the equipment for pipeline installation are made.

Pipes & Pipelines International, 1989, 34, No.6, 10-14.
Pipelines and the aquatic environment.
F. H. DAWSON (Institute of Freshwater Ecology).
The environmental impact of pipelines constructed across rivers, wetlands or estuaries is discussed. Route selection and planning, which formed part of the environmental impact $[1massessment$[0m required for the pipeline construction authorization, are considered. Information required in preconstruction field surveys is described together with the likely consequences of different types of $[1mconstruction$[0m. Measures for $[1menvironmental$[0m monitoring during

$[1mconstruction$[0m, reinstatement and post-construction surveys of the pipeline construction site are outlined. -U.K.- ; -Journal Paper- ; -Review-

Water Environment & Technology, 1992, 4, No.11, 11-12.
Better wetlands data improves pipeline proposals.
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Cemeteries

$[0mPaper presented at a meeting of the Committee on Public Administration of the Union of Western Europe, 1959. 14 pp.
The public health aspect of the struggle against pollution of waters.
DELECOURT.
The author discussed the French laws controlling the hygienic quality of mineral water and public water supplies and prohibiting the pollution of ground and surface waters, including individual laws relating to radioactivity, cemetaries, shellfish beds, bathing places, fisheries, and trade waste waters. It is pointed out that Ministers other than the Minister of Public Health can also contribute to the campaign against pollution of water.

$[0mSanitalk, 1960-61, 9, No. 1, 9-11
Protection of surface water supplies.
H. J. STEINHURST
This paper includes the text of the revised regulations to be adopted in Massachusetts for the prevention of pollution of certain waters used as sources of public water supply. The regulations apply to all surface sources in Massachusetts, except the Merrimack river, Concord river, and Ipswich river and Long Pond in Lakeville and Freetown, and relate to the discharge of domestic and trade waste waters and other putrescible materials ; the construction of sewerage systems, cemeteries, hospitals, and manufacturing plants producing harmful waste waters ; and recreational and other activities which might involve contamination of the water.

$[0mOff GesundhDienst, 1963, 25, No. 1, 21; Zbl. Bakt., I, Ref., 1964, 192, 105-106
Intensive measures for garbage disposal.
W. SEIDENKRANZ
The author discusses the existing laws on and methods for garbage disposal in Germany, and stresses the need for intensified measures in controlling cemeteries, crematoria and carcass disposal, for which no legislation exists so far, and which would have a detrimental effect on the sewerage systems and on the quality of water. He then suggests that the following rules should be applied: disposal sites must be chosen according to their needs, the use of these sites should be made compulsory, and all existing knowledge of sanitation and hygiene must be observed when dealing with garbage disposal. The author believes that provision should be made by the authorities to initiate disposal units responsible for safe garbage disposal.

H2O, 1988, 21, No.12, 327-331 (in Dutch, English summary p.319).
The quality of surface water, drainage water and groundwater in the neighbourhood of cemeteries.
H. VAN DER HONING (Zuiveringschap Hollandse Eilanden), F. J. J. BRINKMANN, W. P. J. VAN DER ENDE, and A. HOOIMEIJER.
Analyses of the surface water, drainage water and groundwater in the vicinity of 5 graveyards in the Netherlands were conducted on a large number of physicochemical, chemical and microbiological parameters; results are presented. Several of the waters were also used in toxicity tests on ~Daphnia magna~ and ~Poecilia reticulata~, and lethal and sub-lethal effects at 24 and 48 h were noted. The presence of pathogenic viruses was not investigated. None of the levels found showed any significant increase over those found in more remoter locations, but in view of the possibility of elevated levels of

corporeal decomposition products from newly-buried bodies, it was recommended that drainage waters, especially from newly-commissioned cemeteries, should be intercepted, and led to a sewage works. (Full translation 115 pounds sterling). -Netherlands- ; -Journal Paper- ; -Case Study-

Water Science and Technology, 1991, 24, No.11, 97-104.
Cemeteries - a potential risk to groundwater.
A. PACHECO (Universidade de Sao Paulo), J. MENDES, T. MARTINS, S. HASSUDA, and A. KIMMELMANN.
Data are presented from a study on the bacteriological quality of groundwater under 3 cemeteries in Brazil. Most of the water samples contained faecal streptococci and sulphite reducing bacteria and salmonellae were detected in 1 sample. Proteolytic and lipolytic bacteria, associated with the decomposition of animal and vegetable organic matter, were also found in the groundwater and the water had an unpleasant smell. These cemeteries posed a real risk to the groundwater. The bacteriological quality of the groundwater depended on the soil type and depth to water table. -Brazil- ; -Journal Paper- ; -Experimental-

Points of large abstraction

$[OmH2O, 1982, 15, No.15, 395-399 (in Dutch, English summary p.367 and 399).
Environmental effects of groundwater withdrawal and compensating measures .
G. VAN DER VELDE , (KIWA NV, Nieuwegein) .
Abstraction of groundwater (which in the Netherlands is intensive) can have serious detrimental consequences for other land uses: methods have been devised to assess the decrease in the yield of a dairy farm through lowering of the groundwater level. The aim is that those responsible for the abstraction refund the farmer for damage costs. Ecological aspects of groundwater abstraction are also discussed. -Netherlands-

Journal of Institution of Water and Environmental Management, 1987, 1, No.1, 27-38.
A method for managing river abstractions and protecting the environment.
P. J. DRAKE (Yorkshire Water), and J. D. F. SHERRIFF.
The development is reported of an improved method to assess and control the quantity of water available to river abstractors. The sensitivity of the river environment to abstraction was quantified by an environmental weighting system which considered fisheries, angling, aquatic ecology, terrestrial ecology, amenity and recreational aspects. Maximal permissible volumes of abstraction and minimal permissible river flows were established on the basis of subcatchments. Application of the guidelines for the determination of abstraction licences in North Yorkshire are described and future developments considered. -U.K.- ; -Journal Paper- ; -Application-

H2O, 1993, 26, No.16, 436-437 and 440 (in Dutch, English summary p.435).
Environmental impact assessment concerning the deepwell project in the area of Kennemerduinen.
H. J. ROELOFS (Grontmij NV), and J. B. de BRUIN.
Adverse ecological effects within the dunes of the South Kennemerland water company, Netherlands, caused by over-pumping for a prolonged period, are to be rectified, in accordance with the policy of the government of the Province of North Holland, in whose area they lie. The plans of the company to reduce abstraction by nearly half, making up the deficit by injecting treated water taken from the Rhine, constitute a project of such a size and with such a potential environmental effect as to require an environmental impact assessment; the case was reinforced by the location of the proposed injection wells within the area of a national park. The scale of the project, the aspects which the assessment will consider, and the relative priorities and weightings which will be assigned to them within the 2 broad headings of improving the environment and securing adequate water provision are outlined. (English translation 120 pounds sterling, valid for 1993).
-Netherlands- ; -Journal Paper- ; -Case Study-

Water Bulletin, 1993, No.575, 10-11.
Fishy goings on in Yorkshire.
M. WILKINS.
A project by Yorkshire Water to reinforce supplies to the industrial area of West Yorkshire, including Leeds, is outlined. The plan, to be approved by the National Rivers Authority, envisaged an augmentation of supplies, via the Eccup water treatment works, by increasing the fraction derived from the Ouse river at Monkton Moor. This fraction was limited by the terms of an abstraction licence to 68 ml per d unless the river flow exceeded 100 Ml per d, when the

abstraction of 99 Ml was permitted. Since the flow exceeded 600 Ml per d for 95 per cent of the time, Yorkshire Water sought permission to abstract 144 Ml per d at a flow rate to be determined. As an aid to making this definition, the effect on the river's aquatic life of a permanent reduction of flow was being studied during the natural low-flow conditions obtaining in summer and early autumn. The environmental assessment team has been using 2 fish counting and identification techniques (hydroacoustic surveying and electrofishing) to define the fish-stock density, fish types, and fish sizes in the stretch of the Ouse which would be affected by the project. The data obtained would be made available to all interested parties, including objectors.
-U.K.- ; -Journal Paper- ; -Case Study-

Water Victoria, 1989, 1, No.5, 5-7.
Water for the $[1menvironment$[0m.
An outline of the objectives and scope of the $[1mguidelines$[0m prepared by the Victoria Department of Water Resources to help water abstractors to meet the $[1menvironmental$[0m requirements for new water resource projects set out in the Victoria State Conservation Strategy is given. Within this, all new diversions and abstractions had to accommodate a river flow pattern that would minimize harmful impacts on downstream ecosystems, while future water abstractors would have to pay the costs not only of $[1menvironmental$[0m maintenance but also of ascertaining what that maintenance entailed. The $[1mguidelines$[0m suggested an early $[1massessment$[0m of why the proposed development was needed, what the options for it were, what information would be needed to make an informed choice from among them, who was to be consulted as to its effects, and whether the project would be consistent with State governmental policy. Defining the $[1menvironmental$[0m water requirements for each individual situation would rely initially on studies for comparable cases conducted in other countries, pending the outcome of research to meet specific Victorian riverine, estuarine and wetland requirements, especially in terms of indigenous fish. -Australia- ; -Journal Paper- ; -Case Study-

Land & Water International, 1993, 77, 18-20.
Environmental impacts.
J. G. A. COPPES (Witteveen & Bos Consulting Engineers).
The growth in The Netherlands of awareness of the environmental consequences of water control structures, such as dykes, and of water abstraction in general is traced, and set within the context of the decline in the availability of water of a quality fit for the expectations of various categories of consumer. Netherlands water-related legislation has, since 1970, increasingly incorporated requirements on developers to show that their projects will not adversely affect the environment. The Environmental Impact Assessment Statement of 1986, specifically requires such an assessment to be made for all projects likely to have a substantial' environmental effect, while the Water Management Act of 1989, in calling for an integrated approach to water systems, prescribes penalties if environmental consequences receive inadequate attention. To avoid these, developers have formed a system of independent evaluation of their proposed projects; this will soon be tested against plans for raising the level of a dyke in Voorst, and for a storm surge barrier across the mouth of the IJssel. Guidelines, and a checklist of topics to be considered in environmental impact studies, have been drawn up by respectively the International Commission on Large Dams and the International Commission on Irrigation and Drainage; these are briefly summarized. -Netherlands- ; -Journal Paper- ; -Case Study-

Points of large discharge

ENDS Report, 1991, No.194, 34-36.
Ministers agree directives on wastewater, diesel emissions and chemical testing.
EC $[1menvironment$[0m ministers had agreed the wastewater treatment directive. Implementation plans had to be drawn up by the end of 1993. Deadlines for achieving discharge standards were: 1998 for sensitive areas; 2000 for population equivalents (PE) over 15,000; 2005 for PE of 10,000-15,000 discharging to coastal waters and PE of 2000-10,000 to freshwaters and estuaries. Secondary treatment would also be necessary for any effluent from a PE of 150,000 or more. Discharge limits, as daily averages, for BOD and COD of 25 and 125 mg per litre respectively were likely. Suspended solids limits were optional at 35 mg per litre. Nitrogen and phosphorus standards would apply where appropriate and be $[1massessed$[0m as annual averages. A look-up table and upper tier approach were the likeliest means of compliance testing. The concept of normal operating conditions would be invoked in judging performance. Eleven $[1mindustries$[0m mainly connected with food and drink were also listed. Member states had to define discharge requirements for them. -Europe- ; -Journal Paper- ; -Legislation- ; chemical oxygen demand

$[0m2nd U.N. int. Conf Peaceful Uses Atom. Energ., 1958. A/Conf. 15/P/297. 22pp
The disposal of radioactive liquid wastes into coastal waters.
H. J. DUNSTER
An account is given of the sampling of fish, seaweed, sea-bed material. and shore sand in environments affected by the discharge of radioactive waste waters from the Windscale Works of the U.K. Atomic Energy Authority, Sellafield, Cumb. (see Wat. Pollut. Abstr.. 1957, 30, Abstr. No. 391). and the results obtained up to the end of 1957 are tabulated. In addition to determinations of total P-activity. individual estimations were made of plutonium, strontium, and ruthenium in fish and seaweed, since these are both used as food. Sampling was carried out at distances up to 50 km from the outlet; at this distance the activities determined did not differ significantly from background levels. The maximum permissible levels of radioactivity in marine materials are discussed; the values adopted at Windscale are tabulated and were used in conjunction with the results of sampling to determine the maximum permissible rate of discharge from the plant. The maximum permissible discharge is limited by the amount of radioactivity accumulated in the seaweed, most of which grows within 20 km of the outlet and is used almost directly as food (see War. Pollut. Abstr., 1960, 33, Abstr. No. 193). From the results obtained, it is concluded that the rate of dispersal of radioactivity in these coastal waters is adequate to permit the safe release of some 20000 curies of total e-activity per month at a point about 3 km off this part of the Cumberland coast. Specific limitations are necessary for strontium-90. ruthenium-106, and plutonium. The applicability of these results in assessing the problem of disposal of radioactive waste waters in other coastal waters is discussed. and preliminary surveys near the Dounreay reactor, Scotland. and the Winfrith Heath Establishment, near Weynmouth (see following abstract) are summarized.

$[0mHlth Phys., 1969 16, 33-46.
The I. C. R. P. critical group concept in relation to the Windscale sea discharges.
A. PRESTON and D. F. JEFFERIES
The critical exposure pathway limiting radioactive discharges of waste waters to sea from the Windscale plant, Cumb., (see Wat. Pollut. Abstr., 1967, 40, Abstr. No. 1137) involves Porphyra which is used in manufacture of laverbread, for human consumption, the critical nuclide is ruthenium-106, and the critical organ is the lower large intestine. Data from recent surveys on the manufacture and consumption of laverbread in the area are presented and used as the basis for a model of the recent 1. C. R. P. concept of a small critical exposure group of the population for use in assessing radiation doses from the results of environmental monitoring. The critical group, which is determined statistically, should be representative of the more highly exposed individuals and should also be reasonably homogeneous with respect to those factors which affect the dose received. In the critical group determined for the Windscale area, the median rate of consumption of laverbread, suggested as a basis for controlling the Windscale discharge, is 160 g per day and based on this figure the estimated average dose of radioactivity to the lower large intestine over the last 6 years is 0.4-0.7 rem per year, compared with the I. C. R. P. recommended dose limit of 1.5 rem per year.

$[0mCalif. FISH Game, 1969, 55, 26-46.
Results of a six-year trawl study in an area of heavy waste discharge: Santa Monica bay, California.
J. G. CARLISLE
The results of a trawl study in Santa Monica bay, California, from 1958 to 1963, to assess the effect on the marine environment of the discharge of sludge and effluent from outfalls of the Hyperion works of Los Angeles (see also Wat. Pollut. Abstr., 1962, 35, Abstr. No. 1860), are given. Fluctuations in abundance, as measured by trawl catches, could not be related to the polluting discharges, and anglers' catches showed only small fluctuations over the study period. Speckled sand-dab showed an attraction to the nutrient-enriched area near the sludge outfall; other species of fish avoided the area of the effluent outfall. It was found that kelp would not develop on artificial reefs in coastal-water areas of the bay where the deposition of particulate matter was related to the discharge of effluents.

$[0mSTI/PUB/283, Safety Ser. No. 36, Vienna, 1971. 81 pp.
Disposal of radioactive wastes into rivers, lakes and estuaries.
INTERNATIONAL ATOMIC ENERGY AGENCY.
This is a revision of Publication No. 10 in the Safety Series (see Wat. Pollut. Abstr., 1964, 37, Abstr. No. 149), incorporating new knowledge and experiences in the management of radioactive wastes. It is concluded that radiation risk is best assessed, discharge limits for radioactive wastes are best established, and continuous surveillance is best maintained, on the basis of the critical nuclide-critical pathway-critical population group concepts; and practical advice is given on the use of these concepts. In appendices, information is given on the exposure pathways associated with various uses of a contaminated water body, on the calculation of doses, and on the environmental effects of radioactive wastes discharged to surface waters in several countries.

$[0mWat. Pollut. Man. 1972, 118-121.
Effluents from paper mills.
C. A. ROBERTS
After outlining the water demand and sources and composition of effluent from paper manufacture, with recent data showing a net consumption of 8000 gal of water per ton of paper, the author compares methods for removal of BOD and suspended solids, to meet blanket standards for discharge to rivers, and considers problems of sludge disposal. When discharge standards are stringent, the necessary process changes tend towards a totally-closed recycling system, but the author recommends a systems engineering approach to environmental problems, waiving the blanket standards and considering the precise effect of discharges on the receiving stream, developing more precise control systems, and using more specific parameters than BOD to assess the effects of an effluent.

$[0mEnergy Agency, Vienna, ,1973. 797 pp.
Radioactive contamination of the marine environment.
International Atomic Energy Agency
Papers presented at a symposium convened by the International Atomic Energy Agency in Seattle, Wash., in July 1972, considered interactions of radioactive contaminants with constituents of the marine environment. Methods for determining concentrations of fission products were compared, and the physical and chemical behaviour of radionuclides and their transfer by rivers to sea were discussed. Models have been developed to predict the uptake and release of radioactive and stable isotopes by marine organisms. Effects of irradiation on marine and freshwater species have been examined, and the dose rate they experience has been calculated on a global basis. The accumulation of radionuclides by edible marine organisms was considered in relation to public health hazards, and public exposure in U.K. arising from discharge of radioactive waste waters has been assessed. Levels of radioactive manganese, cobalt, and zinc accumulated by barnacles and mussels indicate variations in isotope concentrations in sea water. Studies on distribution of radionuclides in marine waters, sediments, and coral reefs were reported.

$[0mFreshwat. Biol., 1974, 4, No. 3, 213-222.
Numerical indices applied to the results of a survey of the macro-invertebrate fauna of the Tamar catchment (southwest England).
P. M. NUTTALL and J. B. PURVES
A survey of the macro-invertebrate fauna in the Tamar river showed an organically enriched upper region and a more stable environment in the lower reaches and tributaries. Invertebrate species associated with organic pollution occurred immediately downstream from discharges of farm wastes and sewage effluents, but species normally associated with unpolluted conditions were widely distributed throughout the catchment area, indicating that the river is free from gross pollution. The Diversity index was found to be the most suitable for assessing the biological condition of the river; the Trent, Lothian, Chandler, and Carpenter indices either gave anomalous results or were not sufficiently sensitive. <00>River Trent,

$[0m S Eff. Wat. Treat. Jo. 1974, 14, No. 10, 549-553 and 555-559.
Heated discharges from thermal power stations.
F. B. HAWES , (CEGB), J. COUGHLAN , and J. F. SPENCER .
Biological investigations on the effect of heated discharge from Bradwell nuclear power station on an unpolluted marine environment which is the centre

of an oyster cultivation industry are reviewed and the environmental impacts of component parts of cooling systems, including entrainment screening and cooling lakes, are examined and assessed. It is concluded that the discharge of waste heat can be achieved in water without rendering it unfit as a resource. A bibliography of 15 references is appended.

$[0m S Ambio, 1976, 5, No. 2, 77-79
A comparative study of the effects on the marine environment of wastes from cellulose industries in Scotland and Sweden
T. H. PEARSON , and R. ROSENBERG
A study to assess the influence of effluents from cellulose industries on the benthic faunas of comparable fjordic systems on the west coast of Sweden and Scotland is reported. The study areas are described, and generalizations are made about sequential changes in the interrelationship of benthos and sedimentary structure. The results of species diversity investigations are presented graphically and it is suggested that discharge of suspended organic material into a semi-enclosed marine area may result in the elimination of benthic animals in an area within 1-2 km of the discharge point. The advantages and disadvantages of using indicator species, comparing faunal groups, and using diversity indices in the description of ecological changes are briefly considered. A bibliography of 18 references is appended.

$[0m S International Atomic Energy Agency, Vienna, 1975, 366pp.
Combined effects of radioactive, chemical and thermal releases to the environment - proceedings of a symposium, Stockholm, 2-5 June 1975.
Papers and discussions are reprinted from a symposium on the combined effects of radioactive, chemical, and thermal discharges from nuclear power plants on the aquatic environment and the atmosphere. The effects of temperature on the uptake of radionuclides by marine organisms; synergism and combination effects in aquatic systems; the effect of chemical releases on radionuclide uptake; synergism and combination effects from releases to the atmosphere; and other factors in the assessment of synergistic and combination effects are reported.

$[0mProgress in Water Technology, 1979, 4, 77-86
Receiving water studies for preliminary design.
L. A. KLAPOW (CALIFORNIA STATE WATER RESOURCES CONTROL BOARD), AND R. H. LEWIS.
Procedures for coastal reconnaissance surveys in advance of determination of suitable sites for waste-water discharge are discussed. In consideration of the acceptability of disposal sites the subjects of dilution and time-dependent decay processes, and criteria based on public health, aesthetic concern and protection of marine organisms are discussed. Many baseline parameters of the receiving waters are given which are useful in assessment of effects of the discharge. Trends towards higher levels of treatment and limitations on the discharge of toxic material may diminish the need for extensive pre-design surveys and environmental analyses. -U.S.A.-

$[0mH20, 1980, 13, No.22, 530-535 (in Dutch, English summary p.519).
Waste discharge into surface waters.
A. G. VAN DEN HERIK , (Afdeling Rioleringen, Grontmij NV, De Bilt) , R. LAGEVEEN , and W. J. P. WORST .
Legislation regarding waste-water discharge into surface waters is described in relation to the Netherlands, including legislation at the national, provincial and water authority levels. Limiting values of the BOD, Kjeldahl nitrogen, ammonia, nitrite, nitrate and phosphorus are tabulated on the basis of the

Dutch Indicatief Meerjaren Programma . Further legislation regarding waste-water discharge to surface waters is also described, including environmental effect reports. Water quality assessment is discussed, including eutrophication. Theoretical considerations in calculating water quality are also described mathematically. -Netherlands-

$[0mJournal of Water Pollution Control Federation, 1980, 52, No.10, 2442-2451.
Bactericidal agents in waste-water lagoons and lagoon design.
J.R. MOELLER, (Idaho Division of Environment), and J. CALKINS.
At the sewage works of West Hickmann Creek, Ky. , treatment is by the Kraus modification of the activated-sludge process, followed by passage through 4 sewage lagoons in series and chlorination before discharge. To assess whether chlorination was actually necessary, studies were carried out on the reduction of coliform bacteria through the lagoon system, with particular reference to the effect of ultraviolet radiation. Based on the results, recommendations are made for improving the design of sewage lagoons to give maximum exposure to light . This might involve the use of UV reflectors located beneath the water surface, with flow limited to periods of high UV intensity; immediately after UV exposure the treated water would move under the reflector. -U.S.A.-

$[0mImpacts of radionuclide releases into the marine environment, IAEA, Vienna, 1981, 535-570. (02De INT).
Collective and individual radiation exposure from discharges of radioactive waste to the Irish sea.
G. J. HUNT , (MAFF, Lowestoft) , and D. F. JEFFERIES .
In the application of controls to discharges of radioactive wastes to the environment, estimates of the total population detriment and the level of exposure of critical population groups are required. The authors consider both these aspects in the context of discharges from the Windscale nuclear fuel reprocessing plant. Total population detriment is assessed in terms of the Normalized Collective Effective Dose Equivalent Commitment (NOCEDEC) which is a total estimated health detriment (assuming a linear dose-response relationship in the sub-threshold region) integrated over the entire population considered for all time. The application of this technique is considered first of all with respect to the major contributor Cs-137 and all the possible exposure pathways (edible fish and shellfish consumption, seaweed products, external radiation exposure and inhalation), and then for the other radionuclides present in the discharge. Finally the exposure level of some critical population groups in the vicinity of the discharge area is considered, comprising groups of heavy fish and shellfish consumers , people frequenting the intertidal mudflats and holidaymakers on the beaches at Blackpool and neighbouring resorts. The results are presented, showing the total effective dose equivalent for a combined critical group, from discharges in 1979, would amount about 25 per cent of the ICRP recommended dose limit for members of the public, of which over half is derived from Cs-137. -U.K.-

$[0mImpacts of radionuclide releases into the marine environment, IAEA, Vienna, 1981, 629-648. (02De INT).
A model to assess exposure from releases of radioactivity, into the seas of northern Europe.
M. J. CLARK , (National Radiological Protection Board, Harwell) , and G. A. M. WEBB .
A regional marine model is proposed for predicting the combined exposure of

populations as a result of the discharge of radioactive effluents into the coastal waters of northern Europe. The model simulates the dispersion of radionuclides in marine waters, their interaction with marine sediments and the concentration mechanisms occurring in seafoods. A local/regional interface is assumed whereby releases are first considered as entering a local marine compartment before more widespread dispersion in coastal waters. Depletion mechanisms also operate within both the local and regional environments influencing the fraction of the total radionuclide release which contributes to collective exposure. In general the results are expressed as collective intakes of activity from the ingestion of seafoods. These quantities can be converted into collective doses per unit discharge, given a knowledge of local depletion factors and the dose per unit intake of radionuclides. Some results for Cs-137 and Pu-239 released into U.K. coastal waters are presented. -U.K.-

Proceedings of Institution of Civil Engineers (Part 1), 1985, 78, 1045-1064.
Planning, design and construction of the Great Grimsby sewage outfall.
C. MASON (Anglian Water), K. J. FLEMONS, and A. G. TAYLOR.
Against recent research findings that harmful environmental effects from discharge of sewage effluents to the sea could be avoided by careful planning, design and construction, a description is given of the three phases leading to the successful completion of a 2 m diameter sewage outfall approximately 3 km long at Grimsby discharging into the Humber river. Details of preliminary site surveys, cost assessments, appraisals of the type and number of pipes to be used and dilution and dispersion studies are given.
-U.K.- ; -Journal Paper- ; -Case Study-

Ingegneria Ambientale, 1986, 15, No.1, 5-16 (in Italian, English summary).
Environmental impact assessment as a tool to link quality objectives for surface waters with the requirements for discharges into the same waters.
S. MALCEVSCHI (Universita di Pavia), G. CIVATI, and G. BISOGNI.
The problems of environmental impact assessment are illustrated by a sewage works serving 600,000 PE in St. Antonino. The co-ordination of discharge standards and water quality objectives of receiving ^ waters is described. How exceptional floods and unforeseen plant breakdowns are introduced into the assessment procedure, is explained. Environmental analysis and ''filter' ecosystems are described and various options for solving the problem of optimizing objectives discussed. (Full translation 220 pounds sterling).
-Italy- ; -Journal Paper- ; -Case Study-

Ecology, 1986, 67, No.4, 929-940.
Environmental impact assessment: pseudoreplication in time.
A. STEWART-OATEN (California University, Santa Barbara), W. M. MURDOCH, and K. R. PARKER.
The statistical problems associated with sampling programmes, designed to assess the environmental effects of a single source of pollution are discussed. A sampling scheme (BACI) is described. It was designed to detect the effect of a pollution discharge on the underlying mean of the mean abundance of biological populations. Detection of ecological effects required sufficient sampling, replicated in time, both before (B) and after (A) a pollution discharge to a river and at both the control (C) and impact (I) sites. The design was not appropriate where local events caused biological populations at Control and Impact sites to have different long-term trends in abundance.
-U.S.A.- ; -Journal Paper- ; -Application-

Environmental Resources Ltd., London, for the Department of the Environment, 1986. 129pp. (40311).
Comparison of environmental quality objectives and limit value approaches to control of dangerous substances: final report.
The relative merits and implications for industry, water authorities and the environment, of the two stated approaches to control of pollutant discharges to the environment are examined. The study involved detailed investigation of the origins and magnitude of cadmium discharges to the aquatic environment, together with a survey of pentachlorophenol (PCP) emissions. As only one consented PCP discharger was identified within the area of the four English Water Authorities involved (Wessex Water, Yorkshire Water, Thames Water and Severn Trent Water) the study is principally concerned with cadmium discharges. Three categories of discharger were distinguished; smelters, platers and others (eg pigment, battery and fertilizer manufacturers) and the effects on these of a change to the limit value (LV) from the environmental quality objectives (EQO) approach currently employed were assessed. The more stringent conditions implicit in the LV approach had serious adverse economic and financial implications particularly for platers, while the discharge of cadmium to the environment as a whole would be unlikely to decrease significantly (treatment residues would require land disposal) and the benefits to water authorities would be marginal or non-existent. -U.K.- ; -Report- ; -Review-

Water Pollution Research Journal of Canada, 1987, 22, No.4, 545-558.
Improving aquatic environmental impact assessment in Canada - a northern case study. W.F.A. DUNCAN (Sutek Services Ltd., North Vancouver), and E.M. NEIL.
A case study is presented of a methodology to predict the ecological effect of a known dose of an aquatic contaminant, while taking account of mediating natural environmental factors. Such an assessment was considered more useful than data-gathering, which might do no more than ensure that what could be arbitrary criteria for wastewater discharges or receiving water quality were complied with. The effects of a one-month bulk release of gold mine tailing waters, necessitated by the need to draw down a storage pond to permit engineering works to increase its capacity, were assessed in the receiving waters, sediments, fish and clams, and their meaningfulness is discussed. Water quality data soon reverted to previous background levels at the cessation of the pond decant. The reaction time of the metals in the release was insufficient to produce effects in sediments or fish but the duration of the discharge formed a significant fraction of the life of clams, which proved the best indicators. The selection of suitable dose terms and effect terms was essential to the proper application of a conceptual framework for relating pollutional causes to environmental effects. -Canada-Journal Paper-Case Study-

Water (Australia), 1986, 13, No.3, 20-25.
Cape Peron environmental monitoring.
P. N. CHALMER (Le Provost, Semeniuk and Chalmer), and L. W. EDMONDS.
The environmental monitoring carried out before and after the commissioning of a 1400 mm outlet from a wastewater treatment plant at Woodman Point, Perth, is described. A comprehensive monitoring programme was commenced in 1984 and showed that effluent discharge was behaving as predicted and not adversely affecting the environment. Sampling was based on annual grid sampling and beach sampling together with water quality monitoring. Nutrients, chlorophyll-a and bacteria were assessed in relation to water quality. Sentinel mussels and the benthic fauna were also examined. Bacterial mortality rates were determined. -Australia- ; -Journal Paper- ; -Case Study-

Environmental Management, 1988, 12, No.1, 85-97.
Effects of discharge fluctuation and the addition of fine sediment on stream fish and macroinvertebrates below a water-filtration facility.
D. C. ERMAN (California University, Berkeley), and F. K. LIGON.
Following an extensive literature review of the effects on fish and aquatic invertebrates of fluctuating stream discharge and increased sediment content, taken separately, results of field experiments to assess their effect when present concurrently are presented. Data were collected from sites upstream and downstream of a direct water filtration facility, operated without previous coagulation and sedimentation, but with introduced alum. The filter in question required up to 60 backwashes per day, with consequent surges in water volume and sediment to the receiving stream. No toxic effects arising from the use of a coagulant were detected in caged fish. At the upstream sites, the number of invertebrates found during autumn, spring and summer always exceeded those found downstream, by a factor of 3-70, due to an unstable substrate occasioned by surge discharges. Reduced numbers of fish below the filter backwash discharge were attributed to the inability of young fish to contend with the mechanical force of surges. The apparent economic advantage of direct filtration was questioned if environmental considerations should make the construction of holding ponds to smooth their backwash discharges obligatory.
-U.S.A.- ; -Journal Paper- ; -Experimental-

Water/Engineering & Management, 1989, 136, No.4, 40-41.
No adverse environmental impacts from water plant discharges.
S. D. LIN (Illinois State Water Survey, Peoria, Ill.).
Four reports, compiled between 1979 and 1987 by the Illinois State Water Survey , on the effects of the discharge of water treatment alum sludges on receiving waters are briefly summarized. The treatment works concerned discharged to a variety of watercourses, ranging in size from a creek to the Mississippi river. The concentration of aluminium in the waters and sediments, and any changes in the macroinvertebrate populations downstream compared with upstream of the discharge points were measured. Detectable changes were confined to areas at most half a mile downstream from these points, and for at most 200 ft from the shore. No evidence of alum buildup on sediments was found, and there were negligible ill effects on aquatic fauna. Although macroinvertebrate species diversity and abundance were modified downstream in the case of the creek discharge, these were not sufficient to change the water quality's category, as assessed by the macroinvertebrate biotic index used by the Illinois Environmental Protection Agency. -U.S.A.- ; -Journal Paper- ; -Review-

Water & Waste Treatment, 1991, 34, No.9, 24-25 and 29.
Your application for IPC authorization - more guidance available.
J. GARBUTT (Nicholson Graham & Jones).
The application procedure for integrated pollution control (IPC) authorization, required by all new and materially changed processes under the Environmental Protection Act (1990), is discussed with particular reference to the technical assessment of a process. The respective roles of the National Rivers Authority (NRA) and Her Majesty's Inspectorate of Pollution (HMIP) as consultee and authorising body, respectively, are discussed. The authorization deals with discharge and other limits, guidance notes giving advice on release limits in terms of mass of substance discharged to a particular medium within a specified time, and certain design and operating criteria required to meet quality of operation, monitoring and environmental effects measuring standards.
-U.K.- ; -Journal Paper- ; -Review-

Korrespondenz Abwasser, 1992, 39, No.4, 526-531 (in German, English summary).
Licensing models for municipal sewage disposal.
E. GAWEL (Universitat Koln).
As a result of the imposition of ever more stringent discharge consents and the escalation of financial penalties and taxation charges for the residual pollution loads discharged to a receiving stream, municipal sewage treatment plants would be subjected to much greater economic and environmental pressures. To assess the consequences of such changes the application of licensing models of the type favoured by economists to assess the most efficient solution is examined. The principles of such models and their application to the overall system for sewage collection, treatment and disposal are described and the consequences of the issue of certificates or consents for operation under certain prescribed conditions are analysed in general terms. The process was specially relevant to the question of whether centralized or local treatment facilities presented the most favourable solution to the problem of effluent treatment for a number of sewerage undertakings. (English translation 220 pounds sterling, valid for 1992).
-Germany- ; -Journal Paper- ; -Cost Study-

WRc plc, Medmenham, Report No.PRU 2276-M/1, 1989. 22pp. (ME/44042).
House of Commons Environment Committee: Water Research Centre memorandum on the pollution of beaches.
WRc plc, Medmenham.
The possible causes and available evidence of adverse effects resulting from the discharge of untreated sewage to coastal waters are considered, and the desirability of introducing physical and/or biological treatment on land prior to discharge to the inshore aquatic environment is discussed. The factors contributing to harmful or unpleasant effects are reviewed, together with the impact of various treatment options on residual levels of bacteria, viruses, heavy metals, nutrients and organic matter. The probable technical and aesthetic benefits of land treatment versus disposal of partially treated sewage via marine outfalls are considered with reference to studies in progress at Langland bay, Swanage and Tenby. Effects on water quality, micro-organisms and shellfish are reviewed, and the risks associated with sea bathing are assessed in the light of epidemiological evidence from other parts of the world. The standards in respect of bathing water quality, shell fisheries and effluent discharges are also considered, together with the extent to which compliance was achieved in the various EC member countries. Other non-quantifiable aspects such as ethical considerations and political pressures favouring a ban on the discharge of pollutants to the marine environment are briefly referred to. From the economic viewpoint, the costs of land treatment exceeded those for discharge via long sea outfalls by a factor of 2-3. -U.K.- ; -Report- ; -Review- ; -Staff Paper-

Water Science and Technology, 1991, 23, No.1/3, 151-161.
$[1mEnvironmental$[0m studies of a marine wastewater discharge from a sulphite pulp mill - example of a general study approach for marine industrial discharges.
N. NYHOLM (Region of Storstrom, Nykobing), H. BACH, J. BIRKLUND, T. L. JENSEN, K. O. KUSK, O. SCHLEICHER, and H. SCHRODER.
A study of a 5000 m3 per d sulphite process effluent of COD 20,000 mg per litre discharged from a pulp mill to the sea was used to illustrate a general strategy of environmental impact assessment and management of marine industrial discharges. The $[1mwaste$[0m was characterized both chemically and by its

toxicity to aquatic organisms. Its degradation was investigated. Field monitoring, including studies of dissolved oxygen, flora and fauna were supplemented by case studies of selected organisms. The flow and dispersion of the pollutant plume were modelled. A predictive tool was then developed for $[1massessing$[0m environmental impact. Biological field data gave an initial impression of the problems, and supported the $[1massessment$[0m, but their time and spatial variability made it impossible to rely on these alone. The particular study was complicated by the $[1mwaste$[0m having both a toxic and an oxygen depleting effect.

Marine Pollution Bulletin, 1982, 13, No.10, 338-340. (Reprint). (36415).
Why do environmental research?
D. G. SHAW (University of Alaska, Fairbanks) .
The value and importance of environmental research projects are discussed in the context of the search for information concerning the impact of various industrial or construction projects on the environment. The author defends his approach based on the technique of cost effectiveness analysis for ranking the priorities or importance of different research programmes, as a means of introducing some degree of rational judgment into an otherwise subjective or intuitive process of decision making. Cost effectiveness analysis applied to environmental research projects will enable the information sought about the consequences of a certain course of action to be assessed in the light of the costs of acquiring it. The author takes as an example the problem of an industrial discharge to a coastal marine environment. Stages in the implementation of a research project are considered, and the author emphasizes that analysis at each stage is not a substitute for scientific judgment, but a way of decreasing the degree of uncertainty, and provides a systematic framework for the application of value judgments when answering the question - is it worth doing or not? -U.S.A.- ; -Journal Paper- ; -General-

Navigation issues

$[0mWater Science and Technology, 1984, 16, No.3/4, 653-658.
Ecological problems related to the Loire estuary development.
B. BELLESSORT (Laboratoire Central d'Hydraulique de France, Maisons-Alfort), J. M. CAILLAT, C. BROSSARD, and J. BOURGOUIN.
In connection with plans for possible future developments in the Loire estuary, France, such as deepening of navigation channels, construction of berths and modification to the banks, studies have begun to assess the likely environmental effects of such developments. The authors outline the programmes of studies planned or in progress on hydraulic and sedimentation phenomena, on water quality, and on benthos, fish and wetlands.
-France- ; -Journal Paper- ; -Case study- .

Regulated Rivers: Research and Management, 1988, 2, No.3, 323-333.
Regulation of the river Thames - a case study on the Teddington flow proposal.
J. R. SEXTON (Thames Water, Reading).
A scheme for modifying existing flow regulation policy on the Thames river to provide an additional 170 Ml of water per day for supply was examined. The scheme, the Teddington Flow proposal, was assessed in terms of the implications for water quality, water levels, ecology, navigation, recreation, and amenity. No significant adverse effects were identified. The proposal would improve the river environment in drought years, while providing greater security for water supplies and less frequent restrictions, with almost no increase in water charges. -U.K.- ; -Journal Paper- ; -Case Study-

Hydrobiologia, 1989, 188/189, 601-618.
In situ bioassessment of dredging and disposal activities in a contaminated ecosystem: Toronto harbour.
M. MUNAWAR (Canada Centre for Inland Waters, Burlington, Ont.), W. P. NORWOOD, L. H. McCARTHY, and C. I. MAYFIELD.
Toronto harbour received polluting discharges from the Don river, sewer outflows, industrial and municipal effluents as well as disturbance of the toxic sediments caused by dredging, dredge spoil disposal, $[1mnavigation$[0m and recreational activities. Size-fractionated primary productivity studies involved experiments on the in situ impact of dredging (pre, during, post), and disposal (pre, post (10 or 60 minutes)) together with sediment elutriate bioassays and statistical evaluation. Results indicated that, due to interactions between nutrients and toxic contaminants, as well as to the variable sensitivity of natural phytoplankton size assemblages to bioavailable chemicals, microplankton/netplankton (greater than 20 um diameter) productivity was increased while ultraplankton (less than 20 um diameter) productivity was inhibited. The in situ $[1menvironmental$[0m techniques as applied to Toronto harbour were effective, sensitive and rapid and had great potential for the $[1massessment$[0m of the ecotoxicology of harbours and other polluted environments. -Canada- ; -Journal Paper- ; -Case Study-

Delft Hydraulics, Delft, Publication No.434, 1990. 28pp.
Integrated modelling as a tool for $[1massessment$[0m of environmental impacts from dumping of polluted dredging sludge.
J. A. van PAGEE (Delft Hydraulics), and J. C. WINTERWERP.
The combined use of mathematical modelling techniques, field surveys and laboratory experimentation on specific properties of mud as a basic tool to

analyse and predict the environmental impacts of dredging activities is discussed, covering $[1mdevelopments$[0m in modelling of human $[1mimpact$[0m on estuarine and coastal water systems, including modelling of mud transport in the Rhine-Meuse estuary and the southern North sea, laboratory research on the settling properties, deposition rate, erosion rate and the physico-chemical properties of mud and integrated $[1menvironmental$[0m modelling of harbour sludge dumping in the North sea. Analysis for alternative options for disposal of polluted dredging sludge indicated that the current storage of class II and III sludge from Rotterdam harbour was the best cost-benefit option for the Dutch Wadden sea. -Netherlands- ; -Report- ; -Experimental-

Power stations

$[0mJournal of Water Pollution Control Federation, 1984, 56, No.6, 654-664.
Power industry wastes.
T. J. CHU (Tennessee Valley Authority, Knoxville) , and M. L. IWANSKI.
Giving a bibliography of 161 references, the authors review recent literature on wastes from the power industry, dealing with legislation in U.S.A. affecting the power industry (this is summarized in a table); assessment of the environmental impact of hydro-electric power plants, and selection of suitable sites; assessment of environmental impact of coal-fired power plants, their siting, disposal and utilization of ash, cooling systems and discharge of cooling water, and desulphurization of flue gas; assessment of environmental effects of nuclear power plants and treatment and disposal of the wastewaters; studies on fluidized-bed combustion; and utilization of waste heat. -U.S.A.- ; -Journal Paper- ; -Review-

British Hydromechanics Research Association, 1984. 221pp. (39398).
Thermal discharges: a guide to power and process plants cooling water discharges into rivers, lakes and seas.
D. S. MILLER (B.H.R.A., Cranfield, Bedford), and B. A. BRIGHOUSE.
The current state of knowledge concerning the behaviour of thermal effluent plumes and the hydraulic behaviour of cooling waters discharged to inland or coastal waters is reviewed. The publication, based on accumulated practical experience and published reports, is divided into two parts, the first of which reviews the factors influencing thermal discharges to natural waters, and the second considers the methods and procedures which allow estimates of discharge behaviour to be made. The authors stress that as no complete mathematical model for simulating the behaviour of effluent plumes and their dispersion in receiving waters is available, predictions must be based on a reasoned assessment of the conditions applying to the discharge and the receiving environment. -U.K.- ; -Report- ; -Review-

Environmental Management, 1989, 13, No.5, 563-572.
$[1mEnvironmental$[0m monitoring at Hanford, Washington, USA: a brief site history and summary of recent results.
R. H. GRAY (Pacific Northwest Laboratory, Richland, Wash.), R. E. JAQUISH, P. J. MITCHELL, and W. H. RICKARD.
The monitoring programme conducted at Hanford to $[1massess$[0m the impact of nuclear and non-nuclear industrial and research activities on the $[1menvironment$[0m is described. The history of Hanford operations is outlined. Radiological and non-radiological materials could enter the $[1menvironment$[0m through releases of airborne and liquid effluents and solid wastes. Field sampling and chemical and physical analyses of air, groundwater and surface water, fish and wildlife, soil, vegetation and food for radiological and non-radiological materials is described. None of the air samples taken from perimeter sites exceeded $[1mguidelines$[0m. Radionuclides at the Richland water intake on the Columbia river were below concentration limits established for drinking water. There are 38 references. -U.S.A.- ; -Journal Paper- ; -Case Study-

$[0mWater Science and Technology, 1983, 15, No.11, 109-131.
Marine disposal of fly ash from coal-fired power plants.
O. HJELMAR (Water Quality Institute, Horsholm) .
It has been proposed that fly ash from coastal power plants in Denmark could be

used to construct an artificial island about 1 km offshore, and laboratory and field studies are being carried out to assess the environmental effects of such a construction. Results are presented and discussed from investigations on the composition of the ash, monitoring of operating and old ash ponds, and leaching of trace metals from the ash. -Denmark- ; -Journal Paper- ; -Experimental-

$[0mJ. Anim. Ecol., 1959, 28, 243-258
The cooling water of power stations: a new factor in the environment of marine and freshwater invertebrates.
S. MARKOWSKI
A general survey of several power stations and a more detailed survey of three stations (at Leicester, Wakefield, and Roosecote) were made to find whether the cooling water system had any effect on the aquatic invertebrates in fresh and sea water. At Leicester and Wakefield fresh water is used for cooling purposes, and at Roosecote water is taken from a brackish dock connected with the sea. Samples of zooplankton were collected from the intake and outfall waters and examined qualitatively and quantitatively; 35 freshwater and 62 marine species were identified. No detrimental effect on the organisms was observed, and they remained alive after being circulated through the condensers. There was no qualitative or quantitative difference in the composition of the fauna in the intake and the outfall. Freshwater forms were able to live and reproduce in the cooling ponds of the power station. It is pointed out that only a limited number of samples was taken and only a small number of species was examined. This does not mean that all species exposed to these conditions will survive, and systematic annual observations over a long period would be required to assess the full effects of cooling water on zooplankton.

$[0m S Eff. Wat. Treat. Jo. 1974, 14, No. 10, 549-553 and 555-559.
Heated discharges from thermal power stations.
F. B. HAWES (CEGB) , J. COUGHLAN , and J. F. SPENCER .
Biological investigations on the effect of heated discharge from Bradwell nuclear power station on an unpolluted marine environment which is the centre of an oyster cultivation industry are reviewed and the environmental impacts of component parts of cooling systems, including entrainment screening and cooling lakes, are examined and assessed. It is concluded that the discharge of waste heat can be achieved in water without rendering it unfit as a resource. A bibliography of 15 references is appended.

$[0m M Texas Univ Water Resources Symp No. 8, 1975, 420 pp. (25272)
Water management in the electric power industry.
H. F. GLOYNA , H. H. WOODSON and H. R. DREW (editors).
This symposium covers the entire energy industry's need for and management of water, in the context of the 1975 U.S. situation. Section 1 reviews the current and projected needs for water; Section 2 considers potential improvements in the design of cooling systems: Section 3 deals with water treatment, including desalination and water re-use; Section 4 includes 6 papers on the water requirements for production of additional fuel (e.g. improved coal and oil recovery from traditional extraction techniques, geothermal energy, solar energy, and the reprocessing of nuclear fuels); Section 5 covers some uses of low-grade heat (e.g. in agriculture and horticulture, for fish and shellfish production, etc.); and Section 6 assesses the implications for policies of environmental improvement of the energy crisis, and makes the particular point that the energy industry must be considered as a prime contender in the competition for use of available water supplies.

Journal of Indian Water Works Association, 1986, 18, No.1, 39-47.
Impact of thermal power plant emissions and effluents on water quality.
R. THAKRE (National Environmental Engineering Research Institute, Nagpur), D. S. RAMTEKE, and V. P. THERGAONKAR.
Groundwater, surface water and wastewater samples were obtained from areas adjacent to a coal fired 1080 MW power station. Water quality as assessed by chemical analysis was used to determine the effect of fly ash residues on the environment. The effect of indiscriminate and unplanned disposal of fly ash in dry or wet slurry form on groundwater was related to the distance of the abstraction point from the point of disposal. Turbidity, silica and oil and grease levels were higher. Surface waters showed increased turbidity at the abstraction point. This turbidity clogged filter sand in water treatment works. -India- ; ~Journal Paper- ; -Case Study-

$[0mU. S. Atom. Energy Commn, TID-24951, 1969. 63 pp.; Nucl. Sci-. Abstr. 1969, 23, 3002.
An ecological study of south Biscayne bay in the vicinity of Turkey Point.
R. G. BADER
Studies are being carried out in Biscayne bay, Fla., to assess the effects of increasing amounts of heated effluents near Turkey Point, where 2 conventional electric generating units are now in operation and 2 nuclear units will shortly come into use. Some deterioration in environmental conditions has occurred in the immediate vicinity of the discharge, but there are areas of the bay where there are no changes in temperature or biota.

Marine Pollution Bulletin, 1991, 22, No.7, 334-339.
'Oyster-watch' for monitoring coal ash lagoons in an $[1menvironmentally$[0m sensitive area of Hong Kong.
A. ASHTON (China Light and Power Company).
The $[1menvironmental$[0m $[1massessment$[0m and planning stage of a project to install lagoons for the disposal of coal ash from the Castle Peak Power Station (one of the largest coal fired installations in the world), in Deep bay, in the western New Territories of Hong Kong, and the Mai Po marshes nature reserve, are described. The 3 adjoining lagoons (West, Middle and East sites), situated at Tsang Tsui on the mouth of the Bay, had an estimated total capacity of 7.5 million m3 covering nearly 1 km2. Ash was transported as a seawater slurry to the lagoons through an underground pipeline and supernatant seawater was returned by a second underground pipeline to the power station for $[1mdischarge$[0m to an open body of tidal water in the vicinity rather than into the bay. A grout-filled geo-textile mattress had been incorporated into the rubble-filled outer seawalls at the design stage to reduce permeability. Results of a monitoring survey using the Pacific oyster (~Crassostrea gigas~), the commercially cultivated species in Deep Bay, for 6 months prior to commencement of lagoon filling, in 1987, followed by nearly 3 years of regular monitoring up to December 1989, indicated no detectable changes in concentrations of selenium, arsenic, zinc, cadmium, lead, copper and chromium at any of the monitored sites after ash deposition began. The necessity for monitoring the $[1menvironmental$[0m effects of current and projected developments in the area is emphasized. -Hong Kong- ; -Journal Paper- ; -Case Study- ; Pb

Oil refineries/oil exploration

$[0mProc. R. Soc., B, 1971. 177, 275-468.
A discussion on biological effects of pollution in the sea.
At this discussion, arranged by the Royal Society Marine Pollution Study Group and held in April 1970, 15 papers were presented dealing with methods for assessing the effects of pollution and the toxicity and maximal- permissible concentrations of wastes in the aquatic environment; sub-lethal effects of pollution and changes in ecosystems; studies on the effects of pesticides, sewage, heated discharges, mercury and other heavy metals, oils and oil-dispersants, and radioactive wastes on the marine environment; and the monitoring, control, and study of this pollution. MINERAL OIL

$[0mBulletin of Environmental Contamination and Toxicology,
Discharge of alkanes during offshore oil production in the Bucaneer oilfield.
B. S. MIDDLEDITCH , B. BASILE , and E. S. CHANG.
The quantities and types of alkanes in brine discharged during routine production in an isolated oilfield, in the Gulf of Mexico, have been determined to assess their environmental impact. The survey showed that the mean concentration of C12-C36 alkanes was approximately 2 ppm and the mean rate of discharge of alkanes was 191 g per day. Further work is suggested on dispersion rates, pool size around the production platforms and their relevance to biogenically produced alkanes. (REF CONTD)1978, 20, No.1, 59-65. -U.S.A.-

$[0mGWF-Wasser/Abwasser, 1984, 125, No.8, 366-373 (in German, English summary).
Removal of subsurface hydrocarbon contamination by microbial decomposition.
G. BATTERMAN and P. WERNER .
Following accidental spills or leakage of heating oil and other hydrocarbons from storage tanks, subsequent pumping and flushing operations to remove the contaminant from the underground environment are necessary. These measures were applied following an oil spill in the upper Rhine catchment, but enough mineral oil remained in the soil to occupy some 5 per cent of the pore volume. Owing to the proximity of abstraction wells for water supply, various methods of eliminating this residual contamination were assessed. Finally, a recirculation system was installed in which abstraction and injection boreholes were connected via a supply tank and a pressure filter. The evacuated water was sprayed into the tank to remove methane and dissolved gases and dosed with nitrate (500 mg per l) as an oxygen donor, plus small amounts of ammonia and orthophosphate, to assist the growth of hydrocarbon-decomposing organics in the soil. Theoretically 3.3 mg of nitrate were needed to eliminate 1 mg of hydrocarbon. During a recirculation period of 300 days, roughly 50 tons of nitrate were consumed, equivalent to 16.6 tons of hydrocarbon. By warming the injection water and installing another well , the removal rate was increased to 75 kg per day, in addition to which quantities of unchanged hydrocarbon were separated out by the filter in the circuit. Arrangements for continuous monitoring of circulated water quality are outlined. (Full translation £70)
Environment Canada, Ottawa, Ont., Report EPS 1/PN/1, 1987. 151 pp. (41197).
Environmental status report for the Canadian petroleum refining industry 1983-1984. M. L. GEADAH (Environment Canada).
The level of gaseous, liquid and solid waste discharges from Canadian oil refineries and petroleum installations is reviewed in detail, and the adequacy of existing treatment facilities and the degree of compliance with Effluent Regulations and Guidelines for the years 1983 and 1984 are assessed. The survey covered 36 refineries of which two were not assessed because no discharges were

made to the environment during the period in question. Of the remaining 34, 12 complied with all the limits for over 99 per cent of the time, and 5 for 95-99 per cent odf the time. Reasons for non-compliance among the remainder were examined. The study concluded that a properly operated and well-maintained biological treatment system could remove organic priority pollutants from the effluent, while most metals were concentrted in the sludge. -Canada-Case Study-

Environment Canada, Ottawa, Report EPS 1/PN/3, 1990. 105pp.
Environmental status report for the Canadian petroleum refining industry 1987.
L. LOSIER (Environment Canada, Ottawa, Ont.).
This is a comprehensive review of the liquid wastes and the pollution control methods of the Canadian petroleum refining industry. Federal and provincial effluent requirements are presented and the state of the industry's compliance is $[1massessed$[0m. Effluent qualities continued to improve and under good operating conditions the wastewater treatment systems at existing refineries should meet the limits in existing regulations and $[1mguidelines$[0m. Usually when these were exceeded it was due to overloading or mechanical deficiencies. However, it was recommended that federal effluent regulations and $[1mguidelines$[0m should be reviewed and updated. -Canada- -Report- -Review-

$[0mHelgolander Meeresuntersuchungen, 1980, 33, 246-256.
Methodology for environmental assessment of oil and hazardous substance spills.
W.P. DAVIS (U.S. EPA), G.I. SCOTT, C.D.GETTER, M.O. HAYES, and E.R. GUNDLACH.
An integrated zonal method for assessment of the ecological impact of oil spills is proposed which utilizes a team of 3-4 people (geologists and biologists) who undertake geological mapping and quantitative biological surveys within the affected area defining the nature of the ecosystem and the extent of penetration of the oil. The immediate survey is followed by regular monitoring at prescribed intervals to evaluate chronic effects. The scope of the method and its application in practice are described with reference to the Peck Slip oil spill off the northeast coast of Puerto Rico and the attendant pollution of mangrove forests along the coast. In addition the concept of a vulnerability index is developed as an aid to pre-spill contingency planning and some examples of its application are given, especially in the Cook Inlet portion of the southern Alaskan coastline. -U.S.A.-

$[0mEnvironmental Science and Technology, 1982, 16, No.8, 454A-472A.
The environmental implications of offshore oil and gas activities.
C. A. MENZIE, (EG & G Environmental Consultants, Mass.).
The various quantities and types of discharges associated with offshore oil and gas operations are summarized and the monitoring requirements with each type of discharge are described. Laboratory and field studies of these discharges or of particular components are reviewed and the implications of these studies in terms of future monitoring purposes, are considered. Information has been generated on the chemical content of discharges and there is evidence of limited accumulation in sediments around drilling and production platforms and of bioaccumulation within organisms. It is suggested that hydrocarbon fractions most likely to cause toxic effects in marine organisms are the low- and high molecular weight aromatics. A number of biological effects of offshore drilling operations are reported, including reduced macrobenthic abundance and species composition, though some sublethal effects have not been fully documented. A programme is to be initiated to assess the effects at areas removed from the immediate vicinity of the platforms. -U.S.A.-